NASA JOHNSON SPACE CENTER ORAL HISTORY PROJECT
ORAL HISTORY TRANSCRIPT

CHARLES D. WALKER
INTERVIEWED BY SANDRA JOHNSON
SPRINGFIELD, VIRGINIA – 7 NOVEMBER 2006

JOHNSON: Today is November 7th, 2006. This oral history with Charlie Walker is being conducted for the Johnson Space Center Oral History Project in Springfield, Virginia. The interviewer is Sandra Johnson, assisted by Rebecca Wright, and this is Mr. Walker's fourth oral history session.

I want to thank you again for joining us.

WALKER: My pleasure, Sandra.

JOHNSON: The last time we talked, we had just finished talking about your [STS] 51-D mission, and I think we had finished talking about that mission. You had told us that before your 51-D assignment, it was about a month after [STS] 41-D that you found out that you were going to be flying again. How soon after 51-D did you find out, or did you already know that you were going to have that third mission?

WALKER: Well, my management and [I] knew that we had one more flight under the original joint endeavor agreement of seven flights for the electrophoresis operations and space project of McDonnell Douglas'. With 51-D being the sixth flight of that, we knew there was going to be one more. So, yes, we knew we were going to fly again at least once.

NASA was manifesting in a pretty seat-of-the-pants fashion; compared to today, right now, toward the end of the Shuttle Program, where everybody knows pretty darn well what all the payloads for the next fourteen missions are going to be. It was different then. In those first ten, twenty missions in the program, NASA was trying to pack everything on board they could, and, of course, NASA was proceeding as one of their [objectives] with the Shuttle Program to capture commercial payloads, specifically communication satellites—other satellites, but commercial satellites, as well as flying research, NASA research and even industrial research.

So things were coming and going off the manifest, and that caused a lot of dynamic and some fairly short fuses, which was, as I saw it from Houston, my association with the Mission Operations Directorate and Engineering Directorates down there, that created a lot of tension. There was a lot of pressure to get things on board, get through all the processes, safety, materials testing, procedures, etc.

So I guess the point being a lot of dynamics, and specifically to answer your question, I think I remember that when I returned in April [from] 51-D that we knew there was going to be one more flight. At that point in time I think we thought it was going to be in the late summer of that year, of [19]'85. So here I was in April, and I'd flown the previous August-September, and I was looking forward to flying again, and there was still no one for my program, other than myself, trained to fly.

We did have at the program level in St. Louis [Missouri] at McDonnell Douglas Astronautics Company, we did have one other individual who we were, shall we say, in the process of selecting. I don't know how to put the words. He was really going through a bunch of internal company evaluations to make sure that in the company's mind that he was somebody that they wanted to bring forward to NASA as a candidate payload specialist.

While we had one more flight under that joint endeavor agreement, management was negotiating with NASA Headquarters [Washington, DC], Code M, for an extension of that joint endeavor agreement or, if NASA so chose, another joint endeavor agreement to extend the flight opportunities which we had. To reflect again on what the program was all about, we at McDonnell Douglas [were] looking to see developed both a middeck experimental apparatus [and a middeck] development apparatus for the purification of biomedical materials, using the weightless microgravity environment of space.

But there was a phase two, which was to use that technical information and that product and process information in the development of an automated system, which would be test-flown across the cargo bay of the Shuttle, and this thing was going to be big. In fact, in early ’85 and mid-’85, we already had completed the design of this system and were building it and into testing of it.

It was a 5,000-pound across-the-cargo-bay system. It was [equal to] twenty-four chambers, electrophoresis chambers; I think there were six of them. They were twenty-four times the capability of an individual electrophoresis chamber that I was flying in the middeck, and advanced electronics, advanced monitoring and control systems, as well as all the necessary support structure, insulation, and volumetric capacity for the fluids and the liquids, so that it could run out in the open cargo bay and run for a seven-day mission almost continuously, producing large quantities of purified pharmaceutical-grade material.

That development work was under way, and it was going to take additional flights beyond the seven under the original joint endeavor agreement in order to fly that at least once or twice, and we thought we’d have to fly it twice in a development mode before we knew it was going to operate to produce pharmaceutical-grade materials.

Then our pharmaceutical company partner, upon verifying that, would proceed with providing raw material to us, who would then package it and take it to NASA to be flown upon Space Shuttle missions in basically an automated fashion, probably turned on by an astronaut at a rear panel in the crew compartment at the beginning of the mission and monitored occasionally by us on the ground, and then turned off by the crew at the end of the mission, or intermediate operations if necessary. Orbital adjustments would probably cause it to have to be shut down, etc., but the crew would end up shutting it down [just before payload bay door closing].

It would be brought home, and you've got purified pharmaceutical materials. For that, the intention, both ours in the industry side, as well as the expectation of NASA at the time, was for NASA, the federal government, to receive compensation from us for that service. NASA would be providing a unique transportation service to the pharmaceutical industry.

Well, anyway, it would take at least a couple of development flights, we thought, for us to prove the hardware, so that would have taken an additional agreement.

In addition, we were thinking we would continue to use the middeck equipment on occasional Shuttle flights to do R&D [research and development] on new pharmaceutical materials, new processes, then either to produce pure material for research here on the ground, and since there are literally tens of thousands of potential biological or biochemical materials that could be purified with this process, we thought the sky's the limit in terms of the things that we could do with this for medical research, biomedical research, [or material for] other research activities here on Earth. So we suspected that flights would continue into the future with the middeck system as well.

I was kind of scratching my head, thinking, along with my management, when we left the office at the end of the day and we'd talk about what could happen out of all of this besides what

we were doing on a day-to-day basis, I was actually thinking, "My gosh, we could have our own astronaut corps, a private industry astronaut corps. If we really are going to fly these things at the rate that we're talking about and we're going to continue to do R&D aboard Shuttle in the middeck, then there's probably going to be somebody flying with this, and if NASA's really keen on it, then, yes, maybe that's what's going to happen."

Of course, with the turn of events in January of [19]'86, we never got anywhere close to that, and the change in national policy forestalled any possible consideration of that happening. As it turned out, that one last flight, the seventh flight of the CFES [Continuous Flow Electrophoresis System] Electrophoresis Operations in Space system on [STS] 61-B, was then the end of that program. But we can talk about that later.

To continue to your question, I think that I did not know that I was actually going to fly on 61-B for maybe a month or two after I'd landed, and NASA finally decided, in manifesting the next, that seventh flight in the joint endeavor agreement, of our middeck system, that it would be aboard 61-B. I think 61-B at that time—early in '85 was scheduled for the August-September time frame, and I think it then subsequently slipped; I may be wrong, but I think that's what the case was.

So now again, as had been the case on my previous flights, in working around the Astronaut Office and Mission Operations Directorate, I knew or had become at least generally acquainted with virtually all the crew members that were assigned to fly 61-B, which was mostly a flight for satellite deployments, three satellite deployments and two really big-time and important extravehicular activities. So I remember it didn't seem like it was a big surprise to either Brewster [H.] Shaw [Jr.] or the other crew members when I was assigned and joined them in planning the mission and training activities.

I think that Rodolfo Neri Vela, the other payload specialist on board, did join the crew later than I did, and [for] Rodolfo, it was his first flight and his last flight. He was there as, at the time, the payload specialist option that the Mexican government had agreed to have flown, along with their Morelos [Satellite Program, Mexican Ministry of Communications and Transportation] communication satellite payload. So I think the assignment of Rodolfo came later than my own assignment to the crew.

JOHNSON: You mentioned that it was a month or two, and you started training with the crew. How much interaction did you have during that training? Compare it to the training for your other two missions, and I know your second mission was a little different because it kept changing until you finally had the final assignment.

WALKER: Well, and it was different from my first mission, too, since in the case of 41-D, it was new to me. It was new to NASA; that was the first nonscientist payload specialist, non-Spacelab payload specialist, assignment, and so NASA was literally deciding what it wanted the payload specialist of that subvariety to do, what their training would be, etc., as I was doing it. So that was history by now, and NASA was more comfortable with what it wanted to see payload specialists trained in, the roles that it wanted to see payload specialists in. And I think the pilots, [the mission] commanders in the Astronaut Office, were beginning to get more and more comfortable with payload specialists as part of the crew.

It seems to me that Brewster was probably already aware that electrophoresis could appear on his mission. He, of course, knew that I had been flying with that, so would probably be assigned to fly with it there. He also was, I think, aware that the satellites he had on board,

two international satellites, one Canadian and one—I think Mexican was the only other satellite—but with a Mexican satellite on board that he might get a payload specialist assigned there, too. So he was, I think, ready to have at least one payload specialist with the crew. And then the interfaces with the crew were, as I recall them from [here and] now, [with the] perspective of time, as being kind of like, "Okay, so now we know for sure, and so let's just get into it and press on."

Brewster and I were the only ones of the assigned crew that had flight experience. That resulted in my basically being—shall we say, I wasn't held as close. I wasn't watched, I think, as close by the rest of the crew as I had been on certainly 41-D, where I was one of the new guys [among] five crew members other than Hank [Henry W.] Hartsfield [Jr.]. And on 51-D I was still on my second flight, but again, [after] so much bouncing around that we were all trying to learn from each other real fast, so we all kind of all stuck together close to get to know each other and get to know what we were all going to be doing on that flight. But on 61-B we had a few months yet. My procedures were pretty well already written, and so they just needed to be moved into the book.

The interesting part here, I would say, I'm going to emphasize, was that whereas on the previous two flights that I had flown, I trained a NASA mission specialist to be my backup in the flight. Well, on this flight, on 61-B, we, the company, wanted to have a backup named, that is, a company backup for me, another payload specialist. So NASA did agree to that, and that's when—and now I'm going to reference back to an earlier part of this interview when I talked about [how] we in the company thought that we were going to need to have additional payload specialists, and oh, by the way, Charlie Walker flying every seven months just seemed like a lot of pressure that maybe he didn't want and the rest of the company didn't want to impose. And

those were all good thoughts, good and correct thoughts. So I was looking for a little bit of a break if we were thinking about flying a payload specialist on yet another flight. And quite frankly, and I think I remember that there was a conversation with NASA management, between McDonnell Douglas management and my superiors and NASA management at JSC, and probably Headquarters as well.

NASA management, I think, came forward with the idea that, "Well, look, we, NASA, tend to fly with redundant crew capabilities on board. More than one person can do the job. You guys have been flying, and you haven't had a problem with the payload specialists doing their functions there, but we've had a backup trained [each] time. You guys ought to have, if you're going to continue to go forward with equipment aboard Space Shuttle, whether it's a NASA industry payload or whether you end up paying NASA for the opportunity to fly it, you're going to have to have redundant capability. We can't be maybe training the NASA astronauts to be the level of capability that you need, nor that we want to provide, because they've got other things they can be doing, too, other NASA, government, or commercial payloads that they could be operating."

So anyway, the company then went through that selection process internally for somebody that they brought forward to NASA as the second McDonnell Douglas Electrophoresis Operations in Space payload specialist candidate. Robert Wood was the individual's name. We would call him an IT [Information Technology] expert today, but he was one of the computer gurus in our project at the time back in St. Louis. So Robert went through all the physical exam wickets, the testing wickets, to be considered a payload specialist candidate. Then in it seems like maybe the May time frame of 1985 Robert started into payload specialist [training, to] the training syllabus, down at JSC. So he became known to the crew as

the backup for me, so Brewster and the crew had to get to know two people, and of course, this is a backup situation. Nobody's expecting that I'm not going to be flying it, but you've got to be ready. So that attitude was, I think, fully in place.

I certainly expected and was desirous to fly, myself, and quite frankly, I perceived at the time, I remember perceiving at the time, that the mission specialists and Brewster and Bryan [D.] O'Connor, that the crew really were sure hoping that nothing happened to me, because they were more comfortable with me, and they knew how I was going to respond in the space environment, having flown twice before. Robert Wood, they were just barely getting to know him and did not want to have to go through necessarily the dynamic of getting acquainted and feeling comfortable with him as a crew member somewhere down the line much closer to the actual going-to-fly mission.

So anyway, this was all going on during the summer of '85 as we got ready for a flight, which again, I think I remember correctly, slipped during the summer out into the fall and ended up at the end of November. So it was a little different. The relationship was a little different in that at some level it was a relationship of NASA Mission Operations Directorate, JSC, the training folks, and the crew and the Crew Office, with not just one payload specialist for the electrophoresis program, but two payload specialists. And then, as I said, I think in the middle of that flow, sometime in the middle of the year, in came the Mexican payload specialist, Rodolfo, as well. So it was interesting—I'm sure had to be an interesting dynamic for the mission planners, trainers, as well as Brewster, to adapt to and work around all of that interesting flow of people and process.

JOHNSON: During that flight Brewster Shaw placed a padlock on one of the doors, and there was some different speculation about why he did that. Do you have any thoughts about that or why you feel that that was done?

WALKER: [Laughs] Well, Brewster did—and I don't remember that I noticed him translate down from the flight deck within the first couple of hours or so of us being on orbit and place the padlock on the door. I think he must have done that after we opened the WCS [waste collection system]. With the WCS in operation, the door is normally hinged open and you can pull the curtain closed. In the first few hours everybody is going to the WCS, anyway, to take care of what the kidneys are now telling everybody is excess liquid on board. So he might have locked it then. I didn't notice it happening at the time, but within a few hours I noticed that it was in place.

It was a padlock on the handle, the rotary handle which opens or, alternately, closes and locks the crew access hatch, the middeck portside access hatch. So, yes, I noticed it, and I don't remember any conversation in flight about it taking place or about it being there. I don't remember any conversation even after the flight as to, well, this is why Brew did that, or this is what the situation was.

But there have been other conversations which I've heard and have been made aware of about a situation with one crew, and it's a completely different payload specialist, earlier—earlier than our twenty-third mission—in which in flight this individual expressed and, I guess, was observed to behave in a fashion that made the NASA crew a little unsure as to this individual's actions and intentions with regard to the security of the crew cabin and the hatch door. So I was aware that there were concerns about payload specialists and, shall we say, the

safety of the crew, given the uncertainty, at least in the NASA flight crews' minds, of the background and intentions of these payload specialists.

So I think, and again I've had no conversation with Brewster to verify this, but I just have to think that that sentiment as an undercurrent within the Flight Crew Office at the time led Brewster to want to make sure that, by gosh, nobody can accidentally open this hatch. There's no reason to open that hatch, anyway, in flight, [in space,] none whatsoever. So I think he just decided that he was going to make sure that that wasn't an issue that he needed to worry about day to day, minute to minute, in flight. To me it's perfectly rational. I might have done the same thing if I had found myself in his shoes.

JOHNSON: Was there anything significantly different, as far as the launch on this flight, from your other two experiences?

WALKER: Well, it was a night launch. That was the significant difference. That was the big significant difference. Now, there were other differences, of course. This was a different crew of individuals than I had flown with before, different individuals, and so the level of tension-relieving jocularity was a little different and maybe not quite as vociferous as with the 41-D crew, say, the "zoo crew."

But it was also a night launch, so I do specifically remember that it was only, I think, the second night launch in the program after STS-8. We went out to the launch pad, and it wasn't quite yet totally dark. So here we go up to the 190-foot level on the pad, and it's dusk. If I remember right, the sun had, in fact, set, but it wasn't totally dark yet, and so here you got to see the lighting around the Space Shuttle on the pad and the pad area change from near daylight to

complete darkness, except, of course, for these xenon lights, which was like—it probably had to be the second most brightest spot on Earth besides the whole dayside of the planet at that point in time.

These xenon beams coming up at the launch tower, the complex, and the vehicle, but the lighting angles, of course, are just about 180 degrees away from sunlight coming down on you from overhead. These are beaming up at you from below. So a completely different perspective, and yet it's still the same vehicle that's creaking and groaning from the temperature and expansions and contractions of the cryogenic propellants and the ice dropping from the lines feeding the big external tank, the wind blowing through the structure and past the vehicle from the ocean, an occasional bird carrying on out there, and not much other noise than that. So it was an eerie kind of otherworldly perspective to see this gleaming rocket ship standing there in its own light. The rest out there beyond you is just completely dark.

Getting on board the same as before on my flights, basically, and I felt more comfortable at it, but still you don't do this kind of thing without being nervous about it. So getting on board, more or less the same; a little more comfortable. Sitting in the middeck, being ready to fly, I had, as I'd had on 51-D months before, had somebody sitting on the middeck right beside me. Now, going uphill was Mary [L.] Cleave on the hatch side, but to my right was Rodolfo.

So it was a little bit difference experience. Rodolfo was not Jake [Edwin Jacob] Garn, which, the last time this had happened to me, that Jake was sitting there. Jake was a little more conversant. Rodolfo, I think, was nervous, as one would fully expect, but his nervousness kind of equated into, well, he didn't really say very much. His English was perfect; some of his education took place in England, University of Essex, I think. So his English and understanding

and use of the English language was great, so that wasn't an issue at all. Just nervous and didn't have that much to say.

So I kind of watched as he had been strapped in, just making sure that everything, to my eye, was right. I remember we put on our gloves at the same time, and it came to the last couple of minutes in the countdown, and put down and latched our helmet visors closed. I think I remember looking over at Rodolfo to make sure that his visor was closed and locked okay.

So then we get down to the end of the countdown, and unlike my other two launches, this one went real smoothly in that regard. There wasn't a last-minute delay because of a ship out there in the drop zone for the SRBs [solid rocket boosters] or aircraft circling the area. So liftoff happened, and we're on our way. I remember my previous flights, daylight, I loved to look out the side hatch. There wasn't anything else to do down there in the middeck except maybe worry about the latches on the lockers, which were up there in front of me, and hope that those had been secured nicely. But I think I got my head through that, so I was, as we had left the launch pad, looking out the window.

I remember that previously here was a steel gray launch pad which suddenly became a white-yellow launch pad with the brilliant illumination of the SRBs now reflecting off of it, with the blue sky in Florida background behind it. Well, here at night, now, you look outside, and this launch pad is a blue-gray from the xenon light reflections bouncing off of it, with a completely black background behind it.

All of a sudden the launch pad brightens up again with the solid rockets igniting. The launch pad brightens up to a yellow gray, but then the whole background, suddenly there's like a sunrise that's happened over Florida. It's no longer black behind the launch pad as you're looking through the launch pad out that port hatch window. Now you can see the Florida

landscape for miles back that way. Sure, the sky is still black, but suddenly Florida has been illuminated by a new sunrise. So as we left the launch pad, and in four seconds' time you've left the steel of the launch pad behind, and now I can see the Florida countryside, and it's a yellow, white-yellow-orange color, the coloration of the brilliant hot flame from the solid rocket boosters, primarily.

Then we rotate around, and I'm watching the dark sky, and I could see the dark gray-blue of the ocean from a distance, barely illuminated by the SRBs, rotate by, and then I'm looking elsewhere down the coastline. From what I remembered before, again in the daytime, I knew where I was looking, and within [that first] minute the coastline is lit up brightly again, but then it starts to fade out as you climb away from it, and the illumination diminishes and dims on the ground. So the ground below me starts to vanish, and, of course, it's black in the distance, anyway, as we're looking south. I'm looking south out that port window.

Now, this whole time, the ascent, as it's been before, rocking and rolling and going uphill. Kind of occasionally I think I remember looking out the corner of my eye at Rodolfo, and he's holding onto his seat like I'm holding onto my seat and doing nothing else, and we're not saying anything, of course; listening to the proceeding of the launch as best we can tell over the intercom. With the solid rocket separation, wham! [Laughs] I remember that—I don't think we were supposed to, but Rodolfo and I unlatched our visors at that point, of our helmets, so we lifted them up, and so we could talk to each other now shortly after the SRBs separated. We could talk to each other without talking over the intercom.

The situation is that the vibration from the SRBs is gone when they burn out and separate. Suddenly the ride and the acceleration drops back from a little over two gravities to

just one G as you start to accelerate now just on the main engines. I can remember sitting there thinking, "Oh, my gosh, the SRBs are gone. That's good. Here we go."

Rodolfo says [whispers], "Charlie." In this low voice, he says, "Charlie."

"Yes, Rodolfo."

He says, "Have we stopped?"

And I think I remember like, "Oh, gosh, where was this guy during that lecture?" But I told him, I said, "No, Rodolfo, everything is fine. We're still on our way. Six more minutes."

[Whispers] "Okay. Okay." [Laughter]

So, there's six more minutes. I remember after we got into orbit that—in fact, I think that Brewster or Bryan reported to the ground. Even back then there was a standard check with the ground, after you're on orbit, of how did the separation appear, how did it sound. I think they noted, and Brewster, again, was the only veteran on the flight deck, so he noted that the SRB separation sounded a lot louder to him than he remembered it during his STS-9 flight. I didn't register that in my own head, but it probably was the case; it was probably a little louder than it might have been on other flights, for whatever reason.

But he also noted, and they note to the ground, the pilots note to the ground other observations, like debris hitting the windows, and of course, this was long before [the Space Shuttle] *Columbia* [accident, STS-107] and the realization of the threat of foam from the external tank to the vehicle. But I remember that either Brewster or Bryan reported that Bryan O'Connor's, the pilot's, window took a couple of hits, it seems like to me, from what they thought was insulation from the tank during ascent, I think even before we went through Max Q [maximum dynamic pressure]. So again it was noted as, "Well, it looked like some kind of big

chunks of insulation hit the windshield, but—you know, left little white marks as they smashed against the window, but they're gone and no damage." So it was duly noted, and move on.

But as I think back on it, I think, gosh, you know, the things we didn't imagine were happening to us but probably were happening to us at the time. Something else that I recall after the fact, certainly after the loss of [the Space Shuttle] *Challenger* [STS 51-L], everybody, I think, tended to look at the record of how solid rocket boosters had performed during each of the flights previous to 25, STS-25. I recall that—again, this was in '86 or '87 looking back at then the public record—that there were burn-throughs noted by the [Morton] Thiokol [Incorporated] and NASA team that would disassemble the solid rocket boosters after each flight, the casings. There were burn-throughs, or—I'm not correct in saying it that way. There were burns, not burn-throughs, I don't think, but burns on the inner O-ring, the primary seal on at least one SRB in one segment on each of my three flights, including that last flight 61-B, which was two missions before *Challenger* [was lost].

But again, that was something that, in retrospect, I don't think the crews, and me as a payload specialist, I know I don't recall ever hearing anything about that during my training or crew briefings, systems briefings. I don't think that the office heard much about that. Whether it was spoken and it was just like another one of the little details, or whether it wasn't spoken, I don't know, but I was not made aware of those as issues that really somebody should look into. But after the fact everybody's sensitive to it, so I noticed it, and on all three of my flights there were those scorches on the O-rings of the SRBs that had pushed us to orbit.

Anyway, we got on orbit, and then again it was business as usual, so to speak. A crew that's highly ecstatic in the seconds just after SSME [Space Shuttle Main Engine], the main engine, cutoff. And then you get right down to getting things set up for orbital flight,

transforming the Shuttle from a rocket launcher to an orbiting space vehicle, and so proceeded into the operations, which needed to start right away. I was going to turn on the electrophoresis apparatus that first day before the day ended for us on orbit. If I remember right, I think the crew was launching a satellite that day as well, so lots of things had to happen, and again, all the transformation details of transforming the software loads, the commanding structure, the onboard systems to an orbital vehicle from a launch vehicle.

JOHNSON: Shortly after you achieved orbit, Brewster Shaw and Bryan O'Connor, they performed a main propulsion system dump, and Bryan O'Connor remembered it as causing quite a visual effect of a bright flash of light when the reaction control jets fired. He mentioned that he and Brewster were discussing it, and they felt that they probably frightened the rest of the crew with their discussion, but they were trying to figure out exactly what was going on. Do you remember that incident?

WALKER: It seems that I do remember it as—I wouldn't have characterized it and I don't remember it as frightening. I remember it as another, and I remember automatically throwing it into the category that had several items in it, by my experience at this point in time, having flown twice before, of another one of those awesome sights and/or sounds of the space flight experience. A little startling, maybe, but within a second you think of the rational reasons why it happened, so nothing to be afraid of; but gosh, really impressive when it happens. Because, I didn't see it. I didn't experience it. Myself and at least a couple of the other crew members, Rodolfo and Mary, were still down in the middeck, and I think I remember it, yes, kind of like,

"Wow, those guys really took note of an interesting phenomenon then, back there, behind the vehicle."

The timing, I think, was such that, again, the vehicle would have been in darkness, in the complete darkness on the nightside of the Earth. So compared to my earlier flights, and probably, given that this was only the second night launch, probably most if not all previous Shuttle flights to that point, save for STS-8, the flash of any reflection, or should there have been any ignition, and I can't imagine that there was enough density of gas out there surrounding the back end of the vehicle where there would have been any ignition take place. But just literally a cloud of particles that, upon the flash of the RCS [reaction control system], the reflection of the illumination would have been like you're inside of a cloud, or you're seeing a reflection from a cloud. That would only happen when you're in the darkness, the shadow of the Earth, versus all those other flights where they were probably still on the daylight side, and the sunlight would have completely masked that reflection phenomena. So probably one that had not been observed before at all, so consequently a good observation on their part.

JOHNSON: Well, how did the CFES apparatus operate on this flight? I know on the first one you had some disappointments with some of the contamination, and you had better success with the next flight.

WALKER: It operated quite well, actually; not perfect, but quite well. The first flight I accompanied it on, which was the fourth flight of that kind of equipment, my first flight, 41-D, we didn't know that we were contaminated while it was going on, so I thought everything was working well during the first flight. It was only within a week or so after we had returned that

our team found—and we were then, upon inquiry from whoever might have been asking from the outside, we were clear with them that yes, we did encounter some problems, we'd come to find out now. So I thought things were working fine that first flight.

Second flight, we had some difficulties with electronics, actually some programming difficulties. There were set points with pressures and temperatures, so I just needed to do a little bit of reprogramming in flight. But other than that I think the only problem might have been the formation of gas bubbles as part of the electrolysis process that went on different from the electrophoresis thing, but a part of the subsystems operations. I had to overcome that or try to overcome those, the bubble formation difficulty, in that flight.

But on this flight, my third flight with the system, it was a different system yet. We'd upgraded it, as one should do in scientific or technical research and development and experimentation. Every time you find out the way something works now, you work to make it work better, so you change systems and you change processes and procedures, and you try to get up to the next higher level of ability to operate.

That's what we were doing on this flight. We were yet one more level of advancement from having modified the equipment to where it's now—what I was flying with on 61-B was not purely a research and development test. It was now a preproduction test. I've mentioned that production apparatus, which would be flown and operate out in the cargo bay of the Space Shuttle, that was still in final testing back in St. Louis for a future flight. In fact, we were manifested, tentatively manifested, on I think it was STS 61-M tentatively in June of 1986.

This flight that we're talking about now, 61-B, was literally testing some of the production flow processes, settings, and software subsystems that would be flown in another eight months aboard that EOS-1 [Electrophoresis Operations in Space], as it was going to be

called, in the cargo bay of Shuttle. So this was a preproduction flight. I literally had, not a series of samples to be tested—separated, purified, and tested—as I'd had on previous flights, but literally one major sample, over a liter, about 1.1 liters of one particular impure hormone in a single tank aboard the apparatus. I was working continuously for 175 hours or so during the first few days of the flight to have that quantity flow through the machine and separated and collected, and its pure fractions that we wished to have collected in pure form, collected and isolated aboard the apparatus.

Now, in addition, once I had that primary objective done, then I had secondary objectives to be done, which included some small individual test samples, different concentrations of sample and buffering fluid, so that we could get a better idea of what the maximum levels of concentration of these proteins or hormones or enzymes that we would want to purify in the future with this apparatus, what the maximum concentrations that we could work with would be. In other words, we were just trying to establish the operating limits of the device with the kinds, the characteristics of materials, biological materials, solutions, that we were planning to work with in a production and commercial basis in the future. [The determination of zero-g operating limits could be verified only by working in zero-g.]

So I had those secondary samples, a number of those that I ran toward the end of the mission. Now, all through that then I would also collect samples. These were samples to characterize not only the operation of the device to make sure that it was still collecting at each test twice a day, collecting pure fractions of the preproduction material that we wanted to collect, but [samples] that it was also operating cleanly.

Based upon the problem that we had on my first flight, we now had a well-refined test kit to literally allow me to withdraw a sample of liquid, inject it into a small test pocket in a plate,

test plate, wherein there was nutrient that would grow any bacterium that might be in that selected sample. So I was literally going to be able to see in flight if I had contaminated materials or the process had become contaminated, and we never saw that. So I was verifying to myself and to folks on the ground and in the project that we were running without the problems that had developed on 41-D.

So those things all went pretty well. Now, however, I said it wasn't perfect, because I recall that another advance that we had with our apparatus on this flight was that we got to expand the volume and the mass that we could carry—a fraction of a storage locker—to carry spare parts, because it had become clear to us on a couple of other flights, for instance, the earlier flights that I'd flown, that, for instance, [there was] the bubble problem that I had encountered earlier. That really could become a major problem in the long term, many tens of hours of continuous operation. When you tried to have a stable electrophoretic process operating, bubbles could cause instabilities.

So we needed to have some way to make sure we could overcome that if it should happen. We also wanted to have a spare pump. We had lots of liquid pumps operating in the device, and if any of those should go bad, well, you're just dead in the water, so to speak, so you'd like to have a spare pump. So I had a spare pump. I had a spare de-aeration—it captures and literally absorbs the bubbles—a de-aeration device that I could connect via some valves and temporary connectors; that I could plug into the apparatus as an augmentation to what was already in the device.

I needed to have that, because, as it turns out, I remember several tens of hours into the operation, the bubble formation problem began on this particular flight as well, and so with consultation with the ground, a quick consultation, I basically said to my folks back on the

ground, "I'm going to plug this in. The bubble problem, to my eyes, is going to continue to build up here, become a problem. I'm going to try to hit it early."

So part of the way through the operation of the device I literally took the side panel off the flow chamber apparatus. Now, this panel is probably four foot in height and a foot and a half wide and bolted onto the side of the flow apparatus with—and I'm forgetting here now in time—but it had to be a good two dozen or thirty quick-release bolts. And there was a seal to prevent any liquid that might be leaking inside from getting out into the cabin. But I needed to get in there to interconnect this de-aeration apparatus. So I took the side panel off, and I let the crew know what I was doing, so if there was any immediate problem or a concern on their part that, well, we'd figure out a way to overcome those issues and yet try to get that emergency procedure on my part done—not an emergency, per se, but an auxiliary procedure—finished.

So I let them know. I did. I opened up the side panel, and lo and behold, I remember that we had apparently had either a moisture leak, slight leak, around some connector in there during the several hours of operation before, or it was condensation, maybe, from just temperature differences and that the moisture in the air was condensing on the cold fittings in there. Anyway, there was some liquid in there that kind of drifted out a little bit, a few drops that drifted out into the cabin. I remember I think Mary was a little anxious about that, or certainly noticed it and expressed, "What's that? Can we keep that from happening again?"

But I don't think it was a problem, although a couple of us afterwards noticed a little bit of an eye irritation, so there might have, in fact, been something, some solution, some salts, maybe from the solution that we were using, which had no toxicity to it as such; it was just a little bit of an irritant. But apparently that did happen after I opened the door and before I could seal the hatch again—or the side panel—with the connections having been made. So I had to do

that, and I had to reverse it at the end of the flight as I was deactivating my device, disconnect that apparatus that I had connected in an auxiliary fashion; take the side panel off, break the connections, put the side panel back on then, and stow away all the equipment, such as it had been launched for reentry and return. So the operation had to be repeated.

But the activity overall was a success. After the mission an analysis by the laboratory folks back in St. Louis, Missouri, with the company revealed that we had separated as we had expected. We had collected the pure materials as we had expected to do. So we were extremely happy with the outcome of the flight and were very much looking forward to the next big step up in our project, our commercial project, to fly the first R&D version of the semi-automated system out in the cargo bay of the Shuttle in mid-1986.

JOHNSON: In September of ’85 Ortho Pharmaceutical had backed out of the CFES because they could do it cheaper without the space travel. How did that affect the project itself and your plans to go forward with the automated version?

WALKER: Well, I would characterize it as a bump in the road. It was a pretty good bump in the road, but the vehicle, which was the project out of McDonnell Douglas, continued on down the path. As we went into the fall and into the flight of 61-B, we were courting other pharmaceutical companies to develop with us the same material, the erythropoietin. It was right about that time that I think we publicly announced that it was erythropoietin that we were developing. Up until that time it was a company proprietary secret as to what we were doing; competitive security, and Ortho Pharmaceuticals had insisted upon that, for competitive reasons, to that point.

So, and I don't remember exactly the reasons why; maybe it was Ortho that in fact revealed that it was erythropoietin that we were working together on. But the relationship on that material went away. I mean, just literally, as for the stated reasons, their business plan, in their minds, was not going to work out. Competitive pressures—genetic engineering, primarily—other competitors having made some real advances that they had just determined on their own. Other competitors had made real advances in ground-based processing of erythropoietin. So they basically said, "Well, on this material we can't proceed along."

We still had an agreement with Ortho Pharmaceuticals to develop materials that were competitively positioned to be purified using the advantages of microgravity and space flight, and so we were looking with Ortho for other materials that we could work with. What I flew was erythropoietin, and again, we were marketing it to other pharmaceutical companies. In fact, I think at that point in time we may have even—by the time I flew, we may have had signed an agreement with Riker Pharmaceuticals, which was a part of the 3M Company, for that material. In other words 3M Riker was replacing Johnson and Johnson [Pharmaceutical] in the business plan which we, McDonnell Douglas, had under way, in part with these R&D flights aboard Shuttle of the middeck system, and then later to be the production system in the cargo bay.

But we were also talking to a couple of overseas pharmaceutical companies, one in France and another two in Japan. So it was a bump in the road in that it changed the details of the business plan. It changed the name of the pharmaceutical company partnering with us for that particular product in development, but it did not change at the level at which I was working, which was the technical development of the process itself. It didn't really change that. The electrophoresis process is the electrophoresis process, and you can separate one of tens of

thousands of types of hormones or enzymes, proteins of all kinds, in solution. You can separate dozens if not hundreds of types of living cellular bodies in suspension in the device.

We were actually even at the time doing our own internal research at McDonnell Douglas and consulting with some other companies about wild things like even doing solid suspended materials like ore separations, rocky ore separations, with this device, things that could never be done with this process here on Earth because sedimentation would make it completely just laughable to even talk about it.

But when there wasn't any such thing as sedimentation in a place where gravity is not a concern, then it becomes possible to use the electrical charge characteristics of any small, microscopic or even very tiny particle suspended in a fluid to separate it from any other type of material, and so you could separate any kind of thing. So we were talking to others about kind of wild projects, nothing that ever even got into the laboratory test phase on Earth.

But back to the point, even with that partnering arrangement adjustment in the fall of '85, we still had other prospective customers out there, pharmaceutical companies and otherwise, that we were in active conversation with, and as I said, we had either at—and my memory is not good enough to tell me right here, remind me here, as to whether McDonnell Douglas had signed with 3M Riker at the time I flew, or if not then it was immediately thereafter, within December, probably, for development of this product. So we continued to work.

Let me just add that what I've just said should not be taken as an attempt to discredit the statement of Ortho Pharmaceuticals at the time, that is, the part of the statement which said that they could no longer proceed with the pursuit of this erythropoietin product because of competitive pressures and then technical advancements and the like. That statement was completely accurate across the board. There was a tremendous advance at that point in time, in

the early eighties, mid-eighties, tremendous advances in genetic engineering within the pharmaceuticals and medical diagnostics research and development and manufacturing business arena. New companies were springing up not only across this country but around the world that were using genetically engineered bacterium and cells to stimulate artificially, so to speak, stimulate and increase the production of medical materials, pharmaceuticals which, coming out of those cells, looked just like the pharmaceuticals that come out of natural cells within the human body, say, but they were just produced by a different living engine, a different kind of cell than what the body uses to produce them.

So erythropoietin was one of those, and AMGen [Applied Molecular Genetics], just to name the company that was the primary antagonist to Ortho Pharmaceutical's business pursuits of the time, AMGen was just getting started, but was showing tremendous advances in producing this anticlotting enzyme, erythropoietin, its natural name, and tremendous advances in producing it in large quantities using genetically engineered cell lines. The prospect was that that was going to continue over the years and decades ahead from that point within the pharmaceutical and medical research business with almost probably any other kind of cell that you could genetically modify to produce the hormone or the enzyme that you wanted to see produced.

So that was a real threat, and we were very much aware of that. That was part of the reason why the Electrophoresis Operations in Space project at McDonnell Douglas was trying to make inroads into other communities, other business realms than just the pharmaceutical and medical business realm, to look at other products that could use this electrophoresis phenomenon.

But let me just back up half a step and say that we were also, at McDonnell Douglas, continuing to find ways to use the electrophoresis process here on Earth, because we had

apparatus. Much of my time between my Shuttle flights, and certainly years before my Shuttle flight, was spent in the laboratories in St. Louis working with different varieties of electrophoresis apparatus that we had built from basic principles, and apparatus that worked much better than any other kind of electrophoresis device here on Earth at that point in time. We had devices that were better on Earth and unique in space at using electric fields to purify, separate and purify, materials of all kinds, living cells, hormones, enzymes in solution, etc.

So we were doing work on the ground in addition to what we were doing in space as a part of our overall business plan to provide this technical purification service to, first, the pharmaceutical and medical research communities, but maybe to other communities as well with other kinds of separation and purification needs for either research or manufacturing purposes. So we were trying to broaden our business opportunities as well, again, at least in part in recognition of this threat of genetic engineering to the pharmaceutical community in the purification realm.

JOHNSON: You actually launched the day before Thanksgiving. Did the crew have a chance to celebrate?

WALKER: We launched on the earliest date scheduled. Again, the manifest changed, but I think down to about launch minus three months, the 26th of November was set as the earliest date for launch of the 61-B mission, and we did end up, obviously, launching on that date. So we knew in advance that we were going to be launching—we felt we knew; we were certainly planning on, let me put it that way—we were planning on launching and being in flight over the

Thanksgiving holiday. So, yes, we did plan on a celebration up there, and we had worked with Rita [M.] Rapp, who was the Foods Manager at JSC for the Flight Crew Office at the time.

We worked with Rita to come up with a menu, and the dietitians, to come up with a menu that they, as the dietitians, would agree with, but yet were peculiar and specific to the holiday. Certainly turkey; yes, we had sliced turkey in the presterilized containers, aluminum packages. So we had sliced turkey and/or, if I remember, or ham as an option. We had relish in plastic containers. Actually, this is the first time I had encountered during the flight that NASA apparently even just bought the container off the shelf and didn't repackage it, and I will presume that, of course, the circumstance was not exceptional; it was just a matter that the packaging turned out to be outgassing-safe, etc., etc. It met all the criteria.

So we had relish, and we wanted dressing. I don't think we got dressing as such. We had vegetables. We wanted a pumpkin something; we wanted pumpkin pie. The crew specifically asked Rita for—and if I remember right, Rita said something like, "Okay, I can fix you pumpkin pie, and so let's plan on that."

Well, what everybody knew was, of course, Rita's selections had to go through the Engineering Board and all that, so the engineers had to have their cut on it. Well, we found out later—because we didn't get pumpkin pie. We actually flew with pumpkin bread. The reason we didn't get pumpkin pie was because when the review board looked at pumpkin pie—and so I think actually somebody even did some testing; I think I heard later there was some testing of a pumpkin pie.

See, the foodstuffs have to not only be in outgassing-safe containers, but the materials, the foodstuffs, have to withstand the launch environment. So apparently somebody did the jiggle test, the vibration test, on the pumpkin pie, and what we were told later was, "Well, pumpkin pie

does not make it to orbit. The center of the pumpkin pie turns back to liquid, so you won't have pumpkin pie, you'll have pumpkin slop in orbit, and you really don't want that, so sorry, no pumpkin pie."

So Rita said, "All right, how about pumpkin bread? We can do that, and that will work, we know." So we had pumpkin bread on orbit for Thanksgiving.

I remember we had stickers on the food [containers]. Somebody had put cute little stickers on the food, like I remember on the turkey container there was a little cartoon turkey that was holding up a sign saying, "Eat more beef." So it was cute. We didn't have jack-o-lanterns for the holiday, the overall holiday autumn season and that kind of thing, but we did have a meal. We certainly sat down, and Brewster made sure that we all were together during the meal. We had to educate Rodolfo a little bit about this holiday, but he was into it. Again, Rodolfo was very familiar with North American culture, so he knew what it was all about and was very much into the whole thing. So we did celebrate Thanksgiving. We thought about it. I think we sent our families messages from orbit.

Rodolfo, just to mention, Rodolfo had, of course, the desire, and probably the need, as it was perceived back home from Mexico, to be seen to be flying with some local Mexican cultural things, and so food was one of those. And just for a comfort level, I'm sure Rodolfo wanted to fly with some Mexican cuisine. So that had all been arranged in advance as well, and so one of the things that Rodolfo wanted to fly with, of course, was flour tortillas.

In retrospect, I think that this amounted to something of a minor revolution in the U.S. Manned Space Program, in that up to that time, of course, when crews wanted to have sandwiches in orbit, well, you went into the pantry, and you took out the sliced bread, sliced leavened bread that had been flown, for your sandwiches. Well, sliced bread, of course, always

results in some degree of crumbs, and the crumbs don't fall to the floor in the cabin in space. They are all around you, in your eyes, in your hair, and so it's messy and just not that attractive.

The crew saw Rodolfo flying with these flour tortillas, and immediately thought like, "Ooh, this may be real good," and it was real good. It was real good. It was tasty, after all, but when you took spread or anything that you wanted to make into a rolled sandwich, and devoured it that way, but it was just no-muss, no-fuss kind of thing. So, actually, I remember taking some sliced bread, but there may have been some sliced bread that even made it home, because we just found that the flour tortilla thing was well in advance of sliced bread, crumbly bread, for the preparation of sandwiches or just as a bread to go with your meal. The flour tortillas worked well, much better than that.

I think that there's still, as an option which is often pursued by crews, of flour tortillas today. So it happened on that flight, thanks to Dr. Rodolfo Neri Vela.

JOHNSON: Plus they fly well. I've seen the video of them tossing them.

WALKER: But you haven't seen the bread toss, huh?

JOHNSON: No, I haven't seen the bread toss.

WALKER: Well, gosh.

JOHNSON: I have seen the tortilla toss. [Laughter]

As you mentioned, there were a couple of EVAs [extravehicular activities] planned, the EASE [Experimental Assembly of Structures in EVA] and ACCESS [Assembly Concept for Construction of Erectable Space Structures] experiments, for Jerry [L.] Ross and "Woody" [Sherwood C.] Spring to see if they could actually do construction in space. Do you have any memories or specific memories of those EVAs? Were you able to watch them?

WALKER: Well, I do have specific memories, and they kind of go like this. First of all, knowing that they were going to happen in advance, part of my electrophoresis R&D work had, as a planned step, the shutdown of my process and then its restart; shut down before the cabin was depressurized, or reduced pressure down to 10.2 psi from the normal 14.7 psi, and then restarted, my apparatus restarted and recalibrated after the cabin pressure had stabilized at 10.2, because the cabin is reduced pressure to 10.2 like a day before the crew does an EVA.

In our case, I believe I remember that we stayed at 10.2 for not only the first day of EVA, but through the interim day and then through the third day, or the second day of EVA, which was like flight day three, four, and five, I guess. So I had to change my apparatus' operation to accommodate the cabin reference pressure that had to be reduced, again, for the EVA activity. So I remember working in and around that.

But separate from that planned situation, I remember the energy that Jerry Ross and Woody Spring put into their anticipated activity. They were really looking forward to this. Now, they had worked. They had worked long, long and hard, on not only the procedures but the tank training, neutral buoyancy training, preflight, to get these procedures down and to work through this efficiently and reliably and successfully. So they were really primed for the EVAs.

They were really ready for them, and the rest of us were, I can remember, not just watching, but helping Jerry and Woody get into their suits, into their gear, [EVA] day. All of that was going on in the middeck around me, which is where I was working on the electrophoresis apparatus, anyway. So, yes, I could find time to spare to help them out with this, that, and the other thing. I was just peripheral to all that, but still an extra pair of helping hands.

I can remember them going out the hatch and taking pictures as they go out through the—there's a little porthole on the inside hatch door to the airlock, and I can remember taking pictures through there and adjusting the exposures to get the right pictures and all of this as they're going out, because I'm not doing anything now at this point in time. It's everybody else that's helping them with the inside communications and pressure checks and continuity checks and all.

But going outside, and then seeing them outside in the cargo bay putting together the various components, the beams, the bars, the connectors, that all went with the erector-set kind of structures that were out there prepackaged or stored for them to assemble into the various structures and arrangements that they were experimentally working to do. Seeing them doing that was really interesting and exciting. In my own mind I could stretch it forward to a day when what they were now experimenting with would be used by future astronaut crews to actually assemble a Space Station in orbit, because this is what it was. It was literally some of the earliest development work to teach us, all of us, how to design and then operate in the space environment in the assembly of a station in space.

So it was exciting to get a chance to watch them. Now, I'd just pop up and down through the interdeck to the flight deck and look outside every hour or so for a few minutes, and then get back to my work in the middeck, but I can remember that the rest of the crew, Brewster—

Brewster was really excited. This was one of the not very many moments in flight when I registered the recognition that, "Gosh, Brewster is really excited about this." Besides that, he's this kind of the hotshot, ho-hum pilot kind of guy and just taking things on the even keel.

But god, he like, "Wow, isn't that amazing to see them out there?"

"Yes, it is, Brewster. It really is."

And to hear those guys outside carrying on, and the expertise that I remember Mary Cleave putting into the work that she did on the RMS, moving them around, Jerry and Woody out there, during the explicit parts of the exercises where she would manipulate the arm with them, one or both of them, on the end of the arm as they would then move the structures around in free space to test the mobility of those things and the ease of mobility in free space. [Laughs] I remember, Mary being as diminutive as she is, and she's what, I don't know, five-foot-one or something, fairly diminutive, and so here she had to operate the RMS from these panels at the aft station of the flight deck, the panels being just below the windows.

Well, if she had her feet in the straps on the floor as foot restraints, she literally could not see everything over the windowsill or work the panel, all that together. So the crew hooked up a bungee or two, a bungee cord, strapped a bungee cord between switch protectors on the panel just below the switch panel; in other words, on the front of the panels below the windows, and Mary could move herself into a position where she was at a right comfortable working height, where she could see out the window and work at the panel at the same time, but her feet were like six inches to nine inches off the floor. We put the bungee cord, or the crew put the bungee cord, stretched the bungee cords out and around her and behind her legs so that the bungee cord literally pulled her to the panels, and she was kind of pinched between the bungee cord and the

panels. But she was then secured in the spot where she could work, and they just kept her from floating around, and so that worked just fine for Mary.

But she was very intent on getting that RMS job done with a couple of guys out there, her buddies, on the arm. I think maybe there was a good degree of nervousness on her part, but she was well trained at it. I remember standing behind her occasionally in training in Building 9 in Houston, JSC, and she was working with what she and the crew and the trainers called "Captain Cardboard." At the RMS trainer at JSC, they, at the time, and maybe they still do today when they're using the real mechanical simulator, used a full-sized cardboard cutout of a person on the end of the arm so you could get the orientation and see the orientation with your own eyes as to where you had this person.

So she spent long hours, not only working the procedures out, but then working with the procedures and the manipulator training system, flying "Captain Cardboard" around. Now she was doing it for real, and she was well prepared, but still, I think, a little bit nervous at doing it. But it all came off perfectly.

So it was really exciting to see these guys get a chance to do that. I remember when they came in at the end of their first day out there, the first EVA, the first one of the two EVAs, that they were excited as could be getting out of the suits. "Wow, that was really—doing this, doing that, looking at the view, and man, you just can't hardly describe it." We had then the evening meal very shortly after that, and I remember there was a lot of silence, certainly after the meal. They just wilted. It was so physically draining that even in as good a shape as Jerry and Woody were in, that both the physical workout as well as, I guess, the emotion and the adrenaline of the experience, they just kind of ran up against a wall.

The next day, it was a much slower day, because there was a planned day between the two space walks for them to rest and to check out the suits and recharge the suits and get them ready to go back outside again. For them it was a much-needed in-between break, and I think Jerry and Woody made the comment postflight that this was absolutely the way to do it, not consecutive day-do-day space walks, but with a day in between, because they are so draining and so physically demanding that you really need that extra day to get your energy back to go out and comfortably and reliably do the next space walk.

So at the end of the first day—I think it was at the end of the first space walk, too, that they did something different than the continuum of assembling structure in space. Woody was to launch a satellite, and this may have been the first personally launched satellite; maybe the Russians had done it before this, but I'm not sure that they had, either. This may have been the first personally launched satellite. It was in two parts, and it was literally two circular plates that fit together in a cross fashion, so they were perpendicular to each other, and they formed a rough sphere in two planes, if you know what I mean. It was kind of checkerboard in painting, black and yellow, if I remember.

So Woody got the two pieces out of the carrier out in the cargo bay; put the two pieces together. They fit together just right. And then Woody, I think he was out on the end of the arm. Mary moved him away from the Orbiter a short distance, and he, in the right, correct direction, he pushed the satellite out into space to become its own satellite, and it was a target. It was used either later that day or the next day, probably the next day, by Bryan and Brewster for some autopilot and onboard software, rendezvous software, test flights, trying the software out that, if I remember right, was expected to be used in future by Shuttles rendezvousing with a Space Station or other satellites in orbit or with automated or semi-automated transfer vehicles—not the

Shuttle necessarily—rendezvousing with Space Station, for instance. So, anyway, it was a target; it was a rendezvous target to reflect the Ku-band radar in the process.

It was fun to watch Woody launch a satellite, so yes, it was a pleasant distraction for me from the down-in-the-boiler-room, so to speak, in the middeck laboratory work with my apparatus all the time. But it was a great thing to be a part of.

JOHNSON: I think we're going to stop and change the tape for a second.

[pause]

JOHNSON: Were there any other significant events on that flight that we haven't talked about that you would like to talk about?

WALKER: I would want to mention that in addition to the continuous flow electrophoresis system work that I did, there was the manifested work with the protein crystal growth experiment, which, once again, I was doing for NASA Marshall [Space Flight Center, Huntsville, Alabama] and Marshall was sponsoring this work that was being done primarily by the University of Alabama, Birmingham and Dr. Charlie [Charles E.] Bugg and Larry [Lawrence J.] DeLucas.

So, once again, I did this work, and it was again talking about research development work and maybe about the third flight of this apparatus, so it was more advanced than the previous flights. There were several steps that had to be taken, and there was a lot of care that needed to be taken in the movement of the device once it had been activated and liquid was in there

ostensibly trying to crystallize into protein crystals in very small chambers, some twenty-four very small chambers. Once it was activated, and it was activated, I think, on the first day.

I think another one of my tasks on the first day was to activate it. Activating it was basically turning small knobs that would release a droplet into the chamber, but on maybe six of the chambers I also had to inject with a syringe small crystals, I mean very small, almost microscopic crystals. Well, exact positioning was critical, and then once the droplets were in place in the chambers, then the whole thing had to be very carefully moved, because any jostling would throw the droplet off and it would completely ruin the experiment.

So on later flights, which started then after return to flight, there was a mechanical mount which literally moved in and out of the storage locker. So you just turned a crank, and it very carefully moved in and out again, and there was no vibration, no muss, no fuss. But on this flight they hadn't developed that yet, so I literally had to hold the device and move it in and out of its storage container, very carefully position it around, and I know that even that was just too much accelerations, even though they were very small, and vibration, on some of the chambers. So I was a little consternated at my inability to do that experiment as well as it could have been and should have been done.

But I did that as well; initiated the experiment on the first flight day, and I think on the end of flight day six, I withdrew the droplets back into each of the storage containers adjacent to their cylinders, and we stashed it and put it away to come home. So it wasn't much work, but it was an additional task that was necessary to do and was scheduled to do on the flight.

[pause]

WALKER: Let's see. Beyond that, I would say that it was a memorable flight for me also from the standpoint of having Rodolfo on board. It was great to get to know Rodolfo and to get closer to the Mexican culture and the Mexican people as he represented them during that flight.

Brewster had a working knowledge of Spanish, and so there was more than one interview that Rodolfo had with the ground and news services, media, in Mexico, and even one interview, I think, with the President of Mexico at the time. Brewster was involved in one or two of those and did very well representing certainly the crew and, I think, the U.S., in their native language in the interview. So it was fun being a part of that and watching that. It made me proud to be a part of a space program that was as international as it was, and it was working, I thought, very successfully at doing that. And again, getting to know Rodolfo.

That's probably about the extent of my thoughts. Let me add one other thing. There was one little notable during landing. The mission was scheduled to last one and a half hours longer than it did last. We were scheduled to land at Edwards Air Force Base [California], which we did, but we were scheduled to land one orbit later than we landed. We were prepping to come home, and I think the morning—crew morning—that we were prepping to come home, it came up from the ground that the weather forecasters predicted more rain and weather out there, and it may have been, if not rain, then lightning in the area during the day and later in the day.

So we were directed to plan to deorbit one orbit earlier and to land one orbit earlier, which we did. So I think the landing probably would have been at dusk, if not in darkness, had we landed on time, but instead we landed near sunset, I think, or shortly before sunset. Upon landing there, Jerry Ross was in the middeck on landing there at the MS [mission specialist] seat near the hatch. We came to wheels stop, and everybody unbuckles, and they're trying to get

their land legs again. Jerry is over at the hatch real quickly and wants to pop the hatch open so that we've got that part of the job done.

Well, Jerry pops the hatch open, but it literally pops open, because we had—whomever had planned these things had forgotten about the altitude, pressure altitude difference, between sea level at the Cape [Canaveral, Florida] and the—what is it? It's probably 3,000-, 4,000-foot elevation at Edwards Air Force Base. So half a mile high out there, and it's a little bit less air pressure outside. Well, we're still at sea-level pressure inside the ship. So he turns the crank on the side hatch, and the hatch goes, "Pow!" It flops down, and right away, I think Jerry said something about, "Oh, my god, I'm going to have to pay for a new hatch." [Laughter]

But it didn't spring the mechanism after all. It was apparently just fine. But it did literally pop open because of the inside pressure being a tenth or two-tenths psi more than outside.

JOHNSON: After the flight the crews normally went on PR [public relations] tours and that sort of thing. Did you ever do that after your flights, for NASA or McDonnell Douglas?

WALKER: For McDonnell Douglas, I certainly did many times, more times than I could probably even come near successfully trying to recollect for you here. For NASA, I can think of one, and it may have been the only one. That's not really true. There's probably two, probably two, and both of them were associated with crew visits to the homes of the other payload specialists on the crew. The [STS 51-D] crew visited Utah at the request of and with Senator Garn.

Well, [that crew] also visited Washington, D.C., so let me back up to say that yes, I do remember—okay, there was the crew visit to the nation's capital [by the STS 41-D and

STS 51-D crews], a visit to Congress and congressional offices, and in the case of Jake's flight with us, 51-D, Jake arranged a White House visit for the crew. So the crew visited the [President Ronald W.] Reagan White House in the Oval Office, as well. I remember we were entertained by the President with one of his apparently ever-present jokes. So there were those crew visits to D.C., one after each flight. [I don't believe there was an STS 61-B visit to Washington, DC. The STS 51-L accident cancelled any visit.]

Then there were the two, as I mentioned, with the payload specialists, a visit to Utah with Senator Garn and at the invitation of Senator Garn, and a visit to Mexico with Rodolfo. But I think those were the only ones that I went on that were organized by NASA or at the request of NASA.

But plenty of visits, yes, for McDonnell Douglas, visits not only to the pharmaceutical companies, but visits, well, to my hometown. Since I wasn't a NASA astronaut, I didn't get hometowners. Back then we were still doing hometowners at NASA. Even the NASA astronauts were still allowed to do hometowners. But I did them under company auspices, back to Bedford, Indiana. For company business, several trips to Washington, D.C., to express the company's perspective on the opportunities that it had in flying aboard Space Shuttle for commercial business purposes, and then also to the air shows, international air shows, at Farnborough [England] and Paris [France] during 1984, 1985, 1986—I think maybe once again in 1987—to those air shows as a McDonnell Douglas employee, obviously, and representing the company's perspective on space, the prospect of space and space business, for industry.

JOHNSON: Well, that flight landed December 3rd of '85, and of course, next month was the *Challenger*. Prior to the *Challenger* did you feel—and you'd mentioned that they were training

Robert Wood and then you knew that there were going to be some more flights. Did you feel like you were going to be flying again, or were you at that point moving into another position?

WALKER: I was not moving into another position. If anything, I was only kind of growing in the position I was in, because I was training Robert in the interface with NASA and in what I had learned about the Flight Operations regime, working with NASA, the Missions Operations Directorate, and the Astronaut Office, at the same time that I was continuing to do my laboratory research and development for the project in St. Louis and spreading myself between the prospect of at least one more middeck experiment—which I would kind of be the lead PI on that, even if I didn't fly with it—and working with the engineers and the biomedical folks, the microbiologists and biologists in our team that were helping to develop the product that would fly as EOS-1, the automated production system, for its R&D flight, first one expected in '86.

So I was just doing more, but more of the same. Now, with regard to Robert, it was officially expected that Robert Wood would, in fact, fly as the payload specialist and was being manifested as the payload specialist for that EOS-1 flight in mid-1986, and I would be his backup for that flight.

So I was not expecting to fly that mission, but I was thinking that I probably would fly another flight of the middeck under a new joint endeavor agreement. In fact, if I remember right, literally in January before *Challenger* and probably shortly after or during [STS] 61-C flight in early January, that NASA Headquarters had agreed to, if not signed, an extended joint endeavor agreement with McDonnell Douglas for additional middeck flights and at least two cargo bay flights for the EOS-1. I think there may have been numbers attached to both in the joint endeavor agreement. There probably were; I can't imagine NASA not having a legally

constraining document that didn't have specifics involved, so it must have been numbers, and I don't remember what they were.

But the basic tenet was that okay, McDonnell Douglas could continue to fly under a joint endeavor agreement wherein NASA would provide the services for the equipment, would support that, provide that, with McDonnell Douglas continuing to agree to provide the support for the equipment itself and its development. NASA would get a third of the research time aboard the apparatus while it was working in space, up until the point at which the apparatus produced commercial materials and a pharmaceutical company was, in fact, using the materials in a commercial or precommercial fashion. Then NASA would be reimbursed. At that point for those materials and subsequent in that device of that kind, NASA would be reimbursed for the launch services.

So anyway, I was expecting maybe another middeck flight, at least another middeck flight. And I'll say here that everybody at that point in time was thinking not just Shuttle, but was thinking Space Station. Not thinking Space Station as we do today, but—I mean, this was still within a year and a half, two years after Reagan had directed NASA to go build a Space Station and bring international partners into the program, and oh, by the way, have it done in ten years' time. So NASA was still trying to figure out what to do with that, but they had a direction.

Well, and we in industry were looking at Space Station as a place to do what we were trying to do with the CFES and the EOS on a continuing long-term basis. The Space Station was going to be, for us, a platform, power, cooling, human control and attention, a platform for the production of pharmaceutical materials. We would launch via Shuttle exchangeable packages of tanks and whatever else, tanks of liquids in it, that would attach to our apparatus at the Space

Station and we would be paying rent to the U.S. government or NASA for that part of the Space Station, the power, etc., that we would use, as a service for the medical, biomedical industry in this country or internationally.

We were expecting that to be the future, and so I was even thinking, "Sometime or another, maybe I'll even get to go to Space Station." But even though none of us at the time knew when the Space Station was going to be built, the plans in 1985, '86 were that the Space Station, yes, would be built by 1994, and that we would be in operation there starting as early as that date. So I was thinking, "Yeah, I'll get to make another trip or two. I'm not sure exactly when, but look forward to it."

So, yes, the world radically changed with the loss of *Challenger* and 51-L.

JOHNSON: Where were you when you heard about the accident?

WALKER: I was on a speaking trip to the San Diego Planetarium. I had spoken to a public group. It was a planned evening. The planetarium had invited me out and had advertised locally my presentation, and I had it seems like it was probably almost a hundred people from the community. They were university students, some university staff, as well as just the public at the planetarium on the night before the launch.

The next morning I had a flight out, and of course, three time zones away from Florida, it was a lot earlier out there than the nine-thirty in the morning for the launch at the Cape. So my plane, as I remember it, was leaving something like eight or nine o'clock, so I needed to be up and just about out the door by the time the launch happened. I can remember having my bags

packed and having the television on and searching for the station that was carrying the launch. As I remember it, all the stations had the launch on. It was the teacher in space mission.

So I watched the launch, and as I—to this day, and even back then I was still—I was aggravated with news services that would cover a launch up until about thirty seconds, forty-five seconds, maybe one minute in flight, after Max Q, and then most of them would just cut the coverage. "Well, the launch has been successful."

You [referring to that kind of television/media coverage] don't know what you're talking about. You're only thirty seconds into this thing, and the roughest part is yet to happen. And whatever network I was watching ended their coverage. "Well, looks like we've had a successful launch of the first teacher in space." And they go off to the programming, and it wasn't but what, ten seconds later, and I'm about to pick my bags up and just about to turn off the television and go out my room door when I hear, "We interrupt this program again to bring you this announcement. It looks like something has happened."

I can remember seeing the long-range tracker cameras following debris falling into the ocean, and I—I can remember going to my knees at that point and saying some prayers for the crew. Because I can remember the news reporter saying, "Well, we don't know what has happened at this point."

I thought, "Well, you don't know what has happened in detail, but anybody that knows anything about it can tell that it was not at all good."

Then it became a very long day. I got to the airport. I think it was a rental car to the airport, and I was trying to find news stations with continuing coverage on the car radio all the way to the airport. When I got to the airport, somehow the news crews—somebody at the local television stations and newspapers had obviously remembered seeing an astronaut was in town

the night before. There were news crews waiting for me. Apparently they had staked out every airline that was flying from there to St. Louis. It was TWA I was flying on, and so there were like three reporters and a news camera around the counter.

I saw them as I walked up toward the counter, and I thought, "I know what this is all about," and I don't even go to the counter. I turn around and go to a phone. No cell phones then. I go to a phone on the bank of phones on the wall, and I call the [McDonnell Douglas Astronautics Company] President's Office back in St. Louis. I'm detailed out of the President's Office at that point, a part of the program, the electrophoresis program, but associated with the President's Office. I called the Public Relations Director, and I say, "I am ready to leave the airport." I guess right away it was an exchange of, "Oh, my god, did you see what happened? Sure, I did."

So we exchanged our thoughts and our sympathies at that point over the phone, and then I say, "And I'm here at the airport now, and there's news crews waiting for me. What do I do?" So we talked about strategy, and she called company security, who got to San Diego and airport security and police, who—I just hung by the phones for a period of time until a police officer came up, and I identified myself to the police officer, and he, in fact, had gotten a call from his security and his management about the situation. So they literally escorted me to the gate, and the reporters were insistent, and I remember I was told not to make any comments, not to make any comments, but I just felt like it was a situation where I couldn't get by without something, so I said a few words. But then got by them, and the security officer kept them back and away, and I finally got on the airplane.

I remember flying across country in an L-1011, and I had a window seat, and at the time I had a radio; you were allowed to keep electronic devices on in the airplanes then. So I can

remember going across country with a pocket radio trying to find stations as we're flying at 35,000 feet across country, trying to find radio stations that had news reports to give me some update on what was going on.

Got back to St. Louis, and it was pretty chaotic around the office. A lot of emotion, obviously, to say the obvious. The President that I refer to, of McDonnell Douglas Astronautics Company, was John [F.] Yardley. John Yardley had just returned to McDonnell Douglas from NASA, from his position as the Associate Administrator [AA] for Manned Space Flight. This was '86, so he had returned four years earlier, within the year after the launch of STS-1. So he'd been in the office for a while, but John, the consummate engineer, and of course, the NASA AA for the program for so many years during its development, its first flight, was—he was pretty much—I mean, he was solid, but you could tell it really had hit him hard, too.

So we commiserated for a little bit, and his second thought was, "What went wrong?" He'd already been on the phone with NASA Headquarters. I think he had already been in touch with the Administrator's Office. I can remember talking to him. This is minutes after I walked back into that office in St. Louis, and already he had engineering sketches and calculations on a notepad in front of him. He was already hypothesizing that no, it was not a—and this was within seven, eight hours of the accident, and he was already focusing on it was something to do with the solid rockets. And John was one of the thousands of industry and government experts, of course, that then focused on finding out just what had gone wrong and why.

But the project that I was on was immediately—we were knocked back to a standby mode. Yes, we were doing testing on the ground, as I mentioned earlier in this interview, with our apparatus and with new products and processes for the companies that we were both in

negotiations with for business arrangements, pharmaceutical companies, and already in our contract, doing some testing work with our ground-based apparatus with other companies.

So that work literally did continue apace, but the space-based work and the work in preparation to fly space hardware was just put on the back burner until NASA Headquarters came to us with their determination as to what the manifest would look like after return to flight, whenever return to flight would happen. And as we all know now, in retrospect, it was many months before anybody knew just what was going to have to happen, and more specifically, after the Rogers Commission came forward with their conclusions.

So, yes, I was out there with the public when it happened, and it was something I never want to have happen again, for any number of reasons.

JOHNSON: Did you go back to JSC at any point after that?

WALKER: Well, I went back to JSC certainly for the services there in the quadrangle, in the mall, when President Reagan was there. And yes, I went back a number of times. Interesting, with regard to 61-B, though, as you say, we landed on December 3rd. Then there was the Christmas and New Year's holiday, and I didn't see the crew again until, in fact, when I went back to JSC for the *Challenger* memorial service. There were the holidays, and I was expecting a crew gathering or a welcome-back party or whatever. That was all delayed because of the holidays, and then after the holidays came the 61-C launch, and that occupied folks for another week's time. Then there was the preparation for 51-L, and I was told, "Well, we'll have something when the 51-L crew has returned, and we've got some more time to get that together." So I was

never involved in a crew debrief, and I'm not sure there ever was a crew debrief like there had been formal crew debriefs on most missions before that.

I guess there was. In retrospect, let me think and mention there was the pinning ceremony. So the crew did come back, so there was one time, yes, after the landing and just before the holidays when the crew appeared onstage in the Gilruth Center Auditorium and were awarded—I guess Gerry [Gerald D.] Griffin was the Center Director at that time—awarded the Space Flight Medals, and the NASA astronaut crew [members] were given their gold pins onstage. [No Astronaut Pin for the payload specialists, only the NASA Headquarters Space Flight Medal.] But that was the only assembly, I guess, and my only visit back just for a short time before we lost 51-L.

JOHNSON: Well, when was the electrophoresis operations project officially shelved, how far after that time period?

WALKER: Well, I'm not going to be able to give you an accurate date, but it was in 1988, I think, '88 or '89, that the company decided that it was just not going to be able to go ahead with the project. Obviously, with return to flight [STS-26] in '88, late '88, it was some months, maybe ten months before that when it was clear to everyone what the manifest situation was with regard to commercial developments and commercial payloads aboard Shuttle. With that, then, in early '88 the company was looking at, number one, not being able to fly with anything like the priority we had had before.

The only reason that the company was able to decide to continue to support the project at the level—like it did and with the objectives that it had, was with the situation that NASA had in

mind and was working toward with Space Shuttle, that situation being a space transportation system that flew regularly, that flew often, and that provided, consequently, lots of opportunity to fly up and back for science, technology, and commercial. And commercial was a priority. Well, so all of that worked very well for us, in part because McDonnell Douglas and the electrophoresis program was one of the first commercial programs to even approach NASA with the desire and the rationale to be flying aboard Shuttle.

Well, the opportunity just went away with the national policy changes, commercial was fourth priority, if it was a priority at all, for Shuttle manifest, payload manifest. Shuttle would not be flying with the regularity or the frequency that had been expected before. So when that was clear in very early ’88, maybe even late ’87, at McDonnell Douglas Astronautics Company the corporate management said, “Well, clearly, the business plan has got to be changed, and if there’s nothing that can use this technology that can create a profit line for us that really works as a business, then we can’t do this anymore. It’s not something we’re going to be doing.”

So management at the time in St. Louis for the project looked for other areas of business activity to use an electrochemical or fluid electric purification process like we had to help their product production or research, and it was something that we had done on a paying basis, and never found any—without space, without space and on the ground—we just never found anything, so the program was canceled by the company.

JOHNSON: What type of impact do you feel that the CFES experiment had on pharmaceutical research?

WALKER: I think it had a small positive benefit. First of all, I think it stimulated both some NASA researchers, a few NASA researchers that we've mentioned before at Marshall, particularly that in the Material Sciences Lab there had been looking at electrophoresis and electrophoretic phenomena, and it stimulated them to maybe go farther and come up with more of the basic physics and phenomenology of the process as it relates to materials separation and electrochemical processes than they would have done otherwise. In the biomedical business we had a number of patents that came out of this that I think one or two of them have been used to some degree by product manufacturers for the biomedical community, product manufacturers of purification technologies, chromatography, electrophoresis. Those patents and that technology then has benefitiated, if that's a word—helped—others still in the business in this are to improve their products and processes over what they probably would have done otherwise.

The materials we developed, McDonnell Douglas and the project developed not only during the last flight when I was flying, but in preparation for the automated system, so in late '85 and the first month, two, even three or four into '86, even after the *Challenger* was lost, the ground team continued to work at refining the process and at creating our own genetically engineered cell lines for producing this erythropoietin hormone enzyme. They achieved some notable successes in doing just that, notable beyond what we were aware of—again, in a highly competitive industry, the pharmaceutical business—that we were aware of at the time any other company had done, and that in retrospect, I was hearing, talking to some of the team members even years later, that they thought that they had, in fact, achieved some advances that probably no other pharmaceutical company even years later had given evidence of having achieved in that time period, in producing genetically engineered cell lines and in purifying the materials coming out of them in an economical fashion.

Once again, to repeat myself from some earlier interviews, all pharmaceuticals and medical materials have to be purified by some method or another to be used with either animal testing or with certainly human users, and there's a number of purification technologies. Electrophoresis is one of them, but electrophoresis is probably the one that is of the highest scale, or it can purify the most material per unit time, so it has the greatest opportunity for economical purification technology. We refined the ability of the devices, even working in one gravity here on Earth, to purify such large quantities—well, large enough quantities; not nearly as high a quantity as could be done without gravity—but to purify with great enough efficiency and large enough quantities that the technology was, I think, pretty well adapted.

But most pharmaceutical companies, instead of refining the purification technology, they just overkilled the mass production side. What came off their batches of cells, genetically engineered cells, were tens of thousands of gallons of impure stuff, and even the most inefficient purification techniques could produce enough of that well-enough purified stuff that it was economically viable, and so they didn't pursue, haven't pursued, electrophoresis as a technology to really—and focused on the purification technology side of the whole business equation in producing pharmaceuticals or medical research materials.

So it's a realm, I think, and a technology that we advanced that hasn't been even today fully implemented, because the business plans and the other technologies have given side roads and other paths to an economic outcome and a positive business outcome in this realm without using electrophoresis technology. So I think it's fairly unexploited, and so not that much has come out of it directly. Certainly, because we were going to utilize space as the basic key to the application and we're just not able to be there to do that, it's kind of dead-ended to this point, in explicitly the fashion that we intended to utilize it.

JOHNSON: Do you think, with the way space and more commercialization and those kinds of things that are happening now, there's any potential for that to go forward?

WALKER: Oh, I think there's a—yes, there's a potential. I don't think it's a high potential at this moment, because again, key ingredients of what we were doing require inexpensive launch and return access to orbital space, to free fall, the physical free-fall environment in orbital space microgravity. It requires frequent access, frequent and inexpensive, and obviously reliable. You don't want to lose what you're taking up there, and bring it back. It requires all of that, but it requires also facility on orbit to be economical. So there's got to be a platform up there that you can plug into. You don't want to take your whole platform with you every time. That investment is one that in the business plan probably means you can't make money fast enough to suit any market or investor.

So Space Station, whereas we thought twenty years ago that Space Station would be a base of operations and would be a facility that was not only built for but was operated in a manner that would encourage and look for commercial exploitation and use of the resources at that Station, that's obviously not the case today, and it will not be the case for ISS [International Space Station]. And launch access, we've already talked about that, and not only just launch to, but return capability from orbit, because you've got to get the product back. This isn't a digital product like our television signal or a communications channel. It's a physical entity that has to get back, stuff.

So until all of that is in place, the true opportunity is not going to be present again. Now, here's Bigelow Aerospace that's launched its own subscale model of an inflatable, pressurized

vessel with infrastructure, power, signal, communications capability, and Mr. [Robert T.] Bigelow clearly intends to do more of that over the next many years. Maybe he'll have a Space Station up there in a few years' time that will be friendly to and will be promoting access to the commercial business sector. Certainly it looks like tourism first, but maybe beyond that, an industrial park. I know there're others that are thinking and talking about that. But you've got to get the transportation up and back before anything, either in terms of tourism, much less an industrial, hard industrial, capability can be exploited to investors' satisfaction.

So I think it's some time yet, but in my mind, orbital space awaits. It's a workplace that's open for business. It's just that we're having a hard time keeping the door open to get to that workplace. It will always be there, so the prospect and the potential is there, but the opportunity is just not clear and present right now.

JOHNSON: As the first American [non-Spacelab] payload specialist, and you were in a unique position somewhat for a payload specialist because you flew so many times, but if you could, just share your feelings about how the payload specialists were treated as far as the astronaut corps is concerned, and the acceptance or the nonacceptance that maybe was going on, and whether you felt it yourself or if you know that it was happening with some of the other payload specialists.

WALKER: Well, let's see. For clarity's sake, I, of course, was the first industry [and non-Spacelab] payload specialist and the first paying passenger. This joint endeavor agreement that McDonnell Douglas had with NASA was for the equipment. I was an auxiliary component that was not under the [original] agreement and therefore the company had to pay for [me to be

flown], so I was a paying working passenger. I was the first industrial payload specialist, but Byron [K.] Lichtenberg was the first American payload specialist to fly, and he flew on STS-9, Spacelab payload specialist.

Now, at that point in time as I was flying, I remember hearing in the Astronaut Office—this obviously wasn't official, but it was the way they characterized the payload specialists. It was, "Well, there are two types of payload specialists. There's the science payload specialists, SPS, and then there's the PPS, the political payload specialists." The Astronaut Office that I was hearing talk about that, they were characterizing those and in this way. Basically, Spacelab PSs were the science payload specialists, obviously.

But what I overheard—I can't say what I didn't overhear, but what I overheard was they were throwing me in that category, even though I didn't actually fly aboard Spacelab, I was doing science, really, science and technology. But Jake Garn, Bill [Clarens William] Nelson, even Rodolfo, for one, and, hey, Greg [Gregory B.] Jarvis on 51-L, they were there—yes, they came up with payloads, or their sponsors came up with payloads for them to do, but only after they themselves were identified to go as an adjunct to a commercial satellite payload that was being flown.

So in general, while that was a detailed characterization and my understanding of how those characterizations were defined, yes, I ran into a situation where here were the career astronauts, who every one of them went through a very rigorous and highly disciplined selection process to become NASA career astronauts. They were either NASA employees or they were government employees on the military service side, officers who were duty-assigned to this other agency for the period of the contractual arrangement. And by gosh, it was their job to fly, and

who appears on the scene to take another seat here and there, but literally an outsider. So, As I saw it to start with, the Spacelab payload specialists, as well as myself, were seen as outsiders.

There was nothing clearer, no clearer indication than that the physical arrangements of office space and where we lived and worked at the Center, in that the PS office was established over in Building 39, whereas, of course, the Astronaut Office was over in Building 4. It was made clear to us from the beginning that they didn't expect to see us over on the fourth floor in Building 4 except for scheduled meetings. We were just outsiders who would become crew members for a short period of time and would train mostly on our own, but when there was necessary crew combined training, certainly we would be there.

It was desirable to have a high degree of awareness in the career astronauts with knowing the payload specialists personally, as well as knowing how they would work in a team and crew arrangement, and being confident that they would work in an effective and efficient and safe fashion was very important. But there was a kind of a tension even, I think, in the Astronaut Office and among the Mission Operation Directors, to, "Okay, that's obviously a need, but we don't want to get too close to them. I mean, they're not us, so we don't want to bring them into the office too close."

Well, that moderated. That attitude was [at] an extreme [in] the beginning, and I'll say it, there are some individuals, I think even today, that hold the same attitude virtually to the same degree, but they are a vanishingly small number of people today. That has long since merged, especially after *Challenger*, where the offices were combined. Even while I was training for 61-B, I had office space. It was oh, by the way, catch it as you can, but you got office space over on the fourth floor, Building 4. You need a place to sit and work when you're in town, come on

over. Finally they moved the PS Office out of Building 39 over to Building 4 in that time period just before *Challenger* was lost.

So the adaptation, it took a couple of years, and the adaptation began to happen, I think, in serious fashion as those that saw, looking at you're taking the risks and you're flying in this thing together. It's not a positive to keep yourselves apart during the preparations for all of that. So I think that reality certainly came home, and today it's much better. I say today; there aren't any payload specialists flying, essentially, today. Sure, there are international mission specialists.

But I think the clearest example as an indicator of how things transformed was to follow the teacher in space activity and that line, because originally the teacher in space was to be a space flight participant/payload specialist, and I witnessed a lot of slicing and dicing of just what do you call Christa McAuliffe. Is she an astronaut? Well, most people at the time at JSC and certainly in the Astronaut Office were, "No, she is not an astronaut. We were selected by NASA to be astronauts. We're the astronauts. She's a payload specialist."

Well, she's not really a payload specialist, either, because she's, you know, the President said, "You'll fly her," and she's a teacher in space.

Well, okay, payload specialists; we've already got a category of flight crew member we call payload specialists, so she'll be trained under that, etc., etc. But just maybe even to clarify that term, there's got to be another for those that will only fly once, and they're not there doing any science or technology. They're certainly not an operating crew member. They're a space flight participant. Okay, they're a space flight participant, okay.

So that has then transformed as the teacher in space capacity in the late eighties, early nineties, was once again to be filled. But that individual has to train as a mission specialist and is

in the corps as a mission specialist, and they're also a NASA employee. The same way with the internationals. There's the international astronauts, but there hasn't been a payload specialist fly in a long time. They're all trained as ISS and/or Shuttle international astronaut mission specialists.

So I think we've seen the era of payload specialists come and go, at least during the Shuttle Program and the ISS Program. We'll see if it comes back at some future era, because, as I said earlier in this interview, space awaits all users, and it's a matter of access and capability in space for the commercial side and the like to go there, and certainly space tourists. That's happening, clearly.

So, yes, I saw the payload specialist thing change, and it changed for the better. It started off rough, but I heard stories from some of the original Apollo scientists-astronauts that were just about the same. [Laughter]

JOHNSON: Well, after *Challenger*, you continued with McDonnell Douglas, and after your payload specialist time there, for a number of years, through [19]'97. Also, you've always been involved with NASA in various capacities. Do you want to talk about some of those years and some of the things that you've been involved with as far as the *Challenger* Center and the Office of Commercial Programs?

WALKER: Well, I'm happy to mention as many of them as I can think of. I feel really fortunate for a kid from the Midwest that grew up at the start of the space age, that in those first few years, my preteen and teen years, all I wanted to do was, gosh, get this degree for a thing called an engineer and be able to get out there into NASA or some company that was designing and

building rockets and satellites and space ships, and have the fun of designing those things and then seeing them launched and seeing pictures and things come back from other worlds. That was all that I was wanting to do. To get a chance to finally go and, in fact, fly with them was the icing on the cake, but we're all human beings, so we can go to sleep at night and then we've got the same appetite for the same and more the next day.

So, yes, I wanted to see more of that, and I was happy to get a chance to fly three times, and I would have loved to have had a chance to fly more than that, if it were appropriate. And I'm happy to see others get a chance to do that. I really regret that the era of payload specialists ended as it did and as it has. Even the capability, whatever you call the seat that we did call the payload specialist's seat, the opportunity to go become an itinerant and, best of all, working passenger along with a professional crew, to go that way to do really interesting and productive and new things out there, science, technology, even art [is now past]. I really regret the fact that we're not there today, that we don't have a program or programs, either government or commercial, that yet allow the full breadth of human experience to be extended into space [by non-career astronauts].

But yet I feel fortunate, having the world that we have to live in, that I've had a chance to at least work around the periphery, if not occasionally inside, lots of different aspects of getting this nation into space, and humanity as a whole, and maybe even doing some useful and productive things out there and back down here in making advances with space as the stage or the arena in which the advances are made. But also advancing the human awareness, the American public's awareness, of what space flight and space travel is and can be, and internationally, as well. So to have played a part in that is just very special to me.

That part, it includes—and thanks for the opportunity to talk about a few of them; I won't go into elaborate detail, and I won't even remember everything. In '86 I was testifying before Congress a time or two about, well, what should this nation be doing from this point on in space. Well, we've got to continue to work to build a Space Station. We've got to go then beyond that. We've got to utilize space for human benefit. So congressional testimony, and yes, I was asked by NASA Headquarters to be a special consultant, to bring my experiences and background to the consideration of Space Station operations. So, [I was] the special consultant to the Space Station Operations Task Force in '86, '87.

I was asked to be a member by the Chief Scientist at NASA Headquarters, [of] what was then called the "Quick Is Beautiful" Space Station Task Force, which was looking at how to get payloads, science, engineering, technology, into space and back again quickly and, hopefully, inexpensively. The principal objective of most commercial users and most science users to be able to think up an experiment, get it to space, do the experiment, and then get the experiment and its knowledge and its information back to the Earth as quickly as possible, and then repeat that. That's what science is all about. It's thinking up a question and then finding a way to try to answer that question, and then building that experiment, and then doing that experiment, and then looking at what happened, and then doing it again, because it almost certainly never happens that we're right the first time.

So if space is going to be a place to do science and technology, you've got to have the chance to get up there and get back again as quickly as possible. So, anyway, there was the desire to learn from some of those that had tried to do that, how the nation might actually put together systems, policies, to do that.

At the same time I was working with committees and groups outside NASA and industry in the not-for-profit community and public sector, like the American Institute of Aeronautics and Astronautics, committee work there; the National Space Society, a public subscription and membership organization, a public advocacy organization that, in fact, was formed in the late 1980s. I was party to its merger in the middle eighties, the merger of two space advocacy organizations, one formed by Werner von Braun, the National Space Institute in the early seventies as a public—and the term was probably not used the same way then—advocacy group for space; and the L5 Society, which was formed in the Tucson [Arizona] area from a bunch of sixties hippies, who, oh, by the way, were also training and trained themselves to become scientists and engineers, but took a more populist perspective on going to space and what should and shouldn't be done out there in space.

The two organizations merged into the National Space Society in the middle 1980s, and I became [a volunteer] officer and a board member and an active member of [the group] to try to get the word out to both the public as well as, with the public's name on it, so to speak, back into Washington, D.C., to our elected officials that, hey, the people do want space. They want space to do this and that, and they want to be there, and they want to be part of it. I was one of the first astronauts, flown crew members, to stand up and say, "Tourism would be a good thing." And did that from the late 1980s on, here and there.

The Association of Space Explorers [ASE], the original and to this day the only nongovernmental organization exclusively of astronauts and cosmonauts, formed by a Soviet cosmonaut and a couple of American Apollo-era astronauts in the early 1980s, 1984, specifically. The Association of Space of Explorers has as its charter that to be a member, you

have to have orbited the Earth at least once—period, paragraph. The organization took on a note of peaceful conciliation between the superpowers at that point in time.

Really, it was intended to be a perspective, as organized by the astronauts and the cosmonauts, a forum for perspective that their governments didn't necessarily give them the opportunity to extend to both the publics around the world, as well as elected officials, of what a true leveling experience, human experience, space flight is for anyone of any political persuasion, economic persuasion, or otherwise. Space is a place that's above all of us, and yet it's a place that we can all visit, and all look down on the same Earth in the same way.

So I was one of the first few dozen members of that organization, and I really count as the meetings of astronauts and cosmonauts in the late eighties around the world, those meetings to the ASE as having been a significant contributor to the awareness, I think, behind the Iron Curtain in the Soviet Union of both intellectuals as well as well-placed individuals that all the tenets of Communism were not what really would work long-term for the human race. The expression of what space was and the perspective of space to all of us and an opportunity that that organization provided to express those perspectives internationally, worldwide, I think was very, very positive; still is, to this day. So anyway, I'm proud to have been a member and a continuing member and [past] officer in that organization.

Yes, after *Challenger* I was invited by the families to become an advisor and then, in the middle 1990s, to become an officer and a board member of the *Challenger* Centers for Space Science Education, and still am an officer and a board member for the *Challenger* Centers at the national organization level, and very pleased to be so and to continue that mission.

JOHNSON: Do you know why you were selected for that?

WALKER: Well, at least in part. All of the families had representatives as founding board members, and most of those representatives were the spouses, mostly the spouses, of the individuals. Now, in Judy [Judith A.] Resnik's case, it was her brother, Chuck [Charles S.] Resnik. The Resnik family had even asked me to represent them at the astronaut memorial dedication in Florida at the Kennedy Space Center, what's now the Visitor Complex, at the groundbreaking, not the dedication, per se, because the family was there. But at the groundbreaking none of the family members could be there, and they asked me to represent Judy for the family at that groundbreaking. I was a board member of the Astronaut Memorial Foundation, as well, that established that memorial.

But from that time and before that time, and even to today, Chuck and I are, I would say it, I think, very close; friends and acquaintances, certainly, and Judy's father as well. So there was that association that I think the families felt and caused them to invite me to become an advisor and a member of the board, eventually.

And my interest in education; I hadn't been shy about supporting that very theme as the discussion of, gosh, what is space and how does it affect and influence people and kids. I've never been shy about my certain knowledge that [for] young kids, I think, right up there with ghosts and dinosaurs, there's the concept of space. I knew it was for me, and every time I talk to my grandkids today and other kids in schools anywhere, space is something that interests them, and not just little kids, but the public is in general, the adult public.

But certainly it's the future that we want to all touch, and kids are the future. So the *Challenger* Centers, I thought, was a concept, and if put into play well, would be an entity, an organizational entity and physical facility, at schools or wherever a community decided to put in

a *Challenger* Learning Center, as a nexus for the stimulation of kids' curiosity and interest in math and sciences and just talking to one another about interesting subjects with space as the theme. That was a good thing and should be encouraged, and I think it still should be.

So those are probably the big organizations that come to mind most immediately, but many other opportunities as well. I'm working right now on a National Academy of Sciences National Research Council Committee on the Science Context of Future Lunar Exploration. The short form they call it is the Lunar Science Committee. It's responding to a NASA Headquarters request and contract of the National Research Council to vet and provide to NASA a list of science priorities for the exploration of the Moon as we go back to the Moon, starting in a couple of years with the Lunar Reconnaissance Orbiter, to start with, and then the first human exploration and return to the Moon since the Apollo Program that we'll start doing ten years from now or a little more.

It's interesting to note that I've joined the committee, that committee which is doing the request from NASA Headquarters, and the request from NASA Headquarters was authored by the Associate Administrator for the Science Mission Directorate, who is Mary Cleave [former NASA mission specialist astronaut and STS 61-B crew member]. [Laughter] She did not ask for me by name.

JOHNSON: Is there anything about your time at McDonnell Douglas or then at Boeing from '97 to 2005 that you'd like to talk about?

WALKER: Well, it was an experience that I found rewarding but frustrating in many ways as well. I've just finished talking about how excited I was from the time I was ten years old about

rockets and space travel and the like, and I wouldn't have ever had the chance to do what—I doubt I would have had the chance to do anything close to what I've had a chance to talk to you good folks about at these oral interviews if it hadn't been for McDonnell Douglas and McDonnell Douglas as a corporation's desire to make a business out of utilizing access to space and doing technical and scientific things out there. So that time at McDonnell Douglas is a jewel in my life, in my mind.

Now, of course, after *Challenger* then the objective for a while had to be different. It had to be part of the national team that got this country back into space again. Part of that challenge I remember having to address directly and indirectly was—again, from the public and certainly from our elected officials many times—was, in the late 1980s, "Well, why do we need to be doing this, anyway?" We've heard that again, and I was there in Washington, D.C., still in 2003, in 2004, when we lost *Columbia*, and once again sat in meetings, public and private meetings with members of Congress, who would ask, "Why the heck do we need to risk people going into space? Why do we need to be doing this at all?"

So I feel fortunate to have been able to provide, I hope, some kind of in-their-face, personal representation of why the risks are necessary and what rewards are, in fact, there and can be there if we just take those risks. I hope that what I said and did was of some positive result.

But as rough as some of those interactions were, personally, and as challenging as they were to address the topics at hand, certainly, or the need to, that didn't happen all the time, and most of my time was spent kind of, as we say, turning the crank; doing the company business, talking to government officials, NASA, or congressional or White House about the McDonnell Douglas or the Boeing Company's business in rockets, launchers, or space, whatever, and

answering questions and being the communications channel back and forth. Some of that just became humdrum and ho-hum and what am I spending my time doing this for, because I can't see how this is getting us back into space again or keeping us in space. I'm sure that goes on with everybody's job; I know it does, of course.

So there was the humdrum of the job that I will, off the cuff, relate to, but it was being around, too, here in Washington. Being around the decision makers, the policy makers, the legislators, the management, the government management of our space efforts, it was energizing, and it was interesting, and it still continues to be to this day, although I'm not anywhere near the active player since I've graduated from the Boeing Company and from big corporate life like that.

It's not what it was for me, but I look back on it, and I don't know what I would have done differently. I had the opportunity any number of times with the companies, McDonnell Douglas or Boeing, to have taken a company position somewhere else outside of Washington, D.C., and away from the Government Relations Office. I chose not to for a variety of reasons, but never once was the reason because I loved Washington so much. I put up with it. My wife and I both relate to each other almost on a daily basis, "Oh, we're still here, and we've still got to put up with the traffic and the high costs."

But it's a totally unique place, and I mean, not only do you get to go to things occasionally at the Kennedy Center that not too many other people get a chance to do, but you get a chance to be around, as I said, the corporate planners and decision makers, the policy makers, and the legislators on occasion that few other people get a chance to. If it ever happens that you do have a real chance where you can say something that somebody listens to, and it's a

positive thing for our pursuit to live and work more efficiently using the resources out there for benefit back here on Earth.

To get a chance to do that, I just would not want to think of myself in my later years as having missed a chance to have done that when I could have, and hopefully help a positive end in that regard, and only can you do that by only being here, or being around here, anyway. There's just not another position that would have brought me back to this town from wherever else, from Houston, from the Southern California area often enough. You've got to kind of live here and keep your head in it, even though for an engineer like myself it's basically a revolting environment.

JOHNSON: Were there any anecdotes from your time at NASA that we haven't talked about that you wanted to tell us about, or any that you can tell us about?

WALKER: Oh, gosh, let's see. Note long pause here. None has come to mind. No, I think everything that probably I can remember and want to remember in that regard, I've brought up; found opportunity to bring up.

JOHNSON: Okay. I was going to ask Rebecca if she has any questions.

WRIGHT: I just have one. You worked with three crews; you had three different commanders. Reflecting on those time periods, especially in the training and, of course, up on your mission, can you share what you feel were some of the strengths of the commanders and, if you could

have maybe made some input on how to improve some things, things that would have worked differently as far as leadership and team building skills?

WALKER: Well, a line that probably sounds like a throwaway line—I guess it is—to start with, is everybody was different. Every individual is just that, an individual, and so the three commanders that I worked with were all different individuals. They obviously could, number one, get the job done and get the job done successfully, and they had different styles at doing it. I've got to say that I think that, just in general without making any, I think, specific personal allusions to individual personalities or otherwise, I'll just say that across the board my observation is that in this environment where a commander, a mission commander, a crew commander, has to work with a large number of people at different levels of working with.

You've got your training teams that have to train you and your entire crew. You've got the mission planners. You've got technical support at a variety of different levels. You've got the Flight Directors. You've got the crew itself, and I think they need to be working—and I don't think there's any one commander I've ever seen or much less worked with that does this wrong. They work first with the crew. You've got to get the crew working together, at least able to fulfill the mission working together in a smooth and efficient and effective fashion.

So I think all of the commanding officers that I've worked with have done that, and have done that well. Different styles, different approaches, but have done that well, and that's as it should be. NASA, once again, extraordinary at its skills in picking good people.

But a facet that then I think can be improved is helping individuals, up-and-coming mission commanders, crew commanders, to broaden their interpersonal skills and their management skills to number one, be able to lead large enough groups of people. I know that

some of the mission commanders, that as they come into NASA, the pilots who will become mission commanders, maybe in their military responsibilities they've only commanded one or two other people, particularly in the aviation arena. In aircraft there's not a lot of large flight crews, like five, six, seven people as there is in the Shuttle, out there.

So one would hope that they have had experience in managing large groups in high-stress technical situations, managing groups of people beyond two or three, because I think that the skills change. The skills that one uses in managing two people versus managing six, again, in fast-paced, dynamic, high-risk situations, the management skills are different. So I would encourage a breadth of experience and/or capability going into the command capacity that takes that need into account.

I'll say this, although I think NASA again is already doing it very well. The ability to work with international individuals from outside the American culture is an absolute necessity today, and I think it will be going into the future, as far as I believe I can see. I say thank goodness for the ISS as it has come together and as we've needed to manage ourselves and it, that's given a tremendous amount of experience to individuals in managing cultural differences and diversity. I think that's just to the benefit of everybody involved. So I think more of that, at least as much if not more of that, is a good thing.

Part of that probably is language skills, and I know for a fact that though the languages of the Station, of ISS, are English and Russian, that astronaut members of the Astronaut Office can do better at their Russian language skills. We have yet to be tested in a really, really bad operational situation where the language skills were critical to life or death, and I hope we never are. We never should be. But as we know all too well, space is just not a forgiving place, and it's not a place where you look to always be safe.

So sometime or another, good, accurate language skills are going to be absolutely necessary in another language, and right now Russian and English are the two Station languages. I can't speak so much for the Russians, although I suspect that probably the same criticism that I would give applies there. I just think that all the parties need to be much better at knowing the languages that are and can be spoken in any circumstance, so that the understanding is unquestionable, because there would just be no time to think about, "Well, what do they mean by that?" for actions necessary.

So language skills, cultural skills. And I don't know if this will apply to NASA today. I've already mentioned how the payload specialist—the itinerant space flyer—there are those today, but now they're tourists. We've had how many tourists aboard Space Station? Two, maybe three, to date. The treatment that Mrs. [Anousheh] Ansari got was a heck of a lot different than what Dennis Tito got at the Space Station, and I think clearly and very positively shows a difference in attitude. In part, that's due to the fact that there's more specific discipline expectations, responsibilities, and roles defined today than there were when Dennis Tito flew, and that was a great, great, great deal of the tension back then.

But they're very different than the rest of the professional flight crew that's there, but they're going to be there. They're there now because the Russians, in their very interesting current manifestation, have grabbed commercialism and capitalism with both hands and both feet, and are doing whatever it takes to make a dollar. That's okay, but it's led to situations, again, where, while there's no longer payload specialists, there's no longer that outsider—we call it *payload specialists* to the astronaut corps—there's now the occasional itinerant that maybe one of the international partners brings up to the common facility, the orbital Station.

You just need to have people in command, and certainly I hope within the entire crew, that recognize that this is a complicated world that we live in, and it's a complex world in which there will be circumstances like that with different people come up. I hope that the technical management on the ground has vetted that individual to make sure that they're not going to be crazy when they get there, and they're not going to do insane and unsafe things.

But on the other hand, they are different. They may be in—most cases are—people who, they've not flown high-performance aircraft. They've not been in military combat before. So they're not the same kind of people that you deal with on a daily basis among your professional ranks, but you've got to find ways to work with them in a positive fashion, because more and more as time goes on, maybe not in the exploration realm, but certainly in the low-Earth orbit operational realm, the people that are aboard the Station or the facility are going to be a mix of people.

You've got to be able to work with them, not just in the everyday, ho-hum operational regime, but if something happens. If fire breaks out, you get a micrometeoroid impact that perforates the pressure vessel, everybody's got to be able to work, and you've got to understand what their weaknesses are, and, in a positive sense, not just in a critical sense, you've got to know how to work with their weaknesses and around them, etc. So anyway, more understanding; broader understanding, I think—the broadest possible, let me put it that way, because I don't want to diminish the fact that I think these people that are in command positions aboard Shuttle and Station today are extremely bright, capable people. But nobody's perfect, and I say, if we're going to talk about improving, working more toward the perfect, these are things that I would see as being important characteristics.

JOHNSON: Okay. I appreciate you coming today and spending time for this interview, and for all your interviews. Thank you so much.

WALKER: Sandra and Rebecca, I thank you all very much for the opportunity. It's always been a pleasure for me, and thanks much.

[End of interview]