

NASA JOHNSON SPACE CENTER ORAL HISTORY PROJECT

ORAL HISTORY TRANSCRIPT

STEVEN R. NAGEL
INTERVIEWED BY JENNIFER ROSS-NAZZAL
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ROSS-NAZZAL: Today is December 20, 2002. This oral history with Steven R. Nagel 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 this morning. We really appreciate it.

NAGEL: Thank you. It's good to be here.

ROSS-NAZZAL: Great. I'd like to start out with a background question. Can you tell us about how you became interested in aviation?

NAGEL: Yes. That was easy. That was through my father. From the time I was—before I was born, he had an airplane, a small airplane, a Piper Cub, if you have ever heard of that. It was the popular light airplane back in the 1940s and '50s. I think he actually took me flying in it when I was an infant, but then shortly after that—the airplane was covered with fabric, and it had to be rebuilt, recovered, so he tore it apart and had it in the garage. So my earliest memories of that airplane was it was just sitting in our garage in pieces.

He then, in conjunction with that project, remodeled our house. So it took a few years, and by the time I was about eight years old, he had the airplane running again, got it flying, and I flew with him all the time. And so he really is the one who taught me to fly, even though he wasn't a certified instructor. And then later, I flew with an instructor and soloed on my sixteenth birthday which is the earliest you can. So I had this from the very beginning.

And along with that, about the time I was in high school, is when the space program started, when the Mercury astronauts were selected, and I kind of got swept along with this wave, along with everybody else, with the emphasis on math and science, which were my favorite subjects anyway in school. And that in conjunction with my interest in flying kind of steered me down that path. So it all started with my parents, and particularly with my father.

ROSS-NAZZAL: So had you always wanted to be an astronaut?

NAGEL: Since high school. I mean, since there were no astronauts till 1959, and that's about the time I was getting out of junior high and into high school. So from that time on, yes, but it was such a long shot, I didn't talk to people about it. I've always been interested in aviation, so at the very least I wanted to go in the military and fly jets, and that was a long shot. Even that seemed to be a long shot. So the astronaut thing was totally almost ridiculous to think about. But, yes, I was thinking about it.

ROSS-NAZZAL: Why don't you tell us about your career with the Air Force.

NAGEL: I applied to the Air Force Academy [Colorado Springs, Colorado] actually, first, just to jump back one step, and didn't get accepted. I got an alternate position. So my second choice turned out to be a real good one, which was to go to the state university of my state, Illinois, University of Illinois [at Urbana-Champaign, Urbana, Illinois]. They've got a good engineering program. So I enrolled in ROTC [Reserve Officers' Training Corps]. So I did the ROTC and engineering thing, got my commission on graduation and went into the Air Force, and I graduated in January, I guess, of '69, midterm. I went one extra semester. Then went right into the Air Force right after that.

Like today it's different. The military is much smaller. That was at the time Southeast

Asia was rolling along. So the people pipeline was wide open, so the classes were big in pilot training, and it was pretty easy to get in, actually, to be honest.

So I went straight to pilot training at Laredo [Air Force Base] Texas, and out of there to—my first assignment was an airplane called the F-100 [Super] Sabre. I had to train for six months at Phoenix, Luke Air Force Base in Phoenix [Arizona]. And then—am I jumping ahead of your question here, rolling into my whole life story here? But anyway, I did [not] go to Southeast Asia in that airplane. They were all coming home by that time. Things were winding down. So I wound up going to Louisiana for a year and then over to Southeast Asia after that.

ROSS-NAZZAL: So how did you become involved with NASA? Did any of your supervisors, for instance, recommend that you apply for the astronaut program?

NAGEL: No, no. It's just something I wanted to do. I mean, lots of us wanted to do that. I even naively, when I was getting out of pilot training, I was high enough in my class I had some choices of what kind of airplane I flew, and I wrote to somebody at NASA. I don't remember who. I got a name from somebody, asking them what kind of airplane I should take. That was a dumb question. They couldn't have told me. Nobody answered me anyway. So I was thinking about it back then.

And then, see, the last hiring before the first Shuttle astronauts was in 1969 of astronauts, 1969 to '78. There was almost a ten-year gap there. So I was right in the middle of that ten-year gap. I kind of didn't forget about it, but I put it on the back burner for a while. It seemed like it probably just wasn't going to happen.

But I wanted to continue my career along the path that would make me competitive for that, which means going to test pilot school and getting into flight testing, because even if I never came to NASA, that was very interesting to me. The NASA thing aside, "This is a great way to go, and this is what I want to do."

And then it so happened at the time I was out at Edwards Air Force Base [California] from '75 to '78, that's when the *Enterprise* was flying. So all that was cranking up.

Then another thing happened to me, which was almost too much of a coincidence, but I had flown A-7s in the Air Force, it's a Corsair. It's a single-engine jet. So I got to Edwards, and they had A-7s there, but they told me they had plenty of people to fly and didn't need me to fly them. So, fine, that's okay. And then later they did. So they said, "Okay. We need to check you out in the A-7."

"Fine. Okay. I'll fly it."

There was one A-7 in particular that was kind of a testbed airplane out there. It had a different flight control system in it. It used some digital technology in the flight control system. It was kind of a test airplane. And the test pilot school was going to use it. A person in my squadron who had been flying it had left on another assignment. He was gone. And the astronauts who were involved in the early Shuttle flights, some of them wanted to fly this airplane. And I was the only one around, as it turned out, to check them out in the airplane. So I gave them a little ground school, and I flew them in the airplane, and I didn't ask for that. I just kind of happened to be there. It's a single-seat airplane, so I had to give them a ground school, and then you can't get in [it] with [them]. You chase them in another airplane. So it's really—it's a good deal for them. They really liked it. But I checked out Fred [W.] Haise, [C.] Gordon Fullerton, Joe [H.] Engle, Dick [Richard H.] Truly, and Vance [D.] Brand. All five of them, I flew them in this airplane.

I mean, it was just fortuitous for me, because when it came time, when I applied, I didn't go ask them for any special favors, but they knew me. So it just happened at the right time in my life. I had no control over that. I looked at myself compared to the other people who applied, other pilots who applied at the same time. I think I was probably competitive, but I don't think I stood out in the group. Probably that one thing allowed me to be known to some of the people down here, and it was just my good fortune at that period of time, because I had done that with

them—when did I fly them? About one year before I interviewed.

ROSS-NAZZAL: What a great connection.

NAGEL: Yes, I know. So that's probably why I'm here. I don't know.

ROSS-NAZZAL: How did you find out that they were selecting the group of '78?

NAGEL: Oh, it's well known. A community like Edwards Air Force Base, all these test pilots, all these people that want to be in the space program. I mean, the word travels fast. So it's just through the grapevine initially, the fact that, "Okay. NASA is going to be hiring the first group of Shuttle astronauts."

Actually, also, the commander of the test center out there at that time was [Thomas P.] Stafford. General Stafford had come from NASA back to the Air Force. He was the commander of the flight test [center], the whole base, the whole center. So he had a big mass meeting one meeting at the O Club, Officers' Club. He said, "Hey, anybody wants to talk about the space program, come on over," and they packed the place. We were all sitting there listening to him talking a little bit about his experiences and the upcoming Shuttle Program.

So everybody was—almost everybody was very motivated. And then, of course, then there's the official part of it where you had to actually fill out the paperwork. In the military you don't apply directly to NASA; you apply through your parent service, so you had to apply through the Air Force. The Air Force actually screened all those applications and didn't send all of them forward. You had to make two screenings through the military or one for the military and then another through NASA to get down here for an interview.

ROSS-NAZZAL: You actually made it, and you went through an interview. Can you tell us about

the interview that you went through, what it was like?

NAGEL: Yes, it was a week long. Did that in the fall of '77. I was not in the first group that got picked. I don't think we went alphabetical. I forget now how they did it, but—maybe they did. But it was kind of funny, because the first ones from Edwards that went down there for the interview would come back and give us feedback on what happened. The first group came back, and those guys said, "Oh, the interview was very easy. All we did was kind of like this. We just talked about ourselves. It was very easy. There was nothing to it."

Then the next group came back, and they said, "Oh, it was awful. All they asked us about was current events." So everybody was running out and buying *Time* magazine, reading up on the current events. And by the time I got there, I forget how large the group is, but you come in on a Sunday night and meet us over at the—what's the name of the hotel? It's a different name over there, NASA Road 1 now. And John [W.] Young came over, I believe. Maybe George [W. S.] Abbey was with him. I forget now. But gave us a little briefing, and then you start the week, which consisted of a screening physical exam that takes a good part of that week, scheduled through the week, and a psychological exam, and then tours, orientation tours and briefing.

I think all of us came back from that just chomping at the bit, wanting to get down here. You don't want to get your hopes up, but once you've seen the place, you really would like to come here. So it was a great week. It was a very interesting week.

ROSS-NAZZAL: So when did you officially find out, and how did you find out that you had been selected?

NAGEL: We interviewed through the fall of 1977 for my group, and then we were going to find out—they said we were going to find out before Christmas, but that didn't happen. There were

delays, there's always delays announcing these things, and it was after the first of the year. It was January of '78. And it's always a phone call, and Mr. Abbey would always call those who got selected. I think somebody else on the board had to call those who didn't get selected. I didn't know it at the time.

But it was fairly early on a weekday morning, and he called my house, the typical low-key thing. He says, "Well, do you still want to come to work for NASA?"

I said, "Yeah, sure. Yes, sir. Yes, sir."

That was in January. And my group—I don't think they ever did this since then. They called us in January, and we weren't coming to work till July. They brought us down for an orientation in February, I believe, of that year. I think we all came down, I think, for a week, house-hunted, did an orientation and everything, and then went back home and came back late June, early July of that year. I don't think any group has ever done that since. They probably decided they didn't need to do that anymore. But that was kind of the time frame. The interviewing was all done the year before, the summer and fall of '77, and then the announcement in January of '78, and come to work in July of '78.

ROSS-NAZZAL: What did your family think when they heard you were going to be an astronaut?

NAGEL: My wife was—I didn't have any kids at the time, and she was happy, real happy, thought it was a neat thing.

ROSS-NAZZAL: Was your father still alive at that time?

NAGEL: Yes, my parents are still alive now. He's now ninety, which is a good thing. I mean, it's wonderful that he has lived to have seen all this happen. Some people, like another one of my class members, his father passed away before his first Shuttle flight. I always thought what a

shame, at least his father didn't get to see any of that. But, no, my parents have lived right on through all this.

ROSS-NAZZAL: Were they excited when they heard the news?

NAGEL: Oh, yes. Yes. Of course, I'm from a small town. So that's a bigger deal, I think, in a small town than if you're from Chicago or somewhere.

ROSS-NAZZAL: Why don't you tell us about your training and your assignments when you first came down to the [NASA Lyndon B. Johnson] Space Center.

NAGEL: Let's see. This has been a long time ago, so the memories aren't too fresh anymore. But I do remember one of the first days at work going to Building 1, the ninth floor, big conference room up there, 966, with Dr. Kraft, Chris [Christopher C.] Kraft briefed us, our group. It was kind of a big deal for our group, because we were the first group of Shuttle astronauts. It marked a big change in the program. The Astronaut Office, if I've got my numbers right, there were twenty-six or twenty-seven astronauts prior to our group. That's how small that office was. My group was thirty-five, so we more than doubled the size of the astronauts, plus the first women, first minorities, everything. So it was just a huge change. But it was very well accepted, and as far as I could tell, there never was any problem.

Dr. Kraft was really nice to us, gave us a good briefing, and I just remember him saying, "The important thing is you have fun while you're here," which I did. He said, "Work hard, but have fun at it, too."

I think they wanted us to have a two-year candidacy period. I believe that's how they stated it initially, but I believe they just figured they'd done everything they wanted to us with us after a year and declared it over. Subsequent classes, I think, had a one-year candidacy period

for a long time. Now I think they're back to two because there's so much to train everybody on with the Shuttle and the Station.

But anyway, we had a one-year candidacy, and I can't remember all of it, but a lot of it was general classes and science—I call them gentlemen's classes. No testing, just have geology class or astronomy class. You just go in and have great people come in and lecture you, but at a real top level. It's real interesting. They were really good classes. And then basic Shuttle systems and spacecraft design. Had a lot of people talk to us who actually designed this thing and were experts on the systems. So we did all that.

We took a couple of field trips. We went on one en masse out to the West Coast where I think we went to NASA Ames [Research Center, Moffett Field, California] and down to [NASA] Dryden [Flight Research Center, Edwards, California] and saw all that, and we took another one to Kennedy [Space Center, Florida]. Then much later there was another field trip up to [NASA Lewis Research Center] Cleveland [Ohio] which I didn't go on. I think I had a conflict or something. What else did we do?

Our class was big enough it was divided into two groups. They couldn't handle us all for the academics and all the stuff they wanted to do without breaking us in half, so there was a red and a blue group. I think I was in the red group. I can't remember now.

So you're pretty close with your classmates when you're going through something like that. It's like a school, schoolhouse or something. Then later you kind of get broken up into different assignments. But all that lasted a year. And then there was no formal graduation, just kind of said, "We're done. You're eligible for technical assignments, PRs [public relations]."

Nobody was going to get a crew assignment at that time. I mean, the Shuttle hadn't flown yet, so everything—it was a totally different climate. Everything was focused on STS-1, totally, getting the Shuttle to fly, and that's all anybody thought about. So I got out of that in '79, the training in '79. It was two more years before the Shuttle flew, almost.

ROSS-NAZZAL: What were some of your assignments until STS-1 flew?

NAGEL: First one was software. They'd assign somebody to chase, follow the software changes that were being made, go to the control boards and things like that. Now, [Robert L.] Crippen was the real guru on the software. He was very smart, and he knew the software inside and out. So I think I was one of the lower ones down the pecking order on that, but I did the—tracking the software changes, being the person that speaks for the crew point of view on whether you agree with the change or you don't, or you think this or that ought to be done. That kind of thing. It gets you to know the software and also the process, the board process and everything. That's how NASA operates, these big boards, approval. It looks cumbersome, but it's the right way to do it. You need strict configuration control on everything.

So I did that, and then the next thing I did, I think it was just some months later, I got assigned to SAIL. Do you know what that is? The Shuttle Avionics Integration Lab, which is over in Building 16, and I worked there for a couple of years almost up to STS-1. I think I did that in conjunction with the software job. Actually I think I was doing both, as I recall, but I'm not sure now.

SAIL is just shift work. They were on three-shifts at that time, first, second, and third shift. Sometimes you pulled third shift, midnight to eight. You're running the simulator, flying the simulator, doing test cases, so it's not like training. They're actually verifying the flight software that's going to fly. SAIL is one step beyond a simulator. It has all the real black boxes the Shuttle has, all the real cable runs, the same length and everything. It's got a full payload bay and avionics back where the tail of the Shuttle would be, so that's all real Shuttle, but then you've got to have computers to simulate the environment that it would be flying in. It was an interesting time to be there, because there were problems with the software and the computers. We were crashing a lot. I wondered, "Is it going to work?"

There were three big things in the Shuttle that were big challenges were the computer

technology, the five computers that run together, and the software to synchronize all that to make it work. The other thing was the main engines, the liquid [fueled] engines; then the third was the tile, thermal tile.

But as far as the computers and the software, it all started coming together, in my mind, in SAIL, anyway, about nine months before the launch. These [runs started] working out real well by the time it flew. I knew that part would work.

ROSS-NAZZAL: Did you enjoy working at SAIL?

NAGEL: Yes, I liked it. I mean, it was kind of dog work. I think the average number of formal, what you call formal runs per day, was .7, or maybe it was per shift. I don't know. So [it's] not like [you're running a lot], there [was] a lot of preparation time for each run. Then you make the run, then there's a lot of time afterwards. So things moved pretty slowly, but you really got to know, from a personal standpoint, you really got to know the software and how it all played together with the avionics there. You learned a lot. It just took a long time to learn it. But, yes, we were doing good work there. It was a good place to work. I wound up working there three times, so three different assignments. I think I paid my dues in SAIL.

ROSS-NAZZAL: Finally, STS-1 went up, and you were actually the backup chase plane pilot. What were some of your duties as the backup?

NAGEL: I didn't get involved until shortly before STS-1, because by that time, actually, I been asked to be on the support crew for the second Shuttle flight, Engle and Truly. So I was doing that, and then got put on in addition—I think I must have been out—yes, I was out of SAIL by that time. We trained to chase, to rendezvous and chase the Shuttle down. Figured on the first few flights that you want to—kind of like flight testing. You always do. You want an airplane

to be able to join up on them, look them over for any damage for the entry. I mean, there's not much you can do. He's going to land anyway. But then give him a quick comparison of air speed and altitude to make sure that his indications are correct. It's the first flight.

So we had this big cadre of chase airplanes. There were several out at Edwards Air Force Base, where it was going to land. I don't think we had anything in Florida [Kennedy Space Center], but Northrup Strip in [White Sands Missile Range] New Mexico was an abort once-around site. So if you go once around the world, they wanted to land at Northrup. So I wound up being there with Shannon [W.] Lucid, and all we did that morning was we got up, flew pretty early morning in the dark, flew up there and checked the weather as best you could see it, and came back and landed, and then watched the launch on TV.

Had they come into Northrup, we would have taken off and we would have chased them, but the chance of them coming there was very low. So we just watched the flight. We watched the launch from the TV there sitting at El Paso, and then later that day, I guess—did I stay the whole mission? I can't remember now. Maybe I had to stay the whole mission in case they would have landed there, because—I probably did, because Northrup was what you call under-burn site. In case of de-orbit burn cutoff early, it'd overshoot Edwards there. There was a slim chance they could wind up at Northrup. I think I probably stayed there the whole mission because it was only two days long, and then came home after that. So it was a great time. It was quite a mission, the first Shuttle mission. It was incredible.

ROSS-NAZZAL: What were your thoughts when you saw the Shuttle finally lift off?

NAGEL: I had my fingers crossed that it all keeps working. Once it lifts off, it's got a long ways to go before it's in space. It worked amazingly well on its first flight. They had some glitches, but nothing serious. That's incredible for something that complicated, and you put people in it the first time. Those guys were really sticking their necks out flying that thing. That's probably

one of the most hazardous first flights of anything, ever. It really was. My hat's off to John and "Crip".

ROSS-NAZZAL: You had also mentioned that you worked for the support crew of STS-2, that you had actually started before you were assigned to STS-1. Why don't you tell us about your duties as a support crew member.

NAGEL: You're a gofer, actually. It's a great job, but I don't want to make more of it than it is. It was honor to be picked by—Joe and Dick asked Terry [J.] Hart and myself, I think we were the two. I don't think there were any others. But we hang out with the crew, we're their eyes and ears, and they would parcel out duties to each of us to follow, so we can go to the meetings that they can't go to when they're in the simulator, and be their voice, and give them feedback.

One thing I worked on that's near and dear to them, of course, especially Joe being the test pilot he is, the early Shuttle flights had flight test maneuvers on the reentry to learn the characteristics of the airplane. He was big into that, of course, and he assigned me to be his person to follow that, which I wound up doing for that. I wound up being the support crew for the third flight also for [Jack R.] Lousma and Fullerton, I'm pretty sure. Yes, I was working for them. So I worked on the entry flight test maneuvers for both those flights, for those guys. I'm not the one that designed them; I'm the one that gave the crew input. I actually wound up having some of those same flight test maneuvers on flights I was on later. They were still doing them.

ROSS-NAZZAL: So you designed the flight test or did you actually test them in the STA [Shuttle Training Aircraft]?

NAGEL: No, we tested them in the simulator. We didn't actually design the flight test maneuvers. The engineers would do that, and then we'd fly them in the simulator. Most of them

are automatic. You turn them on, and the computer does some—others are manual, and the manuals, you say, “Well, is this practical for this point in the entry?” and everything like that. So you’re always looking at it from a crew member standpoint. “What’s the workload like? Does this work out okay? Is there a better way to do it?” That kind of thing.

ROSS-NAZZAL: One of your duties on STS-2 was to act as a CapCom [Capsule Communicator], and you were actually the backup entry CapCom. Can you tell us about your duties there?

NAGEL: I just was sitting next to Rick [Frederick H.] Hauck, who was the entry CapCom. I was trying to think of who—we had it different in those days. Nowadays there is a flight control team that works both ascent and entry, and then you have your orbit teams. Then, they had a separate team for ascent, a separate team for entry, and a separate team for orbit. So I was on the entry team with Rick. I don’t know if I ever really even talked on the radio to the Shuttle. I think I just rode sidesaddle with him, was learning from him on that one and assisting him. So that then on the third flight I did it; I was the CapCom. And I only did it for one flight. Nowadays these guys go over for assignment and the Shuttle flies often enough that they’ll do several flights while they’re working over there a couple years. I wound up being there just for two flights, but there was a longer time between flights then. Really, I don’t remember much about STS-2 except that I was kind of Rick’s assistant and learning from him. It was like OJT [On-the-Job Training].

ROSS-NAZZAL: Okay. What about STS-3? There actually was a landing made at White Sands.

NAGEL: Right.

ROSS-NAZZAL: Is that something that you simulated as a CapCom?

NAGEL: We did, yes, late on, because what happened was—let's see. That flight was in March, and that's the rainy season out in California, and the lakebed was flooded at Edwards, and they weren't landing on concrete runways yet. There was even some consideration of landing at Kennedy, but they weren't quite ready for that. So the program decided this fairly late on—I don't know, a couple weeks before the mission or maybe three weeks. I'm not sure. Said, "Hey, we'll land it at Northrup," and they actually were taking trainloads of support equipment from Edwards to Northrup.

They got all that set up, so when they launched, they intended to land at Northrup strip, which they did. That was a fairly long flight. The first Shuttle flight was two days long. The second flight was shortened. It was supposed to be five days. It was shortened down to two and a half because of that fuel cell problem. But Jack and "Gordo's" flight was like eight or nine days long, I believe. It went around one extra day for weather, because they were going to come in and land, and had a windstorm at White Sands. And then the day they did land, it was still a windy day when they landed, and a windstorm developed, a dust storm after they landed. So I think the managers never want to go back to White Sands again, because it's got this real fine-grain gypsum sand that got everywhere inside the *Columbia*. They said if you had your car parked out there with the windows up, there'd be sand inside the car. It was pushing past the seals and everything, it was so windy, and the sand is so fine.

But it was a fine place to land. It's where we [train] all the time in the Shuttle Training Airplanes. I've landed on those runways [in] airplanes. They're very nice. It really wasn't a big issue landing the Shuttle there.

ROSS-NAZZAL: Did you have any specific duties as CapCom during that mission?

NAGEL: I was the entry CapCom, so we came in, worked the entry, checking the weather, and all

the duties for talking to them during the entry. It was an exciting mission.

ROSS-NAZZAL: You finally got assigned to a mission, STS 51-G. When did you learn about this?

NAGEL: Oh, I'm trying to remember now. I think it was like in the summer or so of '83, I think it was. And it wasn't called 51-G then. I was assigned to 51-D, I believe was the first—there were so many changes on that assignment. I've lost track, actually, but I think we had a TDRS [Tracking and Data Relay] Satellite first. We were going to start training for a TDRS satellite. There was so much turmoil in the manifest at that time, there was just no stability at all. The crew assigned was Dan [Daniel C.] Brandenstein, John [O.] Creighton, John [M.] Fabian, and myself and Shannon Lucid. And we had two payload specialists, I think, with us from the beginning, was Greg [Gregory] Jarvis and Charlie [Charles D.] Walker. I think they were assigned with us from the beginning.

The TDRS, at some point in time that flight changed to be LDEF retrieve. Do you remember what that was? The Long Duration Exposure Facility. So we trained for that one with those two PSs [Payload Specialists], right up to—this is kind of funny, because we did our preflight press conference, which we're talking like a month or less, three to four weeks before the flight. We did our preflight press conference about the LDEF [retrieve], walked back to the Astronaut Office, and we didn't have the flight anymore. It was gone.

And so we're shuffling, and I can't remember the reasons for all this. But anyway, okay, so we're shuffling again. This is like March of '85 by that time. Dan, I owe Dan a lot. He is a real people person, and before I even thought about it—I'm jumping ahead here. Sorry. But somewhere in that process when I was training for 51-G, Mr. Abbey assigned me to another flight. So I had two flights going. He assigned me to 61-A, a German Spacelab flight. Great, as a pilot. And the two flights were sitting about a year apart or so. The spacing was nice.

Well, 51-D, then G, just kept slipping, and the other one didn't. So we just kept crowding the other flight, so when we got back from this press conference and lost our flight, and now we're going to be in the summer, now those two flights are like four months apart. Before I even thought about that, I wasn't even thinking about it yet, Dan said, "You're in trouble here."

So he went over and talked to Mr. Abbey about it that day, and negotiated for me to stay on both flights, that I could train for both for a while, then stop training for the second one, finish out the first one. I don't think they'd ever do that today. So I owe Dan—the fact that I was able to hang on to both of those. That worked out nicely.

So anyway, then we pick up two other PSs. Just because of change in flights, we lost Greg and Charlie, and we picked up Sultan and Patrick [Baudry]. Sultan [Salman] Al-Saud. There's a "Bin" with a lot of other names in the middle. I can't remember. [Laughs]

And so that whole experience was funny, too, because a different mission—okay. Here it is March. We're going to fly in June. It's a different mission. We had different satellites. We've got all this other stuff to train for, and now we've got two other PSs, and one is from Saudi Arabia. And Dan, again, being the people person he is, is worried about a cultural gap. So he arranged for ARAMCO, Arab American Oil Company, to come down and give us some briefings on the cultural differences.

This is humorous. I remember they were good briefings, very good briefings. But I remember he says, "No camel jokes. No harem jokes. Don't do that around them." So after all that, we go over and we meet Sultan over in Building 32 there, and the first thing he told us was a camel joke and a harem joke. [Laughter] He had gone to school at the University of Denver [Denver, Colorado] he'd been around the world. I mean, he was more western in some ways, anyway, than most of us. Very well educated. Really nice guy.

He gets with Dan. All of us were sitting around the table, and he said—we don't even know each other yet, and he said, "I want to fly a camel." And Dan thought he said "camera."

And Dan said, “No, no, it’s okay. NASA provides all the cameras. You don’t need to bring your own camera.”

He said, “No, I want to fly a camel, so I can have the fastest camel in the world.”

There’s camel races over in Saudi Arabia. It’s a really big deal. It’s a national thing. So that’s how Sultan was. He was a funny guy.

Patrick was a test pilot from France, and he was fine. So we all got along fine. We had a very short time to train together, just two to three months at the most, and we flew. We picked up 51-G as a mission that had belonged to Joe Engle and his crew, and we got that mission and flew it.

ROSS-NAZZAL: Why don’t you talk to us about the training. Once you got a new payload, within a few months, you were about to launch. Tell us about that.

NAGEL: See, it had three satellites in it that were PAMs, payload assist module. John Fabian had already done that on a mission, so he was well experienced in that. So that wasn’t that hard for him to do, to train. So he was the primary person on that. You divide all this up. No one person knows it all or does it all, or is the expert on all that. So John did that.

There was the first flight of the SPARTAN [Shuttle Pointed Autonomous Research Tool for Astronomy], the little satellite that you grapple. It was an in-house project that you can put different scientific payloads, and this had a little telescope in it, so it was the first flight of the SPARTAN, but I mean Dan had already trained. We, as a crew, had already trained to do the rendezvous and everything, so to release the SPARTAN to fly away from us, it’s not hard to come back and rendezvous. It’s very similar to the rendezvous you train for the LDEF. So it’s not like you start from scratch; you’ve just got to learn some differences. So it was a lot to do, but it wasn’t that difficult, either.

I guess we must have picked up new mid-deck experiments. We had to learn some things

like that. It was a crunch, but it was very doable. It wasn't that bad. So we flew in June, mid June of '85, 1985.

ROSS-NAZZAL: You were actually selected as a pilot-astronaut, but on this mission you served as a mission specialist. Can you talk to us about how you were selected? Did George Abbey talk to you about this?

NAGEL: No. I think what happened, he didn't explain it, and I didn't ask. To be honest, I really wanted to fly as a pilot, so at the time, because there was no explanation that went with it, I wondered, "Are they telling me I'm not good enough to fly as a pilot?" Nothing against mission specialists. I'd trade my pilot's slot to go be a mission specialist and do an EVA [Extravehicular Activity], certainly, but it's just that "What are they trying to tell me here?"

But I think what it really was, our class was very large, and they're getting down to the point where I think George probably wanted to get us all flown, and this was a way to do it a little quicker, and he flew [S.] Dave Griggs and myself as mission specialists, and we just happened to be the first two that that happened to. Dave actually flew before I did. He got to do an EVA actually out of that, unscheduled EVA.

But we were not the last. I mean, since then there have been quite a few pilots that were flown as mission specialists. Charlie [Charles J.] Precourt flew with me on my last flight, his first as an MS [Mission Specialist]-2. So it's not a bad deal, and it turned out to be a real good deal. I got EVA training out of it, even though we didn't have a planned EVA, so for me it was just fine. But I think—nobody ever told me—I think it was just to get our group flown quicker.

At the time Mr. Abbey assigned me that, he did reassure me, he said, "We hired you as a pilot, and I'm going to fly you, turn you around real quick as a pilot." I don't think he had any idea in his mind how quick he was going to turn me around as a pilot between those two flights, because it came real fast, as it turned out. So he held to his word on that.

ROSS-NAZZAL: Did you have to participate in any sort of extra training since you had been trained as a pilot-astronaut? Was there anything in the AsCan [Astronaut Candidate] training that you felt you had missed that you had to cover again?

NAGEL: For what?

ROSS-NAZZAL: For training as a mission specialist.

NAGEL: No. The MS-2 is like the flight engineer, and so you learn all the same Shuttle systems that you'd have to learn as the pilot or the commander. So the switch from MS-2 seat to the pilot seat wasn't that hard. It was just that I had all the head knowledge, and now I just had to be able to put it into practice. And I had done a little bit of that, but at a certain point I had stopped training for the second flight, and then I got right back with it after the first flight.

But the missions were totally different. But what I had to learn for the Shuttle systems and all that was almost a one-to-one carryover, except for the Spacelab, and the Spacelab was something totally different, and I had had some classes on it and learned some about it before the first flight, even. Then I had to stop and pick it up and really hit it hard before the second flight. So the Spacelab was a big difference.

ROSS-NAZZAL: You also mentioned that you participated in EVA training. Can you talk to us about training in the WET-F [Weightless Environment Training Facility] for this flight?

NAGEL: Every crew, even if you don't have a planned EVA—nowadays almost every flight has an EVA for the Station, but in those days you did not. But even so, there's contingencies for which you would have to go outside to fix something, either on the PAM cradle that holds the

satellite, if something goes wrong with it, or the Shuttle itself, the payload bay doors, if they have a problem, or some other thing. So we'd get this generic training for that.

So I don't know how many runs I had in the tank. It was John Fabian and I were the two EVA people, and we went probably half a dozen times, at least, into the old WET-F. The new NBL [Neutral Buoyancy Laboratory] was not built then.

It was fun training. It really gave me a lot greater appreciation for what's going on in the suit, with the people in the suit, when later I had a flight that did have a planned EVA on it. So I knew a lot about it. So it was valuable training for me.

John and I were always secretly wishing for some minor problem which would send us outside, but you don't ever want to wish for problems, because it could be a major problem, then it wouldn't be worth it.

ROSS-NAZZAL: Certainly. It can be fun, though, I understand.

Why don't you tell us about the launch. What was going through your mind during launch, and how did you feel?

NAGEL: Let's see. The first one?

ROSS-NAZZAL: For the first mission, yes.

NAGEL: No pressure suits in those days. It was pre-*Challenger*, so we were in our flight suits, and I was on the mid-deck, of course. Let's see. Shannon was up there with me. Yes, that's right. And John Fabian was riding on the mid-deck for the launch. So I had crawled in first, and he crawls in behind. I remember—there are certain memories you have—John said, "Nagel," he says, "you're in for one hell of a ride." [Laughs]

So I just remember on the first launch, because you're sitting behind the two—nowadays

we have videos of launches and you can kind of see this, but I remember the noise and the vibration of seeing Dan and J. O.— it doesn't hurt you or anything, but they're shaking in their seats, really vibrating a lot. I remember that impression. And I remember I just was mentally behind. I think I was left on the launch pad with my mind, trying to keep up with this [thing]. It just all happened so fast. There was such a rush of events, and the sights and the sounds and everything was almost overwhelming. I just was kind of—said, "Okay. I got to get back to work here."

The second flight wasn't that way. I felt much more up with it, mentally up with it. But the first flight is like it was just kind of—the thing was out there racing ahead of me, and I was trying to catch up with it mentally, both on the launch and the reentry, actually. Although I had no flying duties, so I was just helping those guys out in case something went wrong or make sure they did their normal chores. But the launch is really something. It's just such a big thing, and it gets going so fast so quick. It really accelerates.

ROSS-NAZZAL: Once you got up into orbit, you actually worked with a couple of experiments. Can you talk to us about those experiments?

NAGEL: Yes, I'm glad you gave me that sheet, because I forgot about this. This has now been seventeen or more years ago, so that's a long time. But what were they? HPTE [High Precision Tracking Experiment] was one and—

ROSS-NAZZAL: And the Automated Directional Solidification Furnace.

NAGEL: Okay. The furnace was—gosh, I haven't thought about this in years. That wasn't that hard. The furnace, you flip a switch and it runs, to be quite honest with you. It was a pilot's experiment. [Laughter] However, I think it did fail. I think something failed in it later in the

mission. But basically what it had, it's a furnace that would heat whatever the material was in there, a metal, and then allow it to resolidify, and it resolidifies in the absence of gravity, so you get a change in the grain structure of the material. That's in a nutshell what they're looking at.

And there was some kind of mechanism that would translate either the heat source or the metal. I don't know which. It's all sealed inside this can, and you can hear it running in there. I guess I must have had to run it every day several times, but finally, the last time I ran it, it was making a real clunking noise in there, so I always figured something must have failed inside it. But I think overall it was a success. But there wasn't much real hands-on. You turn the switch on, let it run, and hope it works. Kind of like a bread-making machine.

The other one, the HPTE, this is nothing fancy. It was just a mirror that you had to mount in the window, the side hatch window, little circular window about that big, [gestures] and all we were to do was to maneuver the Shuttle so that that side hatch or that window would be pointed at this laser from the island of Maui in Hawaii, that would track us. They said, "Don't look at the laser. It probably won't hurt your eyes, but just don't look."

And the only thing that went wrong there, I mean, it was ridiculously simple, but this was a good example of you should always practice these things in the simulator before you do it, no matter how trivial. It was a late add-on experiment, as I recall. I studied the procedure and said, "We can do that." And so we did it, but we did it wrong the first time, and the way we did it wrong was, the Shuttle has a real great autopilot that can do incredible things, and one of the things it can do is you can take a pointing vector from the Shuttle, say you want the top, but you could take any orientation on it. Say you want something off the top to track a point on the ground, you can do it. You can say, "I want to track the Astrodome in Houston when I fly over it, and I want the top windows to track it," so you load that all in the computer, and it will point at the Astrodome as you fly over it. It will pitch the Shuttle just right to do that. It's a pretty neat feature.

You got to put in the elevation of the object you're tracking on the ground. The

Astrodome would be near sea level, thirty or forty feet above sea level. This mountain in the Hawaiian Islands, it was 10,000 feet tall. I think it was 9,999 feet tall. So we type in “9,999,” loaded it in the autopilot, and you start this maneuver quite a while before you get to the Hawaiian Islands. So Dan loaded it in, and John and I are behind him on the aft flight deck. The Shuttle maneuvers very slowly, and we’re watching it maneuver and saying, “I don’t think this is right,” because it’s slowly maneuvering the side hatch to point up in the sky instead of at the ground. You know, “It’s not going to be pointing at the ground.”

So we fly by the Hawaiian Islands with the side hatch pointing there. And we later learned—I mean, it was our fault, it was my fault, it was my experiment—the units are in nautical miles, not feet. So when we loaded 9,999, the Shuttle said, “Okay. I’m going to point the side hatch at a mountain that’s 9,999 miles high,” which would be way above us. So it was pointing up there at the top of a mountain. It did exactly what it should be doing. Actually, should have practiced in the simulator, but also in the checklist, if you looked on the right page of the checklist, it had what the units were on all these. We just missed it. So they figured it out and we later came back and we put in whatever fraction of a mile that is, one-point-something miles, and it worked great. For the rest of the mission, we took flak from the CapComs about feet versus nautical miles. [Laughs] So it was kind of funny.

ROSS-NAZZAL: Seems like an easy mistake to make.

NAGEL: Yes, but it was our fault. But had we done that in the simulator, we probably would have seen that, would have noticed. Even though you don’t have as good a visual scene as the real world, we would have noticed which way it rolled, and it was wrong. So it was a good lesson learned, no matter how simple it is, to go prove it out in the simulator and make sure.

ROSS-NAZZAL: You also received a Defense Superior Service Medal for the first RMS [Remote

Manipulator System]-controlled deployment of the SPARTAN vehicle. Can you talk about that? Did you actually train with the RMS before the mission?

NAGEL: No. I don't know about that, because I think that must have been a generic award for the whole crew. Because I'll be honest with you, I mean, John Fabian operated the arm. I did not. I wasn't a trained arm operator. My duties on that flight were MS-2, and I had some experiments, and I was the photo TV person. I did a lot of photo documentation, which I was proud of, because some of it came out pretty good. I still see some of the footage that I took on some ads around here. But to be honest with you, I did not operate the arm. I did not fly the Shuttle for the rendezvous. I assisted, but Dan flew. Dan did all that, so I think that's part of a group generic award.

ROSS-NAZZAL: Sometimes we see that and it doesn't turn out to be correct. All right.

Why don't you tell us about the crew and the crew's relationship during this mission.

NAGEL: The first one?

ROSS-NAZZAL: During your first mission, during 51-G.

NAGEL: Good. I mean, Dan's a great commander. He later was the chief astronaut. This was the first flight of all crew members from my group, my astronaut group, because Dan, J.O., Shannon, John, and myself were all in the same 1978 class. Then the two payload specialists, of course, but they were not—so it was the first all-'78 group. So we all knew each other pretty well. Dan's a great guy. J. O.'s funny, good, a lot of fun to fly with. Shannon is just great. I mean, that was her first flight, my first flight. She went on to fly a lot, of course. Have you interviewed her?

ROSS-NAZZAL: No, we haven't. She's on the list, though.

NAGEL: You need to get her. But she's just well adapted to space flight in every respect. She's just really good at it and a pleasure to fly with. John's a lot of fun. John was a real kick to fly with. So we all got along well. And Patrick and Sultan were fine, too. There were no particular problems with that crew, from my standpoint.

ROSS-NAZZAL: When you came back, were you actually able to go with the crew to France and to Saudi Arabia?

NAGEL: Saudi, but not France. They went to France before my second flight, and I couldn't go with them to France. So everybody but me went to France, and then to Saudi, we all went because that was in December of that year, and that was shortly after. My second flight was in October, November, late October, early November. And December we went to Saudi Arabia. So it was quite a year. Nineteen eight-five was a benchmark year. I've never had a year before or since like that one. But the trip to Saudi Arabia to me, anyways, was more out of this world than going into orbit. Really, it was quite a trip.

ROSS-NAZZAL: Why don't you tell us a little bit about that PR trip.

NAGEL: It was only six days. Sultan wanted it to be longer, and Dan didn't want it to be any longer than that. He was going to take us scuba diving in the Red Sea and stuff like that. We never did. But it still was quite a trip.

We flew on Saudi Airlines out of New York into Jeddah, first class, on a 747. They really took care of us. This is like a Cinderella story. I'll tell you why in a minute. But flew into

Jeddah, and then we flew to Riyadh. I mean, it's just—I don't know how to describe this trip. Everywhere we went, they'd have a regular passenger terminal and a royal terminal, and we got to see some of the royal terminals. But we stayed at Riyadh for a few days, and it is not a society for women, as you well know, but our wives got to do a lot of things that women never got to do in Saudi Arabia and go some places they didn't. So it was really quite a fantastic trip.

In Riyadh, we went to their Air Force Officers' Club, where I guess women never go, but our wives went there. They took us by helicopter out to a farm or a ranch that Sultan's family owns, somewhere outside of Riyadh, and we had the traditional Bedouin meal sitting in a tent, cross-legged on carpets and eating and riding camels and drinking camel's milk. They were flying falcons. It was just really quite something.

Oh, gosh. I haven't thought about this trip in a long time. We had our own airplane. They used a Saudi Airlines 737 and flew us around the country in it. We flew from Riyadh when we left there, down to a place called Abha, which is in the mountains, southwest, real pretty. Then we flew across the empty corridor, the big desert, back up to Dhahran. It's over on the Arabian Sea or the Persian Gulf. We were there for a while. So we kind of hopscotched all the way around the country, and everywhere we went, it was just a big spread of food, more than you could ever possibly eat, not enough time to eat it. We were treated like kings and queens, actually.

Then we literally left town, left Riyadh on an airline after midnight. So it was kind of like a Cinderella story, where we went from being treated like kings and queens back to who you really are when we left. But they did pull out all the stops for us. It was a trip like no other I've ever made.

ROSS-NAZZAL: Did you primarily meet the royal family, or were you out with the public?

NAGEL: Oh, we did, yes. We met the king. Yes, we met the king. See, Sultan is part of the

royal family, but the royal family is very large. I forget how he's related now. He's fairly closely related. He's related to the king. So we did. We met the king, and he's the only person that ever flew in space from that country, so you can imagine, he's a pretty big name.

ROSS-NAZZAL: You then flew on 61-A. I'm wondering if you can talk about how you were able to juggle training for both missions. You said that Dan Brandenstein went to George Abbey and lobbied to make sure you could stay on that flight. But talk to us about how you juggled that training. That must have been difficult.

NAGEL: I just trained for both up to some point before that first flight, and I forget where it was, a few months before, where it became impractical, and my second commander, Hank [Henry W.] Hartsfield, said, "That's okay." And I just stopped training with them, did the first flight, came back, and immediately jumped in with them. And that's how we did it.

We even had time after the first flight where the whole crew for the second flight made a trip to Germany for some training and orientation, but a little bit—it was a vacation. I mean, we even had a few days off over there, incredibly, a few months before that second flight, and we still had time to do it all.

So it was busy, but we just fit it in. It wasn't undoable at all. Again, a lot of what I had already learned was one for one. It carried over directly. It was just the Spacelab systems that I had, and I had already learned a lot of that. I just had to really put the finishing touches on it.

ROSS-NAZZAL: Tell us about the training that you took part in, in Germany. Can you tell us about the simulations?

NAGEL: See, for us, there is a Spacelab crew, the science crew, and the Orbiter crew. The Orbiter crew, especially for that mission, didn't have much to do with the experiments. So,

unlike my second Spacelab flight, where I did have more, a little more to do with experiments than the first flight, I really didn't. We got was some overview lectures about the experiments so we'd know what those guys were doing. They had training facilities over there which modeled some of the Spacelab systems, but more so the experiments. So the payload crew, which was Bonnie [J.] Dunbar, Guy [Guion S.] Bluford, and the two Germans, Ernst Messerschmid and Reinhard Furrer and then Wubbo [J.] Ockels from the Netherlands, they had been training intensively for a couple of years. More than that for the Germans and Wubbo.

So they'd been at it real hard, and Bonnie and Guy had been at least for a year, maybe a year and a half, making frequent trips to Germany, spent a lot of time over there doing that training. For Hank and Jim [James F.] Buchli and myself as the Orbiter crew, it was a one-time trip for some orientation, so we were not trained to operate these experiments. That wasn't the intent. That's kind of how it went.

ROSS-NAZZAL: Was there any sort of language protocol for the mission?

NAGEL: English. There was some dissention about that, actually, but the agreement was, for safety reasons, I mean, they all speak fluent English, but for their PR-type events, of course they could speak German, but as far as conversing, I think the bottom line was all done in English. Or if they did converse in German, they just needed to tell us what they had said so for safety reasons, the commander of the Orbiter crew would know what was going on.

We took some German. Actually, Hank spoke German because he had studied German in college and he was stationed in Germany. So he could speak some pretty good German. He did a press conference in German and gave a speech in German. I could not. They offered Berlitz language training to us then. It wasn't really necessary. I took some of it, learned a little bit of German, but not enough to speak it. And Bonnie and Guy went further with that training, but I don't know if they ever could really speak German. But it's not like our involvement with

the Russians where there really was a language problem, because all the Western European countries have English as their second language, and they are totally fluent, so it's just not really an issue.

ROSS-NAZZAL: This was actually the first Shuttle mission that was primarily operated and financed by another country, by West Germany.

NAGEL: Right.

ROSS-NAZZAL: How did that impact the mission, if at all?

NAGEL: The payload operations center was in Germany. It was just like being in Marshall [Space Flight Center] or Huntsville [Alabama], somewhere. I guess you'd say it's more complex, and there's more issues to be resolved when you're working an international program. Not having a U.S. mission manager made it more complex, but I see that mission was kind of an early lead-in to the Space Station. Maybe in a way a Spacelab is kind of like a mini space station. You are doing scientific work, but your space station's inside the Shuttle, and you're up there, in our case, a week. We'd been up there about two weeks in some of these later missions. So it's kind of like a mini space station, but more importantly, the international cooperation that's required to pull all this together made it—it was a hard mission for Hank to pull together, complicated when you're dealing overseas.

It's not that the Germans aren't good people. We get along fine with them, but we butt heads about things, just like Americans butt heads, but it's just the long distance part of it makes it more complex. So it was kind of a lead-in to we're doing now with the international Space Station.

It wasn't as hard as working with the Russians, where you really do have a language

barrier you both have to overcome with translators and learning their language. We didn't have that.

ROSS-NAZZAL: Why don't you talk to us about flying the Orbiter. How similar is it to flying the Shuttle Training Aircraft, for instance?

NAGEL: For the landing task? It's almost identical. I'm now an instructor in the Shuttle Training Airplane, so I get a lot of hours in both seats, the instructor and the student.

The Shuttle, it has a flight control system in it that is one of the early fly-by-wire systems, which means there is no physical linkage between the stick and the controls. It's all electrical commands through a computer that then tell the flight control surface or the reaction control jet to do whatever it needs to do to control the airplane. So it's what you call a highly augmented airplane. And it has some flying characteristics the way that's all put together that aren't like other airplanes fly. So, consequently, it's not that you can't learn to fly it; it just takes a while to get used to it, and the fact it has no engines, and it's a poor glider, so it's coming down at a real steep angle.

All that coupled together means that it just takes a while to get used to it. So the ground-based simulators and the Shuttle Training Airplane are what allow you to do that. I think the primary is the Shuttle Training Airplane because you have the real world out there. You're looking at the actual runway you're going to land on. And the handling qualities and responses you get out of the Shuttle Training Airplane are very close to what the real Orbiter is.

If anything, the real Shuttle is a little bit better flying, a little nicer, what we call crisper, a little bit more responsive than the Shuttle Training Airplane. But I don't know if I could prove that on paper, but it feels that way. If anything, it's a little bit easier to fly than the STA, which is okay. The only thing about the STA is, it's a smaller airplane, so when the air is bumpy, it bounces around a lot more than the Shuttle. The Shuttle is big and heavy and it's got small

wings, so it doesn't feel the turbulence as much. But that's about it.

ROSS-NAZZAL: Why don't you tell us about maneuvering and working with the Orbiter in orbit. What were some of your duties during this Spacelab mission?

NAGEL: Most of that kind of maneuvering is done with the autopilot. On the Spacelab mission, the first one, they wanted as good a microgravity as they could get, and they felt that turning all the reaction control jets off was the way to do that. But what you've got to do, you have to put it in an attitude where it will be stable. There's a little bit of atmospheric drag even at those altitudes, and there's a gravity effect from one end of the Shuttle to the other, which will cause it to change attitudes. So you get it in a stable attitude before you turn the jets off.

This is kind of interesting, because the one they wanted us to fly, usually you want the long axis pointed at the Earth, either tail of the Earth or nose to the Earth, and the wing oriented in some way that it'll be fairly stable. And we would get it in this attitude, which was nose at the Earth, and the right wing pretty well forward. So you slide along like that and get it all stable and turn off the jets, and it would just stay there. It would slowly wander around a little bit and roll over a long period, like half-hour or so, kind of oscillate. But it made for a very interesting Earth viewing, because you'd go up in the front, the cockpit of the Shuttle, and you look out the front windows, and the Earth is coming by. You're looking straight down at the Earth as coming by from right to left. And you could go down in there, sit in the—it's like you are going down in a gondola really, almost, and you'd sit in the pilot's seat. Then you could observe the Earth that way. But it's almost like you're suspended in a gondola. It was really unique.

So we flew that attitude for, I don't know, eight or ten hours a day, and then the other time of each day we were just called minus-ZLV, which is top to the Earth, I think with tail forward, I don't remember now, but we flew those two attitudes.

All said and done, I don't think you could tell the difference that the microgravity was

significantly better when we had the jets turned off, because on the next mission we didn't do that. We flew many different attitudes based on what we needed for an experiment, but much of it was this minus-ZLV, which was the top to the Earth, which gives you the best Earth viewing, too.

ROSS-NAZZAL: Any memories that you want to share with us about this mission?

NAGEL: Of the second one?

ROSS-NAZZAL: Of the second mission that you flew.

NAGEL: Jokingly, I said all I did on the second mission was purge fuel cells, dump water, and take pictures, and prepare meals for the crew in the back. I had no responsibility for any experiments in the back, so we were helping them out as much as we could. But the good thing about that mission, what I really liked about it was, it was a high-inclination mission. We flew 57 degrees inclination, which means you go from 57 North latitude to 57 South. You cover most of the inhabited part of the world. All of our attitudes were good Earth-viewing attitudes, and we had time. The Orbiter crew had time to look out the window. So it was just a bonanza of Earth observations. It was great.

I was talking to folks that fly on the missions now to the Space Station. That's 51.6, I think, inclination, so that's pretty good Earth coverage. But on those missions, the Earth-viewing attitude isn't always so good when they're docked to the Station. It's not always so good. But also, they're so busy. And we, on this flight, in the Orbiter side anyway, weren't that busy. We shot all of our film, we ran out of film, and the Germans had several rolls of 70-millimeter film that they had brought, that was not loaded in magazines and had to be hand-loaded, and they were out of time. They were too busy in the lab, unfortunately, for them. So

they just gave us all their film, so we were hand-loading the magazines, we shot all their film, we got through all that, and we finally were down to the 35-millimeter film. We shot most of that, so we had lots of time to take pictures. That was my memory of that flight. It was a great Earth-observation opportunity.

ROSS-NAZZAL: What sorts of things were you looking for? Any weather patterns?

NAGEL: We had specific sites we were to look for, both on the ground, in the water, looking for sun glint and reflections. There were some good pictures taken on that mission, one that Jim Buchli took over near Crete in the Mediterranean, where you see a reflection of boat wakes that the oceanographers just went nuts over. But, I mean, from our altitude you could see great detail, the wakes of these two ships steaming along.

Weather patterns, things like that. There were specific sites we were asked to look for. I can't remember what all those were now. I just remember one—talking about this gondola effect, eating dinner one night, just sitting up there, you came down across the United States, and the panorama is really good. I mean, it's not like you can see the whole world at one glance, but it's easy at night because you can see the big cities. If you know your geography at all, you can pick out, for example, up in Colorado, Denver is big, Colorado Springs, a little smaller, Pueblo is a little smaller. You'll see them in a line, and you can see from there all the way down into Texas, and see San Antonio, Houston. So we come zipping by there.

Big line of thunderstorms out over the Gulf of Mexico. I remember this one pass. And then down across South America, which is always covered with thunderstorms, which is very spectacular at night. Then we crossed over by Montevideo into Buenos Aires, down in Argentina, and just kind of watching that recede in the distance. And then I saw a shooting star, a meteorite, go [makes sound] smoking in under us, and I said, "How can I ever describe this to anybody?" It's like nothing you'd ever see on the ground. It's one of those moments you want

to capture in your mind forever. I couldn't take a picture of it. All I could do is remember it. So it was neat.

ROSS-NAZZAL: That's a nice memory.

NAGEL: Yes.

ROSS-NAZZAL: I'd like to move on and talk about *Challenger*.

NAGEL: Okay.

ROSS-NAZZAL: Where were you when you found out about the *Challenger* accident?

NAGEL: Where was I? I was watching the launch over here in Building 4. I had flown in November and had gone to Saudi Arabia in that December, and then we had a PR trip to Germany in January right after Christmas, so we'd just got back from that trip. We were probably a week back from that trip.

Ironically, I remember one of the questions one of the students asked that we had met, we were talking at a university over in Munich, I think it was. Said, "What if one of the solid rocket boosters failed?"

Hank said, "Well, it would be really bad." So a few days later it happened.

So I was just watching it on TV.

ROSS-NAZZAL: Were you watching it in your office or with a group of—?

NAGEL: No, I was down in a conference room. I was sitting—I even remember who I was

sitting beside when that happened, but it was just—we were all watching it, and said—you don't want to believe it. "This isn't right." We all knew it was bad when we saw it, but you just don't want to believe it.

ROSS-NAZZAL: Did you have any duties immediately after the—?

NAGEL: Yes, right after that we had a—Paul [J.] Weitz was the Deputy Chief of the Astronaut Office, called everybody in. I forget what he said, but then Overmyer, Bob [Robert F.] Overmyer was assigned to go to Florida right away and me with him. I don't know if anybody else went down, but I jumped in his back seat in a T-38, and in a couple of hours we went to Florida. The families were still down there. When we got down there, the families were still in crew quarters, at least some of them. June Scobee was there, others. So it was bad.

ROSS-NAZZAL: What did you do while you were in Florida? Did you work with the crew families?

NAGEL: No, they all left. They left later that day, but we quickly got organized and had some meetings about, "What are we going to do?" And there were several immediate tasks like retrieval of debris and cataloging it, things like that. So I got assigned to follow the retrieval of the debris. I mean, the Navy was doing that, but I mean, so I found myself down at the docks a lot, Port Canaveral, where they were bringing pieces in, and then they were getting them arranged in a big warehouse up there. I did that for a few weeks, I guess. I don't know. Because I was even down at Florida when they had the big ceremony back in Houston when President [Ronald] Reagan—I wasn't here. I was in Florida then. So it was a grim time.

ROSS-NAZZAL: It must have been difficult.

NAGEL: Yes. Yes, it was. So I stayed with that for a while, then came back. Somewhere, I can't remember exactly when, but I got into the crew escape thing shortly after that.

ROSS-NAZZAL: Let's talk about that. You actually represented the Astronaut Office in the creation of the crew escape system. What role did you have in deciding on the escape pole system?

NAGEL: Probably pretty big. I mean, I'm not the one that came up with the idea. See, I started with this sometime in the spring of '86 and it was with it for a couple of years or more, two, two and a half years. There was an initial study done, and then the Rogers Commission, of course, came out. One of their recommendations said we need a way of [controlled] flight escape out of the Shuttle. And so that was the charter then.

This was my best time at NASA, actually. Nothing I ever did was more fulfilling than that two years, to be honest, even flying. This was better, because everybody was so focused on getting the Shuttle flying again. It was a good thing to be involved with. But we worked very closely with Rockwell. The NASA manager for this was Bill [William] Chandler, and he and I were very close. We worked kind of hand-in-glove on this whole thing.

The initial concept that was developed working with Rockwell was a powered escape scheme, because you can't—we'd looked at bailout lots of times from the Shuttle. I mean long before *Challenger*. People looking at how could you bail out. The only place to get out is the side hatch. You'd have to get rid of the side hatch. But the wing's back there, so if you jump out, even at slow speed for the Shuttle, the air flow is going to take you back maybe over the wing, maybe under the wing, maybe hit the leading edge of the wing, or you might go right back the side of the airplane and hit the OMS [Orbital Maneuvering System] pod. So you might clear the airplane, but you might not. So it's not a very good way. So you need something to help get

you clear of the wing.

So the one scheme, there had been a use of a rocket-powered escape system in a test airplane where you walked to a hatch and strapped into this thing and the rocket's on a pendant, a rope about ten feet long, and you get in the right position, and then the rocket fires and just pulls you clear of the airplane. It's called the Yankee system, and it was used in an airplane I flew in Southeast Asia, but from a seated extraction. This is kind of a walk-around extraction system.

So, this concept was well along where we put a jettisonable side hatch on the Orbiter. The Orbiter hatch didn't used to be jettisonable. Now we've got pyrotechnics to jettison it. It's on there now. And then there would be a little, like a little tray or a bench that you'd lay down on, and there's a magazine of rockets right here. You take a pendant from this rocket, hook it into your harness, you lay back with your head in the hatch, pull the handle, and the rocket gets expelled and then ignites and pulls you out clear of the wing.

So we got to a point where they had fabricated that, put it in an airplane that they were flying up on China Lake, which is a Navy test range in California, and we were testing it. We were well along with the tests. It worked. It was going to be fine.

And then the idea of the pole came along. I think Winston [D.] Goodrich is the name tied to the pole. He's a NASA engineer here. He gets the credit for it. I don't know if he's the original person that had the idea. But instead of using pyrotechnics, the idea is, you have this deployable pole, that's a telescoping pole that when you blow the hatch it's kind of a curved pole, and it comes out like this [gestures], and it's almost like a fireman going down a pole. You hook your harness into a little lanyard that has rollers that slide down a pole, so when you fall out of the airplane, the pole guides you for about ten feet, and then you just fall off the end of it, but by that time you're at a point where you will go under the wing.

And that really—I was kind of emotionally attached to the other idea, because I had so much time involved and effort into it, but the pole is better, because if you can do anything

without the additional complexity of pyrotechnics and everything, plus it would take more room in the cabin, a lot more room. So that's how we, late on, changed to the pole.

The pole was actually tested as well with live jumps of Navy test jumpers out of a C-141. They put a pole in a Shuttle-like hatch back in the back and made a lot of jumps out of it. So it works. It would work. There is no question about that. The only question is—I think on your list of questions was, is it an effective crew-escape system. It depends on who you talk to. I mean, the charter from the Rogers Commission was to provide a controlled flight, gliding flight escape system, and this does it. This will do it for you. There is a lot of circumstances you can get into in a Shuttle where you're not under control, and then the pole has no function there. However, I think you're better off having a pressure suit and a parachute and some survival gear. Even if it's out of control, somebody might have a chance of climbing out the hatch, in the pieces that are falling down.

There's plenty of evidence in World War II of crew members getting out of bombers with wings off if they happen to be close to an opening or a hatch could get out with a parachute. So it's not what you'd really like for a fully capable escape system, but I don't feel like it was wasted effort. I'm glad we did what we did.

ROSS-NAZZAL: As you mentioned, the Navy actually tested the system. Did you actually do any of the jumps to test the system?

NAGEL: No, they wouldn't let us do that. No. No, the Navy guys—I think what we wound up with on that system, which is a bit worrisome, was always worrisome to me, was it had a small parachute that's not steerable, and with your pressure suit and your gear on, you're pretty heavy, pretty high-suspended weight, so you have a high sink rate. And these guys were jumping out of the 141 onto the desert where there's Joshua trees out there, and they couldn't steer the parachute, and they were hitting hard. They knocked themselves silly landing on the ground.

And they couldn't steer around a tree. We were afraid we would impale one of them on a tree. So we stopped the live jumps after a while and just were pushing dummies out.

Now, the good news with the Shuttle is, in all likelihood, if you ever needed this, you'd be over water, so it just doesn't matter over water. If you're over land, probably somebody is going to break an ankle or sprain an ankle, but you'll be alive, jumping out of it. So it would be nice someday if we could go to a different parachute with it, but it's still a lot better than what we had before.

ROSS-NAZZAL: Did you develop any of the crew training for that? Can you talk to us about that?

NAGEL: Yes, we did. Let's see. What all do we have for crew training for? You've got the classroom lectures on it, and then we modeled the pole or a short stub version of the pole in the 1-G trainers over in Building 9 so that on an egress exercise you're wearing the gear, and you can hook into the lanyard on the pole, and just roll out onto the platform, which is just a foot below you right there with a pad. You just kind of roll out, and the pole is only about that long [gestures] instead of ten feet long. So that gives you the practice of unstrapping and egressing the actual Orbiter.

Then what we modeled or fabricated was a short pole that we put by the swimming pool, the WET-F. I suppose they do it at the NBL now. I don't know. I imagine they do. Where you're wearing the gear, but when you're rolling out of the 1-G trainer, you can't really get the good body-tuck position, because you're right above this mat. In the water, you can do that, so you practice your body position real well, and then hold that position as you slide down this pole and just hit the water. So that gives you the practice of the good body position. And that's about all you need for the training. It's not that hard to use. We never had to use it, fortunately. Hope we never do.

ROSS-NAZZAL: Were there any other plans to build a different type of system on *Endeavour*?

NAGEL: No. *Endeavour* was—there was no plan for that. I really wanted us to do something more, so I kind of, on my own, carried some studies forward, but what you get to is very difficult. It's not only a matter of money. It's not just money, although that would be expensive. But we had Rockwell do some studies for us for what are called the extraction systems or ejection seats as well, and you really have to do major surgery on the Orbiter. You've really got to carve it up to put these systems in there. It already has a forward center-of-gravity problem anyway, so you add more weight to the nose, so you probably have to put ballast on the tail, you cut down the payload, you're cutting down on the room you have for people inside. So I mean, you can rapidly drive yourself to a point where you've got some ejection seats in there, but you don't have enough crew members to do the mission, so you'll kill the program anyway. So it's really a delicate balance.

They've even looked at capsulated ejection where you'd pull the whole nose or a portion of the nose of the Shuttle off. But that gets to be real big stuff, too. It's so big, you add so much weight, and the weight distribution is so bad, you'd have to move the wings on the Shuttle. You're basically almost starting over with a new airplane.

So I do know that when they are starting with the new airplane like—what's the latest we're talking about? The space plane now? Crew escape is going to factor heavily into those decisions, but even when it's on paper, it's real hard to fit a viable crew-escape system in there that will cover, certainly, a good portion of the envelope the thing flies in, the speed of altitude envelope. So it's a hard problem.

Even the seats, the ejection seats they have in the Shuttle on the first four flights didn't cover the whole envelope. I mean, they covered early in the ascent and late in the entry. So I'd like to do more than what we did with the pole, and I think we could, but it's not an easy

problem. It's a very difficult problem.

ROSS-NAZZAL: You actually didn't have much time to come up with a solution, or at least the design crew didn't.

NAGEL: No, it moved fast.

ROSS-NAZZAL: Did that have any result or impact on the design of the pole escape system? You'd mentioned at first there was one design, and then you decided on the pole system.

NAGEL: I don't think so. I mean, if you're going to have an escape system that is only for controlled gliding flight, if you're asking did we hurry so much that we might have missed some other idea or something, perhaps, but the only place to get out of the Orbiter is the side hatch, and given that, you've got to have a way to clear the wing. And this allows you to clear the wing. It's kind of an elegant simple system, so I don't know of anything that would be better for that. Now, if you want to go further and have ejection seats or something bigger than that, then yes. We studied that, on—shoot, I was still studying that in 1990 or 1991, and I kind of gave up after that. I figured I was probably wasting NASA's money, because nobody was going to do anything with it, once I got to a certain point.

But it is being resurrected for Shuttle improvements, if we're going to keep the Shuttle flying for another fifteen, twenty years. They've resurrected this, but I still, since I've gone so deeply into it before, I don't see any major breakthroughs that's going to allow the answer to be much different than it was before. I'd bet we live pretty much with what we've got on the Shuttle and maybe the next vehicle is going to have something different.

ROSS-NAZZAL: You mentioned you continued studying this system. Was it something that the

Chief of the Astronaut Office asked you to do, or was this something that you had just decided you were interested in?

NAGEL: I guess we agreed on it, but I wanted to carry something further on extraction and ejection with Rockwell. I wanted Rockwell to do their own analysis of it and cost it out, which they eventually did, and then I took that to engineering and showed it to them, and that's as far as it went. They were skeptical about the price tag that Rockwell had on it, thought it was too low. They might have been right. But none of it was cheap. It was pretty expensive. I mean, you're starting to have to—you cut holes, have hatches, cut holes in the structure. These are big modifications, big changes. And all the equipment you've got to put inside for an ejection seat like rails and a structure like that.

And then—I may be giving further details than you want, but you can't just have all these ejection seats sitting around in the Shuttle. There's no room to move. They've now got to be portable ejection seats that somehow you can just dismantle. That's never been done before. So it's a lot of new stuff.

ROSS-NAZZAL: So you were actually looking at the idea of having the crew eject from the Shuttle?

NAGEL: Yes. Not just me. There were other studies done. Even early on after *Challenger* we contracted with the Navy to do some studies of how you would eject up to, I think, seven people or so out of the Shuttle. It's hard, though. Ejection seats aren't that small, and to get six or seven of those in the Shuttle and then figure a way to eject them out of the Shuttle and then you've got to go live in it. It's not like an airplane where you just sit in your seat for the whole flight. You're going to live in this place after you get on orbit and you've got to do work up there. So the seats have to be moved somehow to make room for that. It's easy to say, "I want

to do this,” but then when you start to getting down to the practicality of how you actually use this vehicle and what you do with it, it’s hard. It’s real hard. Not an easy solution.

ROSS-NAZZAL: This looks like it would be a good time for us to stop.

NAGEL: Okay.

[Tape recorder turned off.]

ROSS-NAZZAL: So we’re back with Steve Nagel, and I’d like to talk to you about STS-37. That was actually the first mission that you commanded.

NAGEL: Yes.

ROSS-NAZZAL: Why don’t you tell us about your duties as commander. How did they differ from being a mission specialist or a pilot?

NAGEL: You’re responsible. [Laughs] If it goes well, you take the pats on the back. If it goes poorly, you take the blame. But really, I mean, of course the commander is the one that lands the airplane, traditionally, but other than that, you’re a manager of a small group of people who are highly motivated and focused, and it’s really with most, if not all, these groups is a pretty easy job, because all you’ve got to do is point them in the right direction, and they want to do the right thing.

You wind up having to interface a lot with all the other communities like the flight directors, to work out the issues before the mission, and then get to go execute it. But it’s really basically what all the pilots want to do anyway, is get to be a commander of one of these

missions. It was a very rewarding experience. I enjoyed it.

ROSS-NAZZAL: Did you have any opportunity to select your crew members?

NAGEL: No. That's interesting. Not a bit. Just walked over there with them that day, and here they are. So I guess if you don't like who you're paired up with, it's too late then. But it was never a problem for me.

And on the flip side of the coin, they gave me no choice or input in the selection of the crew. On the other hand, when we decided who did what on the crew, especially with regard to EVA, it was totally up to me. Nobody really gave me any guidance on that at all. It was whoever I wanted to pick. Obviously, they wouldn't let you pick the pilot, because the pilots don't do the EVAs, but among the mission specialists. So that was kind of interesting to me.

ROSS-NAZZAL: Why don't you tell us about how you selected these individuals to serve in the various positions.

NAGEL: Oh, it's hard because everybody wants to do an EVA, and just used my own best judgment on that and just try to give people what they want or have an aptitude for, but divvy things up in a fair way so you spread the workload around, including myself, taking some of the workload. It was kind of easy on that mission, because one person in particular had been working the payload that we flew for quite a while, so he was the obvious choice to be the expert on the payload. It just wasn't that hard, wasn't that difficult to put together.

ROSS-NAZZAL: Why don't you talk to us about the crew relationship that developed during this mission.

NAGEL: We slipped a lot on that mission, so we were training for two years, and there was Ken [Kenneth D.] Cameron, Jerry [L.] Ross, Linda [M.] Godwin, and Jay [Jerome] Apt. Now, I wound up marrying Linda Godwin. So I knew you're going to get do that. But don't get any ideas, because that was years later.

But I really didn't know any of them—no, I knew Jerry before, because Jerry and I were at Edwards Air Force Base together, so I knew him a little bit there and we knew each other fairly well from here. And the others I knew, but not all that well, but we worked together well as a crew, and we had a good time, and it was a good mission, actually. It was the deployment of the Gamma Ray Observatory [GRO], which is kind of like the Hubble deployment mission, and it was a great thing to be involved with.

It was a fairly simple, straightforward mission compared to the German [Spacelab] missions, because it's five Americans. I mean, nothing against working with internationals. It's just more complicated when you have people from different countries. You've got the geographical distance. We are all right there in one office, and we did a little bit of traveling out to see the GRO when it was out in the L.A. area at TRW, and went to Goddard [Space Flight Center, Greenbelt, Maryland] a couple of times, I guess, but that was about it. Not much travel. Very fairly simple, straightforward mission.

ROSS-NAZZAL: Actually, when the crew deployed the GRO, there were some problems. Can you talk to us about what was going on in the cabin and the talk with the flight controllers?

NAGEL: Yes. The GRO was big. It was not physically as long as the Hubble, but it weighed a lot more. It was a lot denser. It was a great big thing, about 35,000 pounds back there, and it had three appendages that had to unfold once you get it out in the end of the arm. Linda was the arm operator and moved it very slowly, and got it into its deploy position. Then the ground sends radio commands to deploy the two solar wings, which are folded up like accordions. And

they are mechanically complicated. Now, we were kind of worried about those. We said, "If we get by that, we'll probably be okay."

[They]'d unfold one at a time, very slowly, and it's big. Once those are unfolded, the wingspan of the GRO was seventy feet. From tip to tip, the Orbiter is only seventy-eight feet, so it was a pretty big thing hanging out there on the end of the arm. The only other thing to be deployed was a high-gain antenna. Looked like a satellite dish antenna on a boom, a pole about ten feet long. They'd just unlatch it, and a little motor drives it out.

I shouldn't have said this, but I remember saying to Jerry after the two solar wings were deployed, I think I said something like, "Well, we're out of the woods now." So the ground sends the command to the antenna, and it didn't move. It was hidden from our view, I think. Yes, it was hidden from our view. In that position we could see it with the TV cameras. But it didn't move. So then they resent the commands, of course, more than once.

So then we started down through this series of steps, which had been pre-planned and pre-rehearsed on the ground. And they involved—one was to fire reaction control jets to shake it, and the other was to move the arm to shake it. And I never had any faith in either of those at all, and I was right, because if you fire the control jets on the Shuttle, the arm is this pretty flexible thing, so you can make the Shuttle jump a little bit. But all that motion is going to get damped out by the arm, so the GRO doesn't see that at all. It's not like you can shake it.

And the same thing with the arm. The arm is not strong enough to move anything real fast and shake it like that. It can just barely do this to it [gestures]. That wasn't going to do it. So before the ground said anything, I remember saying, "Jerry, you and Jay better go down and look at your suits, because I think you're going to be putting them on here in a little bit." And they did, and they went outside, and Jerry climbed up on the back of it.

It was an EVA-friendly satellite. It had handholds all over it. It was built for climbing on, and he did just what you or I would do. He's a big, strong guy, but he just grabbed hold of the thing and pulled on it and ripped it free.

And what happened, they think, was a simple thing, but the arm's covered with thermal blankets, and maybe with the vibrations of launch or whatever, the thermal blankets somehow got snagged on the head of a bolt, probably, and the little motor that drives it was far too weak to overcome that. So it took something like Jerry just ripping it free, and just, by hand, deployed it.

And it really kind of saved the mission, because they could've done their mission with that antenna still latched, but it would've been very cumbersome for them to relay their data to the ground. So it wouldn't have been near as successful as it was. We were happy. It was only about fifteen minutes into the EVA when he did that. It took no time at all to go fix that. It was real easy to fix.

But that was the first—what would you call it? *Unscheduled EVA*. It was planned as a contingency, but it was certainly not on the schedule. It was successful.

I think we had another EVA years ago on that *SYNCOM* satellite where they tried the fly-swatter trick with it. Do you remember that?

ROSS-NAZZAL: Oh, yes.

NAGEL: Which they executed okay, but, unfortunately, that didn't solve the problem, so they couldn't fix it. But this fixed the problem. So everybody was happy for them.

ROSS-NAZZAL: Were there any other memorable events on this mission?

NAGEL: Probably. I've got to think. Let's see. Unfortunately, I had a low-energy short landing with the Shuttle on that mission, which was unfortunate.

ROSS-NAZZAL: Why don't you tell us about that.

NAGEL: Oh, it was my own fault, but we got waved off one day because of high winds at Edwards. And then the next day we came in to land, and, like I told everybody, I offer this in no way as an excuse, but it was a windy day. It wasn't a real great day to land at Edwards. There were high-altitude winds aloft, and a big wind shear. And what happened was, I came in to land, it was going to be about 270 [degree] return around to a lakebed runway, and I let the airplane get a little bit outside the turn around there; a little bit low, a little bit outside the turn, and then was not really aggressive about correcting back. I was just kind of smoothly correcting back to get back on altitude, and then rolled out on final approach a little bit low, and then went through this big—there was a big wind shear down there where you really lost a lot of air speed, because the STA guys told me later, they were experiencing a big drop in air speed going through this change of winds.

All that said, if I'd been real aggressive in how I flew the airplane, really slowed it down and stretched it a little bit, I could've back on the glide path probably okay, but I wasn't that aggressive with it. It was all lakebed under me. So I just stayed low and then pushed it over to get some air speed to flare it and land it, and wound up landing short. I wasn't even aware of how short I did land because it was all lakebed under me there, and there's nothing unsafe about it, but it really got a lot of attention. Not so much in the newspapers. There was a little bit in *Av Week* about it, but I don't think anybody noticed much, but certainly in the NASA community everybody noticed.

We went to school on that, and everybody got a lot better after that, about how they fly the airplane and the calls they make and everything. So ultimately it was my responsibility, but there was some information that wasn't passed to me about wind shears and the bad effects of that day. It wasn't a day to be getting low or anything, because it was hard to make it back up. So it was a cheap lesson. Actually, the landing role on that mission, even without a drag chute, was only about 6,000 feet. It was a real short landing rollout for the Shuttle because it was so darn windy and everything.

But that was that, and licked my wounds after that, went on. Never hurt me. They reassigned me to another flight. It didn't hurt my career any.

ROSS-NAZZAL: It seems like it's a good lesson, though. You passed along that information to the other astronauts.

NAGEL: It was a cheap lesson, yes. I pass it on when I'm instructing with the STA. I can set up an approach that looks similar to that, low energy, and say, "If you ever get here, don't mess around. Get back on the glide path right away." I was trying to be real smooth with it and not fully complying with the guidance command, just partway to be smooth and get it back, and that wasn't the answer that day.

ROSS-NAZZAL: It's great that you're an instructor now, and you can offer that advice.

NAGEL: "Here's something I did that you shouldn't do."

ROSS-NAZZAL: In '91, you also became the Acting Chief of the Astronaut Office.

NAGEL: For a year or so, I did, yes.

ROSS-NAZZAL: Can you talk to us about your duties as acting chief?

NAGEL: I did everything—you're running a big office. Not as big as this now. But lots of issues, lots of things to work. The flights. I did everything but the crew assignments.

Dan Brandenstein was the chief, and he retained that responsibility. He didn't parcel that out to me. So I didn't have anything to do with any crew assignments during that period, but I

did the rest, and it was real busy. It was a busy, hard, responsible job, and I think it's a lot busier now. It's a lot more complicated with two programs, the Space Station and the Shuttle, and a lot bigger office than it was. It was probably, I don't know, eighty or ninety astronauts then. Now it's what, 140, 150. I'm not sure.

But it was very busy, I remember, because I got—let's see, I started doing that in '91, like you said. In early '92, I got assigned to this other Spacelab flight, the German Spacelab flight, and I trained for that, and somewhere in the summer or fall of '92, I gave up the—I was within six months of this other flight when I gave up the chief job, and my workload dropped to a fraction of what it was. It was real easy to be a commander of flight compared to running the Astronaut Office. It really was.

ROSS-NAZZAL: Were there any major concerns that you had to deal with or certain issues that the astronauts often came to you about?

NAGEL: Oh, yes, all the time. I can't remember what they were, but there was always something every day. Every day. I think there was one issue for a while, were we going to keep wearing the pressure suits for the launch and entry, and we decided we were. But there were probably other issues. I can't remember what all they were. It was very busy. Running overloaded all the time.

ROSS-NAZZAL: As you mentioned, you actually got assigned to command a second mission, and that was the second German Spacelab. I'm wondering if you could compare the first mission that you were on with that second mission of the Spacelab.

NAGEL: Different crew. I was the only one that flew on both of them. Let's see. We had a crew of eight on the first one when you counted Wubbo Ockels, so we had three PSs plus five NASA

crew. On this one, we had seven, a crew of seven. The two Germans, Hans [W.] Schlegel and Ulrich Walter and then the other payload crew on it—the science crew was Jerry Ross, who I flew with before on 37, and Bernard [A.] Harris. And then there was myself, Charlie Precourt, and Tom [Terrence T. Henricks].

The differences? First of all, it was on *Columbia*, and *Columbia* was heavy enough that they couldn't and didn't need to go high inclination. I was always disappointed it was a low-inclination flight. I was hoping we'd be high inclination again.

The complement of experiments, I think, was more biased in the direction of life sciences experiments than the other flight was. I forget the number of experiments as one compared to the other, but there was definitely, I think, more life sciences on this one.

It was going to be a little longer. It was a ten-day mission. The other one was seven days. They had a tradeoff they could've had there. Could've put a pallet in the back with more cryo [cryogenics] for fuel cells and flown even longer, but they chose to have experiments back there on an outside rack instead of additional days on orbit.

And the Orbiter crew was more involved in the experiments on this one than the other flight. The other flight we almost weren't involved at all. On this one, we were involved in a few of them, where we'd go back to the lab and participate in some of the experiments ourselves, the more the life science experiments on your human body.

So those were the big differences right there. And it was the second of the German Spacelab flights. There was intended to be a third, and maybe beyond that, but their funding became a problem with that, too, so lots of things changed there. So this was the last of the German-sponsored Spacelab flights. Now there is no German Astronaut Office anymore. They're incorporated into ESA [European Space Agency].

ROSS-NAZZAL: Did you do any work at all with the German program manager for Spacelab as commander?

NAGEL: Yes.

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

NAGEL: [Hauke] Dodeck was his last name. Yes, we were friends. He kind of asked me about being on the mission one time, before I was assigned to it. He said, “Hey, we’d really like to have you on this mission.” So I don’t know if they would’ve assigned me or not, but I kind of went and volunteered for it, even though it’s not as glamorous a mission as some. I liked working with the Germans. I enjoyed it, and for me it was a good mission, and I had a good working relationship with him.

He also worked with Jerry Ross more. Jerry Ross was the payload commander on the mission, so probably Jerry had in some ways more direct dealings with Hauke Dodeck than I did. But I did as well. No big issues on that flight. It worked out pretty smoothly.

The only big issues you get on any of those flights is the science community. These missions cost a lot of money, so they want to pack as much as they can into them. We were always fighting the battle. Jerry was carrying the torch on this real well, but trying to keep things under control, because people always figure you can do more than you can actually do, and it’s like anything else, if you put too much on there, you’ll get to this point of diminishing returns where you’re not doing anything well, and the crew is going to try to do everything they can. We were overloaded.

Even with those efforts, we were overloaded. We had a pad abort on that flight, and the mission slipped a month, and at least one of those experiments dropped off. I can’t remember for what reason. And we were always glad it did, because I think we were still oversubscribed, and that got it back to something manageable, because we were just—they’re like sprints, these missions. You want to load them up as much as you reasonably can, because you want to get as

much as you can for your money, but they're like sprints. You just go hard at it for a week or ten days, and you can't do that on Space Station. You've got to have some time to back off a little bit, because you can't keep a sprint up for a long time. But on a mission like a seven- to ten-days, you can do it. You come home tired, but you've been hitting it hard for ten days.

ROSS-NAZZAL: Did you do any training then in Germany since you were move involved with these experiments?

NAGEL: We did go to Germany and we got some training, but, again, I'm trying to remember now if we—the training for these experiments might've been done here in the U.S., I believe, here at the [NASA Lyndon B. Johnson] Space Center. I believe. Yes, the one I'm thinking of, I did the training right here.

ROSS-NAZZAL: Why don't you talk to us about some of the anomalies that occurred on board. I read, for instance, there were some problems with the waste water system.

NAGEL: That was a big one. The Shuttle has under the floor five tanks. There's four for potable water, one for waste water, and we were about a day or two into the flight, and the CapCom, Sam [Charles D.] Gemar said, "Hold everything. We got a waste water leak," or a leak in the waste water tank.

So that kind of stopped everything. "You've got to stop using the toilet." Sounds funny on the ground. For real, this is—there was nothing life-threatening about it, but it could be mission-threatening. If you can't get this problem resolved, you're coming home. And what a tragedy that would be for the millions of dollars invested in this mission.

So they got really good support folks with in-flight maintenance, and we get the tools out, and you've got to take up the floor. There's a big volume that screws into the floor where the LiOH [Lithium Hydroxide] canisters are held. Pull that out, put it aside, lets you get down under the floor where the tanks are. Tom went down there, and what there was, I mean, the tank has a diaphragm in it, and it has gas pressure on one side, nitrogen pressure that pushes on this diaphragm that pressurizes the tank. It fills, but then you've got to dump the waste water out of it periodically.

It wasn't the water leaking, the waste water; it was the nitrogen side that was leaking, but it was not repairable. So what we did, we got down there with some tools with the instructions for the in-flight maintenance, and we rerouted the waste water into a bag. We fly these contingency bags. It's like a canvas bag with a rubber lining in it, and we just put the waste water in that bag. Periodically we'd have to empty the bag. You dump the water overboard out a port on the side of the Orbiter is where it normally dumps from, and except instead of gas pressure to dump, one of us would have to squeeze the bag to dump the waste water. It worked fine. It got us through the mission. So who argues with success? It was a plumbing workaround. That was the big problem. I don't remember any other problems. There might have been some other minor ones.

On the other Spacelab mission, these two were minor, but they get your attention. We had a cabin leak, which gets your attention, a slow cabin leak, which turned out to be a leak through a door on one of the furnaces back there, which is vented overboard. Once we traced that down, that was no big deal. And the other one was a fire alarm, which does really get your attention the first time, but it was a false fire alarm that would intermittently go off until we

disabled it. But the first time that happens when you get a fire alarm, that does get your attention.

But the waste water thing was the biggest thing, as I recall, on that other flight. There was nothing else.

We had one refrigerator fail right after getting into orbit. There were two refrigerators that were set in the locker spaces there, and they were for biological samples. This is a big, like I said, compared to the first German Spacelab flight, this was a big life sciences flight with lots of samples. So they were hanging it all on one refrigerator to save these samples, and I'm sure that's why, when it came time to land, we were weathered out of Florida that day, and we went right to Edwards that day. Surely, if it hadn't been for that, we would have stayed up an extra day waiting for good weather in Florida, but the Germans were deathly afraid that their second refrigerator was going to fail, or freezer, it was; and then they'd lose all these samples. People say, "Why did you stay up an extra day for that?" So that's why, I'm sure, why we came down on landing day at Edwards.

ROSS-NAZZAL: You talked about the fact that you were participating in Spacelab and some life science experiments. Can you talk to us about some of those that you participated in?

NAGEL: The only one I remember was—I can't remember the name of it now. I'll think of it. But you wear a collar right here [gestures] that has a hose out of it, just a collar that seals around your neck, and it pulls the suction, a slight suction on your neck, and there are what are called baroreceptors in your carotid arteries right here, and that's when, when you stand up quick, you feel faint, but also your heart immediately responds with an increase in heart rate to compensate for the drop in pressure that's sensed right here [gestures]. And so you could apply a low

pressure to your neck and cause that same response up on orbit.

I'm trying to remember what the practical application of that was now. We didn't use it for reentry or anything. But I guess they wanted to see if that response was somehow changed in zero-G. I can't remember the results now. I'd have to go back and read the results. But that's one of the ones.

The Orbiter crew cannot get involved in any invasive experiments, which is a great thing, which means they can't draw blood. They can't poke you with needles and things like that. They have you in good shape to bring the thing home, which is okay with me. You didn't have to stick me with needles up there. But any noninvasive experiment, and not one that would tie you down, get you strapped down where it would be hard to get up and get back to the front in a real hurry if you were needed. And this thing, you could just take the collar off and leave.

ROSS-NAZZAL: That's nice.

NAGEL: Yes. I don't know if there were any others I did or not. That's the only one that comes to mind. We had the SAREX [Shuttle Amateur Radio Experiment] radio, but that's not really an experiment in the sense you're talking about.

ROSS-NAZZAL: Why don't you talk to us about that. We know that you participated in that. You talked with Mir, for instance.

NAGEL: Yes, we did. We had a short passing conversation with Mir. I later met that cosmonaut on the ground. But, yes, we had SAREX on STS-37, and we had it on that flight, 55. Also on the first Spacelab flight, the Germans had a radio back in the back, but we didn't use it at the time. They had their license, and they were doing some talking on the radio there.

The NASA involvement in that primarily was, I think, as an educational tool, to talk to

schools. We had prearranged the conversations with schoolchildren, answering questions. It was really a neat thing to be able to talk to schoolkids from space. We might not really be flying over them at that time. I don't think fully understood that, but it's a line-of-sight radio. We had a little antenna we could put in the window, or also they had a little whip antenna on the lab. We could go back and plug into the lab, which is a better antenna, actually. But it's line-of-sight, so you've got to be flying over whoever you're talking to, so we might be flying over Australia or South America, talking to a ham down there, who has a bridge network set back up into the States, even some telephone lines, or something. So it's not a direct line-of-sight always.

But we'd be talking to schoolkids, and it was a good thing to do. You've got to be careful. You can oversubscribe to where it impacts the primary mission you're doing. But it was nice to do.

ROSS-NAZZAL: What sorts of things did the kids ask you about? What did you talk about?

NAGEL: Oh, all kinds of the typical questions. "What's it like in space?" It was exactly the same kind of questions you'd get on the ground if you were in a classroom.

One thing I did, I learned a lesson from was, trying to be a good guy and signed up for something that almost could have been embarrassing, because I got a Profs note. You remember Profs? E-mail note from an employee at Kennedy Space Center before that mission, saying, "How about if you talk to the school?" I forget where it was. Merritt Island or somewhere.

And I said, "Well, okay. If I have time, I'll talk to them."

So we set a time, and it worked out I had the time, and I was talking directly to them in this case. This was not on the approved flight plan. Mission control didn't know that I was doing this and it was, "If I get time, I'll do this." And we flew right over the Cape [Canaveral, Florida]. It was a beautiful day. It was line-of-sight. I'm talking to them, answering their questions and everything, and it all worked out fine.

But my father was down there for the launch, and he stayed through the mission. He went down to that school, and he said, “Boy,” he said, “there were people everywhere. They had the local TV station there. It was covered and everything.”

I said, “Oh, boy, am I glad that I had time to do this.” I would never sign up for something like that again. Really, bootlegging is what I was doing. So I learned a lesson from that, but it worked out fine.

And also, you can just do random contacts at radios. All the hams know when you’re flying, and you come up over Australia or anywhere you can talk to people. And I even arranged some conversations with friends.

ROSS-NAZZAL: Oh, did you?

NAGEL: One good friend. This was on 37, I guess. He was down for the launch. He was going to stay a few days later. I looked at the flight plan. “Well, on such-and-such day, such-and-such a time, if we launch on time, I’ll be flying over Florida. If I get time, I’ll call you on the radio.” And I gave him the phone number for mission control, to call a contact back there to update that time. Said, “Okay. We’ll try it.”

So I call him, and it’s just as clear as you and me talking here, for about four or five minutes, and we had a good conversation. He was standing out in a parking lot by a grocery store, a Safeway or somewhere, with this little handheld radio. And this guy comes up to him afterwards and said, “Who were you talking to?”

And he said, “Well, if I told you, you wouldn’t believe me.” [Laughter]

ROSS-NAZZAL: That’s great. What a great benefit.

NAGEL: Yes. Of course, the Shuttle is kind of hard, because, like I said, these missions are

sprints, so you don't have a lot of free time on your hands. On Space Station, it's ideal. Don't they have a—they have a radio on Space Station. It's not called SAREX, but it's a ham radio.

And to me, if I was on the Space Station for six months, that would be one of my leisure-time activities. It'd be fun to turn on the radio and just talk to people when you're flying around the world on your time off.

But that's the SAREX story.

ROSS-NAZZAL: Why don't you tell us why you decided to retire from the astronaut corps.

NAGEL: I don't know. It just seemed like time. It was a hard decision. I'd been there seventeen years, and it becomes time to move on. I was kind of vying for another flight, working on another flight, and my name had been submitted for STS-71, which was the first Mir docking, but that wasn't going anywhere. I wasn't going to get on that flight. I guess I could've waited. Maybe a part of me says I should've waited and maybe flown one of the later Mir flights just so I could've done that.

And then I was offered a job in management with safety, and it was kind of like all things added together with my professional and personal life. I said, "Well, probably now's the time if I'm going to do this." So I did it. It was kind of that kind of decision process.

Now I don't regret it. The first six months or so out of the Astronaut Office, I was having withdrawal feelings from it, which I think is natural, because it's such a great job. But past that point I'd really never look back. I was happy I was there, and happy where I am now.

ROSS-NAZZAL: Why don't you tell us about your duties in the Safety, Reliability, and Quality Assurance Office.

NAGEL: Actually, I was called the Deputy Director for Safety and Quality Assurance

Operations, a big long title. I was just kind of Charlie [Charles S.] Harlan's understudy, learning about management and safety and quality assurance. I really learned a lot there.

I got involved in—he and his other deputy, Gary [W.] Johnson, had been COTRs [Contracting Officer Technical Representative] for the contract, with SAIC [Science Applications International Corporation], safety contract, and he said, “Steve, how would you like to be the COTR?”

I said, “Well, I'd like learning about that.” I like learning about contracting and things.

Charlie said, “It didn't take much time.”

It was at the time when they were looking at rewriting all the contracts to be performance-based contracts. It became my life for about a year and a half. And I learned a lot, but I also learned I don't want to keep doing this forever. So I was really involved in a lot of that, as well as some Shuttle stuff. But mainly contracts is what I got involved with.

So I did that for a couple of years. Like I said back at the beginning, I'm more of an airplane-oriented person than space-oriented, to be honest with you, and I really missed flying. So I was looking at something to do to get me back into aviation, or closer to operations, anyway. I expressed this to Mr. Abbey, and he was really nice about it. He said, “Well, we'll look around.”

And I even was talking to Leonard [S.] Nicholson, who was the Director of Engineering at the time, and he was very nice, and was working on some positions. But I also was thinking even about the airlines. I was looking at Southwest Airlines, where “Hoot” [Robert L.] Gibson is now. I got him involved in that.

So I kind of went down that path, and then this opportunity for flying out at Aircraft Operations for NASA presented itself, and I was kind of down to deciding between that and going over to engineering for Leonard, which would have been good, too. But I decided I'd just try the flying again, and I've enjoyed it very much. I like being out there. So for me it was a good move. It wouldn't be for everybody, but I thoroughly enjoyed my time out at Aircraft

Operations.

ROSS-NAZZAL: What a great opportunity to go back to your roots in aviation.

NAGEL: Right. It's a good flying job. It's a very good flying job, involves some engineering as well. We don't just do flying, but most of it is operational training-type flying with the astronauts, both the T-38s and the Shuttle Training Airplanes. But we as well get involved in some engineering as well out there. So it's good.

ROSS-NAZZAL: You must enjoy still working with the astronaut corps.

NAGEL: I do. They're all getting younger. [Laughs] No, they're good. Actually, I know all of them, especially the new ones, better than a lot of the folks over in the Astronaut Office do, because I come in contact with all of them from time to time flying with them. So we see them all out there and get to know them all. They're a good group. They're all good.

ROSS-NAZZAL: Shifting gears a little bit, I'd like to talk about your biggest challenge while working at NASA. What do you think your biggest challenge has been, if you could pick one?

NAGEL: Oh, I don't know. Let's see. Running the Astronaut Office, being the Acting Chief was one of the hardest things. That was a hard job, rewarding but difficult.

Certainly the time after *Challenger* was a real hard time, but after we got our mourning process behind us and started looking forward, it was my best time there. It was real challenging, fast moving.

The flights were—actually, training for the Shuttle flights is kind of easy compared to the other stuff. You're kind of spoonfed a syllabus. You're going back to being a student again. I

don't mean to make it sound like it's trivial, easy. There's a lot to learn. You're really drinking out of a firehose, but your life is pretty structured there. So that's not so difficult. Where I'm now is a slower, a little less demanding pace of life than being in the Astronaut Office, even though I travel a lot. I'm on the go a lot. But it's kind of a nice change of pace out there.

So I guess the hardest, most challenging time was Chief of the Astronaut Office, and secondly was the *Challenger* thing. It's all been great, though. I wouldn't trade any of it. There's been the good times and the bad times, but it was a great opportunity to be there. I always felt very fortunate to have been where I was.

ROSS-NAZZAL: I think you already answered this, but I'd like to just go back and clarify. What do you think was your most significant accomplishment while working at NASA?

NAGEL: In my mind, I think the crew escape system, more so than flying on the Shuttle. The flights were great, but in a way, I got more personal satisfaction out of having worked on something that I think did some good like that, than even the flights. Not that I want to trade the flights, because that's why I came here, but that was the high point for me.

And, I've talked to a lot of these people that worked on this project, that crew escape project, not just in NASA, but some in NASA, even Bill Chandler, the manager, the chief Navy jumper, that did the jump on the pole. They said this was the high point of their career. It was the best thing they ever did.

ROSS-NAZZAL: Was it really.

NAGEL: Yes, because it was so important to everybody. I mean, the Shuttle's grounded, and we're doing something that's going to get it flying again. I think everybody, almost no matter what they worked on through that time period, had a similar feeling. Really, it must have been

kind of like people felt going to the Moon, a little bit. I don't want to compare it exactly, but that kind of a feeling.

I had that overall feeling working on the Shuttle Program, anyway, or in Station Program no matter what capacity, even in what I'm doing now. You feel like you're a part of something that's bigger than you, that's worth doing, which is really great. Not everybody gets that opportunity to work on something like we do here. But I really had that feeling on the crew escape project for that year or two.

ROSS-NAZZAL: That's a really interesting perspective.

NAGEL: Yes.

ROSS-NAZZAL: I'd like to ask one more question.

NAGEL: Sure.

ROSS-NAZZAL: You're actually married to an astronaut now.

NAGEL: I am. [Laughs]

ROSS-NAZZAL: Linda Godwin. I'm wondering, how has that impacted your family life? Had you already retired from the astronaut corps when you married Linda?

NAGEL: Yes. Yes, so there was no conflict of interest there, because she would've been my boss, because she was the Deputy of the Astronaut Office by that time. So, no, I'd already left. By the time I started seeing her, courting her, I was almost out. I was within a month of being

out of the Astronaut Office, then I was gone. So we were in different offices

And how did it affect us? I'm not unique, but I've seen this program from a whole bunch of different perspectives now. I've flown in it. I'm now a former astronaut. I'm now a pilot for aircraft operations that supports it. And now I'm married to an astronaut, and she flew two flights while we were married. The last one, we got a little girl, so I got all this and it is very stressful on the families when these flights go. It really is. And I always knew that, but, I mean, you've got to be a family member sitting up there or standing up on the roof of the Launch Control Center watching your spouse go fly. You know something could go wrong. It's not likely, but it could. So I've got a lot higher respect for the families, I always did, that stand by their husband or wife when they're doing this. Now she's not going to go fly anymore. She's publicly said that.

ROSS-NAZZAL: Oh, has she?

NAGEL: For which I am glad. I'm glad she got to do it, but in a way I'm glad that that part's behind us. But she had really a great career. I mean, she flew on the mission we were on with the GRO, and then she got to do a radar-mapping mission with the Shuttle, which was really neat. Then she went to the Mir and did a spacewalk on it, and then she went to the Space Station and did a spacewalk on it.

I told her, in the Shuttle Program anyway, how could you have a more varied and good career? I mean, there's nothing that she didn't do, as far as what a mission specialist would want to do in this whole program. But it was great. It was a great run for her, and she's happy about that, too.

ROSS-NAZZAL: That's great. Great. I'm glad to hear that. Sounds like you're happy.

NAGEL: Yes.

ROSS-NAZZAL: If you don't mind, I would like to ask Rebecca and Sandra if they have any questions.

NAGEL: No, not at all.

ROSS-NAZZAL: Okay. Rebecca?

WRIGHT: I've got a couple. While you were Chief of the Astronaut Office, you mentioned that several of the astronauts or some astronauts would come in and talk to you about different issues, one of them being the pressure suits. Since you've been on both sides of that issue, you flew before *Challenger* and after *Challenger*, could you spend a few minutes sharing with us the pros and cons, from your perspective, as well as from the astronauts, of wearing the two different suits, and what do you feel the benefits are?

NAGEL: It's certainly easier not to wear it. I mean, you just wear a pair of coveralls and a helmet. We had a harness we wore pre-*Challenger*, and that was only for ground egress. You would hook a Sky Genie into it and go over the top and lower yourself down the side on emergency ground egress after landing. So it was very much more comfortable. We wore a G-suit for entry, too, to squeeze your legs

Now, with the pressure suit, there's just a lot more to do to get into the suit, to strap you in. Now, the pressure suit we started flying with was called a partial pressure suit, which really just had bladders that squeezed your arms and legs and kind of sealed things off. It was uncomfortable, and it was hot. Now they're wearing a full pressure suit, which is kind of like the spacesuit you go for a walk-in, except it's a lot lighter, but it's got gloves that snap on with the

rings. If you have a loss of pressure, the whole thing pressurizes, but when it's not pressurized, it's more comfortable to wear.

We also were using fan cooling to try to blow air through those old suits. It didn't work very well. Now they're using a cooling vest, liquid cooling vest. So I think it's a lot more comfortable than it was.

That's the pros and cons, is just comfort, but I'd trade a little bit of comfort a long ways for the protection it would give you. And albeit an unlikely event of a major mishap or a depressurization, it'll save your life.

Kind of interesting how our two programs evolved between us and the Russians. The Russians lost a crew because of a cabin depressurization. Remember that, back in the seventies or so? And they just wouldn't think of a without flying without a pressure suit. We'd never had that happened, and we were kind of a little bit more lax about that, but now we're not.

But it could happen. I mean, something could still happen. This is all conjecture. I don't want to speculate about the *Challenger* crew at all, because that's a real sensitive issue, but we know from the flight surgeon's report what killed that crew was not the breakup of the Shuttle at all; it was water impact. And I hope they were unconscious. If the cabin depressurized, certainly I'm sure they were, because all they had was air to breathe from some air packs.

But if you give a person a pressure suit and a parachute, even if the pole's not usable, if the whole thing breaks up around you, the crew cabin is very stout, and if you survive the breakup, the thing winds up just falling at near 1-G. It's probably not going to pin you in, so there's a chance you could get some people out with a pressure suit and a parachute. There's a chance of that. It's not guaranteed at all.

So that's why I always feel, and I continue to feel strongly, about the equipment that we wear. I wish we could go a little further along, have a more viable escape system, but what we've got is a big step ahead of nothing.

WRIGHT: After *Challenger*, you mentioned one of your assignments was to be part of that debris retrieval team. Could you share with us how difficult it was to be on that, and how long were you there? For the whole duration, or were you there for a short time?

NAGEL: I'd have to go look at my notes to remember how long I was there. It was a few weeks, I think, when a lot of the pieces were being brought out. It was depressing, but there were—this was before they found the crew cabin. I was not there when they found the remnants of the crew cabin, but they were finding big chunks of it that were floating. And then in the shallower waters, they were getting some pieces off the bottom, and we were bringing them back to this big warehouse, logistics center at Kennedy, and they were laying them out, in the position they would be. So we had a lot of that. It was the largest undersea effort for salvage there ever was or maybe has been since then. But, yes, it was not fun.

WRIGHT: On a different note and my last question, you have had such a diverse range of positions while you were in the astronaut corps. Could you share with us how that position changed from [when] you entered it in the 1978 class until you exited it, what was expected of the astronauts by the time that you had left, or how those duties changed compared to what you were expected to do when you first came in to what astronauts are expected [to do] now?

NAGEL: In a lot of ways, it was the same, I think. We had initial training and technical assignments. They still have that. We had your specific training when you're assigned to a flight. A lot of that's the same, but I think it's more difficult now, because it's two programs, not one. It's the Shuttle and the Station. It's the fact that when we signed up, there was just a Shuttle, and now when you sign up, there's the understanding that you're eligible for an assignment for a long-duration flight to Space Station, which is a good thing. A lot of people want to do that. But that involves some sacrifice and hardship that we didn't have to deal with,

like learning a different language, traveling a lot out of the country, being away from your family a lot, and the flight itself being a lot longer, which is good, but it's bad being away from your family. So there's all that. Just a lot more to learn.

I think the office is bigger, so people don't know each other as well. It's hard to know 140 people as well as you'd know—when my group came in, there were about 60 people. But a lot of it's the same.

WRIGHT: Thanks.

JOHNSON: I just have a couple. You mentioned that you were assigned to SAIL at the beginning and that that helped you to understand the software. Did that make a difference on any of your flights, understanding that software better? Or do you feel like it helped you during your flights?

NAGEL: Oh, I think it did. Not that you had to work in SAIL to be adequately trained to fly, but we got to know the software and the associated avionics real well. The first flight we had an MDM, Multiplexer/Demultiplexer problem. In real life, the signatures are never the same as what you get in the simulator, but it probably helped me just in a broad sense, but it wasn't necessary for being adequately trained to go fly.

JOHNSON: And sort of a follow onto Rebecca's, when you entered with the '78 class and now dealing with the astronaut candidates and astronauts now, do you see any differences other than being younger?

NAGEL: Yeah, I got older, and they all got younger.

JOHNSON: Any differences in the people that are choosing to be astronauts as far as their training

or the way they tailor their education or anything of that sort?

NAGEL: I'm thinking here. Not really. No, I don't think so. I think, my group, the pilots, a lot of them had the Vietnam experience because that's the age we were. These folks, a lot of them had the Gulf War experience, some of them, anyway, some got some combat experience. They're very sharp. They're very smart. The others, no, I think the background and the education, the experience of the groups are fairly similar. They're just younger. [Laughs]

JOHNSON: That's all. Thanks.

ROSS-NAZZAL: Is there anything else you'd like to talk about that we've perhaps missed?

NAGEL: No, you've probably covered it. I haven't thought about a lot about this in years. So I'm sorry I probably forgot a lot of things.

ROSS-NAZZAL: No, I think you've done great.

NAGEL: Some people have a real sharp memory for everything that happened to them in the past, and I really don't. I forget about a lot of it, but it's all been fun. It reminded me of some of the really good times on some of these flights. Like 1985 for me was kind of a banner year. [Laughs] I don't think I could stand that pace very long, but it was okay. For a year it was great.

ROSS-NAZZAL: We want to thank you again for joining us today, taking time out of your schedule.

NAGEL: All right. Oh, thanks. No, it was my pleasure.

ROSS-NAZZAL: Thank you very much.

[End of interview]