NASA JOHNSON SPACE CENTER ORAL HISTORY PROJECT
EDITED ORAL HISTORY TRANSCRIPT

GARY W. JOHNSON
INTERVIEWED BY REBECCA WRIGHT
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WRIGHT: Today is May 4th, 2010. This oral history with Gary Johnson is being conducted for the NASA Johnson Space Center Oral History Project in Houston, Texas. Interviewer is Rebecca Wright, assisted by Sandra Johnson. This is part two. The first part of the oral history was started yesterday, May 3rd, and Mr. Johnson is back with us again. We certainly thank you for giving up two mornings to talk with us. We'd like to start, before we move into [Space] Shuttle more, about your brief time as a NASA test subject for the testing of space suits and related hardware. If you could share with us what that was like and how you got to do that.

JOHNSON: Yes, it was back when I was still in engineering working on Apollo. I had an interest in learning more about the space operations and NASA had a program where you could volunteer to be a test subject for testing of suits, so I volunteered. At the time I did that, the program was in the process of qualifying what they call the Apollo B suit.

This was before we were launching the missions with the lunar rover. The original Apollo suit that the crews were using inside the Command Module, when you pressurized them they'd basically straighten you out. You couldn't sit in a chair, because it didn't have what they call a waist convolute. So the B suit was designed with a waist convolute so the crews could sit. Of course this was all designed around the fact that they were going to be sitting in the lunar rover and driving it.

They had to requalify the suit for that and I was involved in some of the qualification tests. One interesting thing happened when I first was in a pressurized suit. I'd gone through the verbal training, but the first time I was ever in a pressurized suit, I thought, "Boy, it sure starts to feel stuffy in here all of a sudden." The tech [technician] looked at me and he said, "You don't look too good." Then he said, "Oh!" He forgot to turn on the air. So I was sitting there all sealed up and no air or anything. Being my first experience I didn't really know, but I got to thinking this doesn't feel quite right.

WRIGHT: Something's not working.

JOHNSON: So he turned on the air, then I said, "Oh, that's great!" The air flows right across your face in the helmet. It washes out the CO^2 [carbon dioxide]. For that particular testing you weren't in the liquid-cooled garments, you were mainly using air for cooling. That was cooling you also so that was much better.

The testing really consisted of some pretty boring stuff. You went through a lot of cycles. They'd have you do a certain motion with your arms, and you had to keep repeating this X number of cycles. Then walking around, and exercising the joints. Got to be pretty boring. The other thing you also did was whenever they're trying to develop techniques for testing the lunar tools, or something like that, they used test subjects in a pressurized suit to go out. In Building 5 they actually had an item there, test stand you might call it; it was filled with this dust-like lunar—it was a simulation of the lunar surface, consistency of it. I was involved in some of the tests where I'd take some of these core samples and a hammer, and while I was in a pressurized suit I'd drive the core sample down, and work with the tools. I'd help them work out

the procedures and how long it took to do those tasks. That was interesting. I've also got a series of pictures they gave me that they were taking of me doing those items in the suit.

I was always involved, like I mentioned earlier, in trying to think of contingency procedures. One of them I worried about was what if you land on the lunar surface in the Lunar Module and you get ready to start the ascent engine and you reach up and you push the button and nothing happens, something's wrong with the switch or the contact. So I developed a procedure whereby you could take, once again, one of these utility contingency cables, and the crew would have to cut it out of the connector and make it. Then also you'd have to do some work outside because there's the pyro [pyrotechnics] boxes to separate the stage from the lower stage down below, and then also they could connect up and go directly to the ascent engine to be able to fire the pyros and fire it as a backup. To see if the crew could do that in a suit, they used me as a test subject, since I had the procedure, to use the surgical cutters and tools that they had, to see if [while] in a pressurized suit I could indeed make up a contingency cable and do the things that the procedure called out.

One of the steps involved crawling in the Lunar Module from the outside in the pressurized suit, to get back in. When you go in the Lunar Module you have to actually raise up, because there's a bulkhead there that's over the ascent engine cover. So when you go in the Lunar Module, as soon as you get through the door in a pressurized suit, you got to raise yourself up and go in, basically stand up inside, then turn around.

Well, this was my first time. I went through the hatch, and I was going in real slow in the suit, and I didn't realize that my head was up against that bulkhead. I didn't raise up. The guys on the outside were hurrying up, "Johnson, hurry up and get in." I was sitting there straining and pushing. Finally there was a guy inside, he looked down to see what the deal was, and he said,

"You're trying to push us over, you got to raise up." So I raised up and of course went along just fine.

Fortunately we didn't ever have to use that procedure that I came up with, but we'd written it up and had it available. The photographs and the work we did there showed that yes, you could do that if you really had to. That was a level of comfort anyway.

WRIGHT: I'm sure the astronauts felt better knowing that there was at least a contingency plan.

JOHNSON: I was a test subject all the way up until the beginnings where we were doing work on the Shuttle program. I did do one in the vacuum chamber for testing the walkaround bottles that the Shuttle crew would use in the suit that they have when they're getting launched in the Shuttle. It was a small test.

That was really the last time I was involved in the test subject program. After all, I was getting older then, getting busy with other things, so I dropped out of the program at that time. When I was doing it before, it always had to be worked around your existing work. But it was interesting. The real thing I learned about it is how difficult it is to work in a pressurized space suit.

WRIGHT: The other thing that you mentioned yesterday was your part in developing the SAIL [Shuttle Avionics Integration Laboratory]. Could you share a little bit more about what you and your team did when the SAIL was being first designed and developed?

JOHNSON: Yes. At that time I was working in Building 16 [Control Systems Development Division], and it became apparent that with Space Shuttle being the first spacecraft that was going to be totally automated with computers—and we had the multiplex system and data buses—that it was going to require an extensive setup.

We also wanted this system to be the actual wire links, to have the equipment installed in the same locations in the avionics bays because we wanted to be able to show what the EMI [Electromagnetic Interface] effects would be. The physical locations, the routing of the wiring. I was involved in helping develop that. Rockwell [Space Division] at the time was the primary contractor to develop that facility and I was involved in following the power distribution and the wiring. Then we had simulators there and also there was a cockpit involved.

SAIL became very important for testing out all of the flight software, and as far as I know it still is today tied into the [Mission] Control Center such that if there's any problem during the mission with the avionics or the software they can go run those cases in SAIL. The other thing it allowed us to do was the [NASA] Kennedy [Space Center, (KSC) Florida] spacecraft people would come in here, and it was used to check out the launch processing software that they had at the Kennedy Space Center, because all of the interfaces into SAIL were also the same data buses from the launch processing. So it was also a great test bed for using that.

The actual flight crew astronauts came over and ran a lot of runs in SAIL. It didn't have the visual displays like the simulators did, but all of the controls and all of the displays was the actual computers and avionics and hardware, whereas you don't have the actual hardware like that in the simulators. Astronauts were used when we made all the mission runs in the SAIL. So it was a very important facility, still being used. They were planning for the Constellation Program to have a similar thing called CAIL [Constellation Avionics Integration Laboratory]

like the SAIL. They did have something similar, not as elaborate in terms of the layout, but they did have a facility out at our NASA [Sonny Carter Training] Facility near Ellington [Field, Houston, Texas] where the NBL [Neutral Buoyancy Laboratory] is. In the same building is the software facility for the International Space Station, likewise set up to run the avionics and the software out there for proving out for Space Station.

The SAIL was the first one to really show the importance of a test bed like that in the program. Of course there was a lot of emphasis on making sure that system was right, seeing as we were going to be launching the Shuttle with a crew in it for the very first time rather than going through the unmanned [missions], like almost all programs in the past had done.

WRIGHT: Just briefly yesterday you mentioned that you were the EGIL [Electrical Generation and Integrated Lighting Systems] flight controller on the first Space Shuttle flight, but you didn't share much about what that moment must have been for you to see a new spacecraft go up, something you had been working on.

JOHNSON: That was very exciting. I was on the orbit team. Chuck [Charles R.] Lewis was the flight director. I actually watched the launch from home at that time because the orbit shift wouldn't come on until later. But yes, that was very exciting.

We actually simmed [simulated] for two years getting ready for that mission. I was over in flight operations in October '79 and we launched in '81. We went through a long period of simulations and training. That whole first team of us went through more training than what the normal flight controller would get because we had all this time.

At the same time we had gotten pulled off to do certification of the simulation facility itself. We did a lot of work on that and they were using us in that role. It was very exciting for me, because that's something even back during Apollo I always wished I had a chance to work in flight control and the actual Flight Control Room. I was able to do that and I had a good team, some of the best engineers supporting me. Dennis [J.] Webb was my young engineer at that time, as my instrumentation. We had an EPS [Electrical Power System] engineer [Richard T. Brown, Rockwell International] and a power manager [Jerry D. Pfleeger, US Air Force Major] and all those people supported me in the back room.

The flight STS-1 itself, fortunately for everyone, turned out to be a fairly problem-free flight. In terms of having to work problems during a mission, in that regard we didn't have that much. It was mainly you'd be attending to your data and everything worked out well. But that still was very exciting.

WRIGHT: We ended yesterday with you sharing with us that while you were part of that group you managed quite a few people that have come through the ranks and are now flight directors. If you don't mind, it would be a good place for us to pick that up. You were mentioning some of the people that you had as part of your team.

JOHNSON: Yes, one thing I'd like to point out since I actually had gone to flight operations from spending a lot of time in the engineering world. When I was the DF4 [Systems Division, Mechanical and Payload Systems] branch chief—that was the branch chief that had the RMS [Remote Manipulator System], the mechanical systems and upper stage—I tried to impress on

the flight controllers the importance of getting out and seeing the actual hardware, because most flight controllers don't really have a chance to do that.

In the case of the RMS area, there really wasn't an engineering support group for that per se. Dale [E.] Moore's RMS area—Bill [William D.] Reeves was one of his lead engineers for that—were involved in the design reviews and did travel at my encouragement, and actually did spend a lot of time seeing the hardware and seeing what the RMS looked like and operated. I was always pushing for that, that they get out and do that more and look at it and they'd be able to perform a better job when they were in flight control.

Well, it just so happened when Bill Reeves was the lead RMS flight controller, and I don't remember now which mission it was, we had a mission when they were checking out and getting ready to grapple the payload to lift it out, the major payload for the mission. We had an indication that the grapple mechanism was jammed. Actually when they were checking ahead of time which would prevent you from going ahead and grappling the payload and being able to bring it out.

The engineering people, the Canadian people [Canadian Space Agency] that were responsible for RMS—everybody was looking and couldn't figure out what was really wrong with the thing. It looked like we weren't going to be able to pull the major payload out and do the mission. Well, Bill had remembered, looking at the hardware and being involved in testing, there was a little flex cable that when the grapple fixture moved in and out this flex cable flexed all the time. It was mainly used not for controlling the main functions, but for the instrumentation and indications on the system.

Bill got to thinking. What if that flex cable actually broke and those little wires opened up? I was in the SPAN [Spacecraft Planning and Analysis] following it. Bill talked to me about

it, and I went out there and we all looked at the drawings. I told Bill, "Bill, I think you're right about this," because if you opened up the circuit on those circuits that were going through that flex cable, it matched all the data we were talking about.

Bill said, "Well, I'm certain that must be the case. The Canadian people indicated that yeah that could be maybe what it is." Bill then was able to give the go-ahead and that was just indication we'd be able to go ahead and grapple that. So there's a case where a flight controller, having seen the actual flight hardware itself, and able to use that information as a part of his troubleshooting the problem actually saved that mission on that Shuttle flight. That pointed out the importance of the flight control people not only being involved in simulations and all the training they do, but if possible to get out and see the hardware.

The other thing I mentioned was, especially when I was in the DF6 [Systems Division, Guidance and Propulsion Systems] branch that one of those sections was the propulsion section responsible for the RCS and the OMS [Orbit Maneuvering System] propulsion system on the Shuttle, a lot of the flight controllers that were in that group later became flight directors. At that time it was Linda [J.] Hautzinger, who later after getting married is now Linda Ham—I certified her to be a front room ascent flight controller for the prop [propulsion] systems, which is a critical position. She'd worked others through the system, then later I believe Linda became one of the first female flight directors. Very sharp lady.

In that same group there was [N.] Wayne Hale, Ron [Ronald D.] Dittemore selected to be my prop section head. Bill [William H.] Gerstenmaier, who is now up at NASA Headquarters [Washington, D.C.], was in that same group. You had a very sharp group of people in that section. I was fortunate the whole time I was working in flight ops [operations] to have the groups that supported me and the various branches, very sharp, intelligent people.

Same of course applied in the early Apollo days as well. Everybody was highly motivated. Back then you had to have a 3.5 grade [point] average or better to even get considered by NASA to be hired on so everybody that came in to work there was very sharp and intelligent.

WRIGHT: Share with us what you did after you were part of the flight ops.

JOHNSON: While I was there as the branch chief for that section, I got a request to consider applying for deputy director of the Safety, Reliability and Quality Assurance [SR&QA] Directorate. I did apply for that and got selected by Marty [Marten L.] Raines. Marty Raines told me at the time he selected me, "You always complained to us about our job and quality." This goes back to when I was doing all those wiring inspections. I quite often was on to the quality people on things they missed, and I've always been concerned about safety in that regard ever since the Apollo 1 fire. I thought to myself if there's anything I can ever do in the program to prevent something like that I'd sure want to do that, so I've always had that interest. Marty said, "That's one reason. You've been the most critical of us, and always improving," so he selected me to be the deputy.

That was in October of 1985, which was just before [Space Shuttle] *Challenger* [STS 51-L accident]. I got a surprise shortly after I was there as a deputy. One of the payload engineers came up to see me and said he was really worried that the Shuttle program was planning to fly the Centaur [rocket] as a liquid oxygen/liquid hydrogen upper stage in the Shuttle payload bay. The [NASA] Glenn Research Center [Cleveland, Ohio] and Convair [Division of General

Dynamics Corporation] out in California was building the support equipment for that and were going to fly the Centaur.

He was supporting taking the basic Centaur system through the Payload Safety Review Panel for the Space Shuttle. They'd had a lot of concerns about single-point failures in that system and the plumbing, and he was frustrated because he'd been flagging that to the management and nobody had done anything. It turns out that even though the payload safety review chairman was insisting they needed to make changes, the Glenn Research Center actually had gone to Headquarters and argued the case. Here's a case, the only time I know of, where Headquarters was basically directing going ahead with the program, even though they weren't meeting the real safety requirements. He [the payload engineer] was concerned that nobody had really taken a real hard stand on that. One of the arguments for it was that the Centaur was a proven vehicle that had flown on the unmanned flights. The problem with that though is that the Centaur vehicle being built for the Shuttle had a different shape, different tanks.

The big concern we had was there's a common bulkhead between the oxygen tank and the liquid hydrogen tank, and it would take very little delta pressure across that to cause it to break and really cause a real problem. Instead of having a direct delta P alarm system in there, that if you were getting close to that pressure it would shut down the pressurization system or try to safe systems, they had a computer program that tended to try to manage the pressure in the oxygen tank and manage the pressure in the hydrogen tank, and between these two pressures that you're managing, then try to make sure you met the requirements for the delta P. But there wasn't a direct measurement and that was the real concern we had. Some sort of dedicated, different from the computers, in case there was a problem with the software or something else. The Safety Panel was insisting we needed to have something separate on that.

The other thing. When you were loading the liquid oxygen/liquid hydrogen, you'd be at the [launch] pad at the Cape [Canaveral, KSC Launch Complex 39]. That loading was being done through plumbing through the Shuttle and then had to go into the Centaur. The plumbing lines had so little margin in them that if we suddenly had to stop propellant loading when you're loading the external tank, the hammer-type pressure you get, pulse from suddenly shutting that off—the analysis showed you had a very good chance you may rupture lines in the orbiter, which would cause the loss of the Shuttle and the orbiter on the pad. That was a big safety concern, that we didn't have sufficient margin in those lines.

At the time I wrote a letter. Jesse [W.] Moore was at NASA Headquarters, and he was a great proponent of the Centaur in terms of wanting to launch probes to the Sun and around, which is what Centaur was meant for. The DoD [Department of Defense] was interested in being able to use the Centaur as an upper stage as well, so there was a lot of interest in making that system work. I wrote up that we were going to have a flight readiness review for that mission. This mission was going to be one of them following what was the *Challenger*. We were having this review in January at the Cape, and I'd written up this letter before I went down there arguing. JSC engineers and people had been working with the Glenn people for a long time trying to get these changes in, and nothing was being made. I got Marty Raines to sign it and I alerted Arnie [Arnold D.] Aldrich [Level 2 Space Shuttle program manager] what I'd done. Also the deputy director of JSC, [Robert C. Goetz]—I let him know about it, I showed him the letter when we were going down to the Cape on the flight for the review.

I got up at the meeting and mentioned that we had these constraints that hadn't been resolved and they would have to be taken care of before we could say it was safe to launch or fly. At the time Jesse Moore said, "Well, those look like they're valid, but action is assigned for you

to go off and work at the Glenn Research Center and work that out." That's what we'd been trying to do for a long time, so we were wanting some sort of other decision. That was the end of that.

Then, as we know, in late January we had the launch of *Challenger*. I was in the Building 45 [SR&QA Division Offices and Technical Library] sixth floor conference room. We stopped our meeting to watch the launch, and of course we saw what everybody else was seeing on TV. I remember some of the younger people in the room wanting to know what happened. I told them, "Well, looks like an explosion. The Shuttle is lost." It was really pretty bad.

I later got assigned to an audit team to go [to the Cape]. Not only reviewing everything and going through all the flight analysis, safety and hazard analysis, but we did something similar to the NASA walk-down inspection. We went and our team, which was supported out of the SR&QA Office at NASA Headquarters, headed it up. We went out to every element before we got ready to fly back, to make sure it was ready. We looked at SRBs [Solid Rocket Boosters], we looked at external tanks, we looked at the launch complex, we looked at the orbiter to assure ourselves all the changes that were being implemented were being put to bear before we made the first flight. Fortunately that flight went off well.

Meanwhile, Centaur was still listed to be launched in the Shuttle, but after *Challenger* there was this renewed concern about safety. There was a big review up at NASA Headquarters. At that time Dick [Richard H.] Truly was the Administrator. I went up there representing SR&QA and once again had all these issues lined out. Rick [Frederick H.] Hauck was going to be one of the commanders for one of the programs.

Before that Headquarters meeting we had an audit out at Convair of the Centaur system and GSE [Ground Support Equipment] associated and the computer system, and I was out there

involved from the SR&QA's perspective. I was reviewing, going through some of the paperwork, and I noticed on some of the critical relay boxes that send the commands from the computer that they'd had a bunch of failures in testing in vibration. I didn't see in the paperwork, any real closeout that said that that hardware ought to be certified yet. Yet we had papers that had been signed off by the people involved saying things were certified and all ready to go, when it looked like to me we still had some open problems that they had to fix.

I called the engineer in that was responsible for that system, and I was quizzing him about we've gone through everything and you had these problems. I said, "What's the rationale for signing that this is ready to go?" I could see [he]—this was a young engineer—was fairly visibly shaken, and he confided that he was forced to sign it by his management. I thought boy. Meanwhile I put out an audit report that talked about a lot of these problems. I didn't mention anybody by name, but I did mention that I talked to this engineer and how he stated to me that he'd been forced to sign this when he himself wasn't feeling it was ready to go.

We reviewed that with Glenn and the management. They took issue with somebody "being forced to sign." I refused to give them the name of the individual, but I says, "It really did happen." Matter of fact, there was another young engineer with me who'd heard that too so [I] had another witness. It was calling out a lot of these problems, and other problems we found as part of the audit. My report got leaked to the IG [Inspector General], the GAO [Government Accountability Office]. They came in to talk to me about it. Then it made some news. I suspect some manager at JSC that was wanting to kill the program too did that. I don't have any proof, but I know George [W.S.] Abbey was very concerned about it, and he was in charge of the astronauts at the time. I think George might have been the one to leak the memo. Then the GAO

came over and went through it and they came up with the same conclusion. There's a real problem here.

Then we had this meeting at Headquarters. I felt pretty good about it, but I was really surprised when I was there because some people from engineering had done analysis and actually had supported Glenn on factors of safety and some of the things about the plumbing and the fact that we only had a single shutoff valve instead of two and a few other things, even though that didn't meet our payload safety criteria. The DoD was there, and the planetary guys were there. There was a lot of arguments being made and there was a lot of scrutiny, but I still stuck very hard to what we were saying. The astronauts themselves expressed concerns, but they were somewhat resolved being on that. I didn't get a decision right then. I was a little bit concerned, but then I heard later that Dick Truly had agreed that we were going to cancel the Centaur program.

After that I talked to Rick Hauck and some of them. They said they were convinced that one of them would have probably died launching that thing. They were that worried about that system themselves, even though they were reluctant to really express that. They were, as test pilots, willing to go fly it. Management said that was the thing to do, but they were really relieved that we finally canceled the Centaur program. I myself was surprised that it took so much effort to cancel that program, particularly after *Challenger* when we supposedly had all this high interest in safety. Fortunately, as far as I know, since that time we've never had a case where the Payload Safety Review Panel chairman has been pressured into approving something that he really didn't want to approve.

WRIGHT: That was quite a way for you to start your entry into the safety.

JOHNSON: Yes, that was quite a way to start my entry. I was put on the frontlines. When I went to work for Marty Raines, he was up in age and he said that he didn't like to travel. So any travel, like those trips to the Cape or any travel involved or any of these audits or anything else, I was the guy that was always going to be doing the traveling. Marty retired after *Challenger* and Charlie [Charles S.] Harlan came over to be the deputy [director].

Charlie came from flight operations. I'm glad Charlie, when he came over, agreed to still have me as his deputy. Charlie Harlan stepped in and did an outstanding job building up the safety organization. Before *Challenger* the organization got to the point where we only had one manager in SR&QA following what we called Level II, which would be the total Shuttle. Then we had just a few other managers following the safety of the orbiter. Everybody else was off working on the early Space Station [Freedom] or other things. The funding for SR&QA had been scaled way back so the organization itself wasn't able to hire and wasn't able to be involved that much. After *Challenger* we got a funding increase.

The other thing that was done organizationally—I usually talk about this. Before the Apollo 1 fire we didn't have a separate safety, quality assurance and reliability organization. In Apollo the reliability and quality organization was a part of the Apollo Program Office. Then there was a small Flight Safety Office headed up by Scott [H.] Simpkinson. After the Apollo 1 fire, because of all the concerns about safety and quality, [Robert R.] Gilruth [Manned Spacecraft Center Director] came out and directed that the Manned Spacecraft Center [later renamed JSC] will have an integrated SR&QA, safety, quality and reliability assurance, organization that reports directly to the Center Director, for the first time. That was put in place.

NASA Headquarters and the other space Centers, none of that was done. Matter of fact, NASA Headquarters, the SR&QA function was a part of the Chief Engineer's Office. After *Challenger*, that was then relooked at, because a lot of the criticism about *Challenger* was about this lack of involvement, all the Centers, including NASA Headquarters, were directed to make, just like JSC already had, an independent SR&QA organization that reports directly to the Center Director, independent of the program. That was done at [NASA] Marshall [Spaceflight Center, Huntsville, Alabama], Kennedy—they all went through a major change, put in new managers. Then the office at Headquarters likewise, and it was called Code Q at the time. Had Code M for spaceflight and Code Q. George [A.] Rodney was brought in from Convair, a famous test pilot with them, a lot of experience, to head up the SR&QA [Safety and Mission Assurance (S&MA)] Office for NASA Headquarters. He turned out to be an excellent manager. We reinvigorated and really added some teeth to the whole SR&QA organization. The funding at that time was all independent of the programs.

WRIGHT: Did the Centers begin to exchange information on how safety was done at [each of] their Centers?

JOHNSON: Yes. After *Challenger* there got to be quarterly meetings with all of the SR&QA directors that Charlie was involved in. There was a lot of telecons, a lot of working together. All of the Marshall, Kennedy and Headquarters as well as JSC got to know the other groups and worked real closely together. That was a big factor really helping out. It's unfortunate that over those later years once again the budgets came into play, and the funding for the SR&QA

organizations was being cut back. This was back during the time when they were even thinking about having the Shuttle go commercial, before United Space Alliance and all that.

Charlie Harlan—I admire Charlie for this. He fought with Headquarters and the program about these changes that were going on. Particularly in the case of what was happening with Shuttle, where they were turning everything over to the contractors and you didn't have the independent quality assurance checks. He was very adamant about doing that and wrote a letter to Headquarters very critical of all of that. Unfortunately it resulted in Charlie being removed as director, but he felt strongly about it. That's when John [H.] Casper from the Astronaut Office came over to head up SR&QA [S&MA].

Also in that timeframe when Charlie was still there, we did have the start of the Shuttle-Mir Program. Charlie asked me to be involved in that. I was really interested in doing that, because it would give me a chance to once again work with the Russians. I really enjoyed doing a long time ago, and it'd been a long time since I'd met any. That was a great program. I'd have to say that the Phase 1 [Shuttle-Mir] Program, working with the Russians was one of the programs I think very highly of and enjoyed as much or more than about any other program I worked on.

It had to do with several factors. The thing that was good about it is we organized into working groups, which the Russians were familiar with because we organized into working groups back during ASTP [Apollo-Soyuz Test Project]. We used the same type of management structure. The working groups would report to the Shuttle-Mir program manager and the Russians likewise, and really we were able to develop our own policies. Me and my Russian counterpart, Boris [I.] Sotnikov, developed the overall joint safety policy for the two of us for the Shuttle-Mir Program ourselves, and it got approved and didn't have to go through a lot of things.

The Russians did a lot to match what we did. Since I was a deputy director at the time, Boris Sotnikov was a deputy manager of the Russian program. He was deputy to the manager Pavel [M.] Vorobiev, and they were like a systems engineering group, which is probably the closest thing to a safety organization. The Russians had a reliability quality organization, but not a separate safety [organization]. That organization also was responsible. Boris Sotnikov, my counterpart, was one of the main engineers in the design of the Buran, which is their version of the Space Shuttle.

Matter of fact, Boris Sotnikov confided to me when we got to know each other real well that they had copied the Shuttle. He said they were actually directed by the Russian military to copy the Shuttle. The Russians at that time were really basically scared to death that we were going to take the Shuttle up and grab one of their satellites and bring it back in our payload bay. So Boris Sotnikov with—it was called NPO Energia at the time, and they later changed to [S.P. Korolev] Rocket and Space Corporation Energia—they really preferred to design their own Shuttle. But the military, because they were concerned about getting something quick, directed them to copy the Shuttle because all of the aerodynamic data and everything else had already been done and cut down the development time greatly for the Buran.

That also meant this group of engineers was extremely knowledgeable of the Shuttle. So when they were working with us—we were concerned about the safety of the Mir [space station] and the Soyuz [spacecraft], they were concerned about Shuttle. Well, they knew the Shuttle systems very well. One of those became apparent in one of our early meetings. Our engineers were giving briefings to the Russians on the Shuttle systems as they had given briefings to us on the Mir, and one of the schematics our propulsion engineer put up, one of the Russian engineers pointed out a mistake in that drawing, and sure enough he was right. So that opened our eyes up

to the fact that these Russians know more about the Shuttle almost than we do. They were a very sharp group, the Russian engineers were, very knowledgeable. We were both willing to really work together.

The other thing I did probably more so than anybody else is whenever they came to the US, I always invited them to our home. On the weekends, even though we're not compensated any way by NASA by doing this, I would take them on trips to Galveston [Texas] to the beach, and did a lot of social things with them, because when they were here they didn't have rental cars, they were pretty well stuck in their apartment. So we always tried to do something with them.

Likewise, they were pretty embarrassed about what they had to live in so they didn't really invite us. I got invited one time to one of the engineers' apartments and the whole family was living there together. We ate that evening on what we'd consider a coffee table, but that was fine with me. They did take us on little excursions. They'd get one of the Energia buses on a weekend, and they'd take us out to Sergiev Posad, which is a monastery type area outside of Moscow where there's a lot of artists and things. They took us on a lot of little trips, just like we would take them.

To expand their knowledge and interest, we would hold some of our working group meetings at other places. We held one of them at NASA Headquarters so they got to go to NASA Headquarters. Boris Sotnikov, I asked him one time what really impressed him about the Americans or the US, and his answer really surprised me. He said, "You're concerned about handicaps." You don't see any of that in Russia. There's no special things on stairs or escalators, there's no ramps, there's nothing they had over there, and he noticed that over here you always had these special areas for people in wheelchairs.

The other thing is he said, "You respect your history." Of course we'd taken them to the Smithsonian [Institution Museums, Washington, D.C] and gone to all that. He said, "History, whether it's good or bad." I think what he meant by that is right after the fall of the Soviet Union they trashed their statues of Stalin and Lenin, and tried to undo all that. So I think that hit home to him too. I thought that was interesting, because you'd expect "Oh, your cars, your roads and homes." But instead those two things he mentioned. I thought that was very interesting.

WRIGHT: It is neat.

JOHNSON: Because most of my team was Rockwell safety engineers from California, we had one of our Safety Working Group meetings out at the facility in California [Rockwell Space Division, Downey, California]. Of course we even took them to Disneyland and got a chance to see that.

WRIGHT: How fun.

JOHNSON: Then while we were there we also went up to Palmdale [California, Rockwell Space Division Orbiter Assembly Facility]. At that time they were building the Orbiter 105 [Endeavour] so they got to see the assembly. We also took them to the [NASA] Dryden [Space Flight] Center, Edwards [Air Force Base, California], as a tour. One of the tours there, they had out one of the Blackbirds, the SR-71 spyplane I call it. We were there showing them that and Sotnikov was able to tell me details of the materials the plane was made out of that I never knew. So once again he knew a lot.

As we got to know each other's families and work and trusted each other—they didn't write this stuff down, but we confided in each other quite a bit. One example of that, one time we were talking about when it was the old ways. He said, "Did you ever know you lost a photographic satellite over Russia in those early days?" I said, "No, nothing was ever published about that." Well, in the early days we had these satellites that were like a big round ball that had [spy] cameras in them, and they would overfly Russia and take pictures. Back then we didn't transmit the pictures; when it came down on a parachute we had this airplane with a big grapple-like thing behind it that would snag the parachutes, grab the satellite, bring it in, then we'd review the pictures. Well apparently, even though this was never reported by the [US] Air Force, one of those spy satellites actually parachuted down, and came down in Russia.

Boris Sotnikov said he got an action from their spy agency, that they needed to get a team together to go out and investigate that. So Boris Sotnikov was heading up a team and it landed way out in Kazakhstan like where they land stuff now. Then when they landed there, they found the satellite all torn apart, torn up. Come to find out, it was this big ball and the Russian manned spacecraft, the Vostok at that time, was also a ball. It landed fairly close to a peasant village or something so they thought a man was in it. They had torn into it thinking they needed to get somebody out. Then meanwhile they found out that wasn't the case. It was humorous—they had taken stuff out of it, and there was a lot of the film they exposed of course. They had pulled the film out, and they found the film wrapped around one of the outhouses. It had served to seal, to keep the wind from blowing through the cracks in the outhouse.

WRIGHT: Very resourceful people.

JOHNSON: Very resourceful people. He said they found parts on tractors and all kinds of stuff. He said they were disappointed the film was all exposed. But he said, "We learned a lot. We were able to determine the focal length of the cameras involved," so they would know in the future exactly what we'd be able to resolve and see. He said they were very surprised that our avionics that we had in the satellite could operate in a vacuum, because all of their avionics at the time was designed to still be inside a pressurized compartment, not in a vacuum. So when they got back they were directed to investigate developing their components that could maybe operate in a vacuum also. He shared that with me, of course pretty humorous.

WRIGHT: Your work together received an AIAA [American Institute of Aeronautics and Astronautics] award I believe in 1996.

JOHNSON: Yes we did. We both received awards for our work from AIAA for the safety joint work and we've written several papers for that part of the program. We got to be a very close group, and we still stay in touch. We considered each other family almost.

WRIGHT: During that time period you had some challenges with the collision and the fire.

JOHNSON: Yes we did. Thanks for bringing that up. We had the fire that occurred on the Mir space station with the SFOG, the Solid Fuel Oxygen Generator system. It burns, often referred to as burning the candles. It's a mixture of solids. Matter of fact, our people even use it on submarines. The airplanes use it now. Where you pull the handle to operate the oxygen on the airplanes, that's actually a solid material in there that burns, that releases oxygen. They used

those in the Mir spacecraft to generate oxygen if the standard oxygen generation system didn't work. They use electrolysis to generate oxygen from water, and then they dump the hydrogen that comes out overboard. But when that don't work, or if they have a power problem, because that system used a lot of electricity, then they would burn these candles to generate the electricity, and they burned at a fairly high temperature.

In one of these cases, one of them had some sort of contaminant inside of it that started burning. Instead of just heating up and decomposing the chemical and generating the oxygen, this high temperature started burning something, and it caught the actual stainless steel container on fire. You had pure oxygen there so it was almost like a blowtorch going on and also generated a lot of smoke. The Russians grabbed fire extinguishers and tried to put it out. It was very difficult to put out with an oxygen-burning fire; it's a water-type fire extinguisher. They did finally get it to stop, but meanwhile it'd done a lot of damage there. Fortunately it didn't breach the spacecraft, but it contaminated the atmosphere. The crew had to keep their gas masks on for quite a while breathing, try to keep that out. They took samples of what the toxic gases might do.

Energia did an investigation. It came out almost like "This is a random event and we don't think it'll occur again." Basically they didn't know exactly what had happened. Well, we, NASA, complained a lot about that, that that really was not an independent group like we, NASA, would do to do that. You had the same company that was responsible for the hardware and the problem that did the review. The Russians did agree, and they turned it over to what my counterpart told me is like our FBI [Federal Bureau of Investigation] lab or something. That group went in and really investigated and repeated tests. They couldn't prove it, but what they were able to show—because they reproduced it—was during the manufacturing process of these

cartridges the workers used these like surgical gloves, the rubber type gloves. The feeling is that somehow a piece of one of those gloves got left in one of those cartridges and that's what caught fire. They were able to reproduce with something like that in a cartridge, and burned the cartridge, and the cartridge caught the metal container on fire just like what had happened. So they were pretty sure that's it, but they couldn't actually prove it since that was gone.

That came out, and it allowed them to make changes in their process and watching for what they did there. At the same time they redesigned and came out with a new system that's used now in the ISS [International Space Station]. Instead of having an impact, almost like a bullet where you'd hit it and it goes off and starts the cartridge sometimes, for ISS they developed a special electronic ignition which would be much easier, and did a lot to improve the safety of that system. Initially they still had the old type system on the first early part of the Space Station, but now on ISS it's got the new design SFOG system on there.

I think the Russians themselves learned the value in having an independent group look at a major problem like that because that group was very thorough, and they were able to come up with [the answer]. I was able to go over and meet with that group and be a part of that. Frank [L.] Culbertson, who was our manager at the time, had me go over and be a part of that investigation.

Then later we had a case where the Progress [Russian spacecraft] had a collision with the Spektr module on the Mir and caused a depressurization which came very close to losing the crew. The pressures got down very low. If it would have been much longer, they'd have been in real trouble. Mike [C. Michael] Foale was the American astronaut on there at the time. They were able to quickly put a hatch in place and quickly seal off the Spektr module from leaking any more.

That investigation showed that—it was really a bad thing to try. The Russians were trying a new experiment. As part of wanting to try to save money, they were taking—the Progress vehicle is one they get rid of after every mission—they were taking some docking system electronic hardware off of the Progress to see if you could strictly dock the Progress manually, and be able to do it from a further distance.

There were several factors in the review of things. One is that that electronic device would transmit data back to the operator telling him how fast it's going and so forth to be on his display, along with the visual display that you use to allow the vehicle to come in. The other thing, because that equipment was off, also they were running a test where the Progress vehicle was further away from the Mir station than it normally would be for when the crew would take over and manually dock. Also, the orientation was such that it was against the background of the Earth where you have the clouds and so forth. The reason I mention that is the visual display. When the Russian was manually trying to direct it in, it ended up coming in too fast and he didn't have this distance data to really tell him. Strictly having to go on the camera views. It turned out it missed the station and came in and hit the Spektr module and damaged it and careened off and caused a leak.

Tom [Thomas P.] Stafford—a special commission was put together to go investigate. Tom himself, as we all know, was well versed in docking, an expert. He commented that this view that the Russian cosmonaut had looking back at the Earth and trying to maneuver in to dock was bad because he remembered back during the Gemini program he had trouble docking with the Agena [target vehicle]. When it was against a similar background he had trouble seeing it. So he said number one that was bad. Number two, trying to do a docking without having this data to tell you how close or how far away, what the proper orientation was, was very bad.

So there was a lot of factors. Initially Energia once again came out and all the blame was put on the cosmonaut. "You didn't do your job right." Tom Stafford brought out all this other information. An independent Russian group [worked for TsNIIMash] was part of Tom's group as well. They came up with all this other information that says he was put in a position where it was almost impossible for him to try to do the right job. And also not being able to train on that system for quite a while was part of it. Nowadays [the Russians] actually have the capability to train on a simulator and practice Progress dockings. The last Progress docking just now to Space Station was done manually because the automatic system messed up. But they have the proper data as well as the visual to do all that with, and the Progress is in a close distance. We've been doing that fine.

I was sent over by Culbertson to sit in on the big review they had at Star City [Russia, cosmonaut training center] during that investigation. Part of that was presenting the history of the training on that cosmonaut, what all he'd done and what his scores were. I was real impressed, because that's an area that we probably should do more of on the NASA side that we don't do, where we track the number of errors and mistakes in training on the simulators and keep track of that data in terms of qualifying an individual to fly and his background. The Russians were able to show the complete history of what training he'd had, and what errors he'd made in that. They also had a good database of what errors crews had made in flight.

Nowadays when we, NASA, want to do probabilistic risk analysis or safety on the hardware, there's always a concern about wanting to put in the human element on doing this analysis. What's the probability of a crewman making a mistake or error? Well, the Russians have the data. Matter of fact, my Russian counterpart told me one time about 10 or 15 percent of all anomalies they've had in flight are attributed to crew error. Bryan [D.] O'Connor one time

asked me, when they were really getting ready to do some of these renewed PRAs [Probabilistic Risk Assessments], if we have any information on crew error for spaceflight. I just was able to tell Bryan, "Well, this is the figure the Russians use." Bryan himself was thinking. He said, "That sounds about right."

You talk to almost any Shuttle crew, and it's just fortunate we haven't had something cause a real problem, but there usually has been a case where we've had a few errors. There's been a few cases that are known in terms of a problem with a payload or something else, but we still don't have a database that keeps track of all that. Even though you want to keep it private, that's something you really want to do—also for those errors to help you with the design. Remember I talked about the Skylab 4 case where those circuit breakers were located close together. There needs to be a capturing of these crew errors to help with the future design of spacecraft. I personally would think that we ought to do like the Russians do. We ought to record those in-flight anomalies and problems that the crew have and keep that in a database somewhere to be used for future designs and make reliability estimates on.

On the Spektr module we then ended up developing a patch for that. Going in the crew was able to patch that, and we pressed on with the program. Turned out to be a very good program, learning to operate—this is one interesting thing though about when you deal with the Russians. They don't rely on a lot of written material and a lot of their training is done orally. All their tests are done orally. In the school system they have there's very little hand writing, it's all oral lecture and then oral tests involved. As a result, every one of the Russians you run into has a fantastic memory. You tell them something one time, and they instantly remember it, know exactly what to do. It's just the opposite in our culture where everything's written, all our tests are written. Somebody tells me a phone number, I'll quickly forget it. If somebody tells

me a phone number and I write the phone number down, even if I turned that over and didn't see it, I'll remember that phone number all of a sudden better. There's something about that writing and feedback that we've grown up with in all our schools. Well, it's just the opposite for the Russians. Their training has all been oral so they've developed this capacity that you tell them something once, that's it.

How that really came home to us is when I was talking to Shannon [W.] Lucid after her mission. Shannon was up there on the Mir, and she said two Russians were getting ready to go out on EVA [Extravehicular Activity], and she was going to have to look after the Mir systems, and she said, "Oh, in case they call from the ground, what do I need to do in here?" The one Russian rattled off and showed the switches you got to throw, do this and this and that and so forth. Shannon said, "Wait a minute! Wait a minute! Let me write!"

"Oh you'll remember that, you'll remember." In other words the Russian's concept was he felt like telling her one time was sufficient because over there that's all it is. Shannon, just like us, "Wait a minute! I want to write that down!" She had to write it down. After the flight Shannon was telling me that they talked about this, about how they're different cultures. That's what brought this out to me, that we in our culture, we have to write something down to not only maybe look at it, but that actually causes us to remember it better. Whereas in their culture they just tell you one time and that's it. I noticed that also when we were working with the Russian counterparts.

Of course they were very dependent on their senior engineers knowing everything because of that. Well, some of those, as they got older they were passing away. So the Russians now have recognized the need to capture and write down to be able to pass on the training. They do more of what we do now just because they had a big case here lately where over the years

now some of their senior-level people that went all the way back to the early part of the program passed on and they're suddenly left without that background and information. So they're doing a little bit more of that.

I tell young engineers, particularly if they're going to work with Russians, there is this culture difference, you need to remember. One is they'll probably not understand why you can't remember things when they tell you something. Number two, it'll be a case you wonder why they never can give you anything written, or it's always got to be a verbal telling you about their system or something else. Bonnie [J.] Dunbar and our [astro]nauts that first went over there had a real struggle because there were these oral lectures and these oral tests that they do over there, and that's just totally different than what we do, so it was a real struggle for them. I thought that was very interesting.

WRIGHT: That is neat. Interesting. When the Stafford-Utkin group [task force led by Thomas Stafford and Vladimir F. Utkin, head of TsNIIMash] began, did they involve you in any of the workings? Or were you just part of the end result with the report?

JOHNSON: I made presentations to the Stafford-Utkin group. Utkin was the Russian side of that. I gave presentations to them on what we knew had happened and what all we had done with our safety documents. Any of our safety assessments we did were all safety assessments done on the Shuttle docking with the Mir, but that same group did review all that also. The Russian side wanted to be sure.

That brings up an interesting item. When the Russians were first coming over here and we were explaining to them how we were going to dock with the Mir space station, we told them

the crew was doing it manually. They got very concerned and wanted to know why we did that, what were the controls in place. The young engineers here at JSC involved in that couldn't understand why the Russians didn't trust our manual docking. So I explained to them the case that happened during ASTP. Nobody over here remembered that. I said, "Look, let me explain to you why the Russians are so scared of manual docking. We almost did them in in Apollo-Soyuz manual docking. That is the reason. You need to understand that and spend the time trying to show them everything that's involved to train our crews and what cues they have."

Eventually we were able to convince the Russians that our manual docking was going to be safe and not damage the Mir, but there was a lot of review. For a while I pretty much had to go around and talk to the engineers, because our young engineers couldn't understand because we'd been doing manual dockings all the time. "What's the big deal about this?" There was nothing written in the ASTP reports about the crew mistakes made during the docking. Also the major impact it had on the Russians, the fact that it really did come close to damaging their spacecraft and causing real problems.

WRIGHT: I've heard it said that the Russians were very glad to see you because it was a familiar face. So many of them were still in the program from ASTP but so many of the Americans had moved on.

JOHNSON: Yes. I was about the only one, you're right. That allowed me a lot more access. They trusted me sooner and knew me better because they knew my background well from having worked together. Even though most of the engineers that were in my direct Safety Working Group were different than the ones I worked with back then—which were still working there—

and I did meet them, had them over and really enjoyed getting with them. They were still in their design areas of the electrical area like I had been back then. Because I was involved in the program they knew I was one of the working groups, I'd been in Baikonur, worked with others. The Russian ASTP managers knew of me. Yes, that was a big, big help. That was a great help. It turned out, particularly later in Shuttle-Mir and Phase 1, I was the only member of all the entire group that had worked Apollo-Soyuz.

At the time I finished working with them and turned it over, which turned out to be 2003 as part of Space Station, my last trip over the Russians gave me a big farewell retirement thing. At the time I was working with Pavel Vorobiev because he was the safety chairman for the Space Station work. They presented me with a Sputnik [first satellite] medal, which is a pretty high medal for there, and a big certificate. It was about—and I hadn't really realized it at that time—30 years of working with them. They had on there 1973 to 2003, and they also had put down—they call it Soyuz-Apollo, Mir-Shuttle Phase 1, and ISS. They had all those programs listed on the certificate. I thought that was really something. I don't know of anybody else in the NASA side that received something like that.

WRIGHT: That's outstanding. How was working with them with ISS different from what you had experienced before?

JOHNSON: There was I'd almost say a little bit of a rough transition for all of us working group chairmen that finished up Phase 1 and went to ISS. We had developed and worked up a lot of lessons learned. We developed a lot of procedures for working safety certificates for the safety

of the cargo and experiments going up, and everything we'd done made sense to follow those same processes over at the Space Station.

When we initially went over to the Space Station people—of course they had been working with the Europeans and Japanese, and everybody'd been going by the NASA processes, NASA safety. They didn't want to have anything to do with all what we'd learned with the Russians. It was very frustrating for the Russians too when they were trying to certify, because the NASA side for Space Station had not developed processes for how we take stuff up as far as crew supplies, cargo, experiments and get them to jointly certify—all of a sudden the Russians came in the ISS and said, "We got part of the Russian segment, you got to certify. We are part of the safety certification, it's not just the NASA Safety Review Panel." The NASA side didn't have any way of dealing with that.

We finally were able to convince the Space Station safety people, "You're going to have to develop a process similar to what we have here, otherwise you're not going to get anything done." They eventually did, but initially it was almost like we got thrown out of the room when we were trying to tell them this is what had worked with the Russians.

That group was very much "Well, we've done it this way and you do it our way or the highway." Which is unfortunate. NASA has got a bad habit of one program not using the lessons from the past, and that was happening here. But in this particular instance, particularly with the Safety Working Group stuff, that pretty much ended up having to carry over, number one because the Russians were pretty much not going to operate unless it was similar to that, and number two NASA didn't have a process in place of that. So the process used in ISS now is very close to what we ended up having.

Things would have gone a lot smoother, been a lot better, if they'd stepped up and adopted what was doing. You can talk to almost any of the working group chairmen that worked Shuttle-Mir and Phase 1—Rick [Richard W.] Nygren or any of those guys will tell you that they went through the same thing that I did, but in terms of their areas when they started working with the ISS people. The other thing that was fortunate, and it helped a lot with our working group getting credit for being one of the better ones. I was the one NASA point of contact from the start of the Shuttle-Mir, even carrying over to Phase 1.

The other problem with the other working groups was turnover. The other working groups went through chairmen almost once every year. The Russian culture is such, they've got to know you and work with you and your background before they'll even start to begin to trust you. The problem with the other groups was just about the time you get to that point where they can start working with somebody, NASA would come in with some new engineer or somebody new to work with them. That's been a real problem.

We never were able to convince NASA management they need to do that. They're still doing this for several reasons. Working with the Russians, particularly where you start out new like that, that's difficult. They're very "nyet." They're very tough negotiators. So it can be very frustrating if you're not very patient and get to know—remember, it's all frustrating for the Russians if they got somebody new that's inexperienced trying to deal with them.

As a result a lot of those people in those positions didn't want to be there very long because it was a very difficult, tough job, and would move on also. In the future as a lesson of that, once you develop a good working relationship, try to keep people in place, particularly if you're working with somebody like the Russians or that culture that depends heavily on that. We were also fortunate during the Shuttle-Mir Program or Phase 1 Program that someone like

Frank—we really had two managers. We had Tom [Tommy W.] Holloway in the beginning and Frank Culbertson throughout that. It was not a lot of turnover for us. In some of the Phase 1 Program working groups, like in the operations group or some of the others, quite often there was quite a bit of turnover. Then, like I said, those other working groups often didn't do all of the social things that we did with them to get to know our counterparts.

WRIGHT: And you stayed with the safety area until you retired.

JOHNSON: Yes, stayed with the safety area till I was retired. When John Casper came in, he was going to have a new deputy. At the same time George Abbey asked Charlie Harlan to do another job. [George Abbey] was wanting to convert the Center to ISO 9000 [International Organization for Standardization management system standard] that Charlie had worked extremely hard to get the Center to do, so he wanted Charlie to head up that office. Charlie was a little upset, but I convinced him that he was the right guy to go set that up, which he did for a while. Matter of fact, Charlie is still working now, fairly busy.

WRIGHT: That worked out well.

JOHNSON: Yes, it worked out well, he's doing well. At the same time George Abbey called me in. He said, "You've worked so well with the Russians and done so much with them. I'm naming you deputy director of Russian projects." I had that title while I was with John Casper, then John left and Yolanda [Y.] Marshall came in. At that time I was changed to be the associate director for technical and that's when we were wanting to improve on our knowledge, lessons

learned. We didn't have a very good training program for our new SR&QA people so I was involved in helping develop the training materials if you were going to be a safety engineer, quality engineer, reliability engineer, and then training materials for how the Center was organized, the history. Then that's when we developed these case studies for the [Space Shuttle] *Columbia* [STS-107 accident] and *Challenger*.

WRIGHT: You were still with NASA when *Columbia* fell.

JOHNSON: Yes, I was still with NASA. I was in that capacity as associate director for technical. I wasn't as heavily involved in the return to flight activities as I had been back in the *Challenger* days. Actually that was also the impetus for doing these case studies, the *Columbia* case, and the emphasis on needing to do the training to improve our skills, SR&QA. That's what initiated trying to work on all that.

Then after *Columbia* we got into this trying to do safety culture change. I will say there's been some things since *Columbia* that have bothered me. Even before *Columbia*, when Space Station organized they developed their own S&MA Office separate from the independent directorate office, which always created an element of confusion between that office and the directorate office. It felt like they had responsibility to support. After *Columbia*, Space Shuttle program did the same thing, developed their own SR&QA Office. Instead of being independent, the funding before *Columbia* had gone away from being independent and was a part of the program. They'd started these cutbacks like I pointed out in the past.

That continued on after *Columbia* so instead of relooking like we did after *Challenger* and strengthening and making sure that the budgeting and the organization was independent of

the programs for the SR&QA organization. Unfortunately—and even the CAIB [*Columbia* Accident Investigation Board] had indicated that should be done—we're in a position now to where the programs have their own S&MA offices. It's a smaller office, you still have the directorate office, but the programming was supposed to be set up as a separate pool of money at Headquarters which would be separate from the program that would fund the SR&QA organization. The problem with that is the programs had reviews as to how much money goes into that fund. And the accounting systems that came in place before *Columbia*, and they're still in place after *Columbia*, regardless of where you worked you had to list a task number for what you're charged to, and some of that would go back to support the programs. So the way we stand right now, SR&QA organizations, my perception is they're not really independent-wise from the budget, like we had gone to after *Challenger*. The organizations now themselves are not independent. They have created what they call a chief safety officer for the program, independent supports.

There's been some things done, some of which I think is good. The NESC [NASA Engineering and Safety Center], safety group that's up at [NASA] Langley [Research Center, Hampton, Virginia] now that does independent engineering analysis has been a good group and they've done some good work and good studies. I'd say that's been a plus that's come about after *Columbia*. I know from working with the people and being in the organization there's still confusion about responsibilities between these program S&MA offices and the directorate line organization S&MA offices. Hopefully that won't cause us problems. I have that concern.

WRIGHT: I know you mentioned Bryan O'Connor a couple times in our conversation. Does the NASA Headquarters safety officer also have a lot of impact on what you do at the Center?

JOHNSON: Yes, Bryan takes a very active role. I've been very impressed with Bryan's work. I know Bryan very well, not only from back when he was an astronaut. Bryan got put in charge of safety from the Astronaut Office right after *Challenger*, and was involved in that. The other thing I forgot to mention—when we were building up the organization after *Challenger*, we brought over Charlie [Charles F.] Bolden from the Astronaut Office to be our safety division chief.

Charlie was outstanding. He helped bring in a lot of the people and being a former astronaut attracted a lot of young and energetic and very sharp people to come into the Safety Division. He developed it and had it running very well and very rigorous. The problem was when Charlie came over—he was a delight to work for. He was a super guy to work for. George Abbey had said, "You're only going to be able to have him for three months," or whatever it was. After that time period Charlie Harlan and I both argued with Abbey trying to get him to stay on because he was doing such a great job. He really enjoyed it, and wanted to do that and would have liked to have stayed on, because it would be a while before he they were going to fly again. But George said no. So he left. That I think has helped, because Charlie Bolden has always had a concern, a little more so, about safety.

Going back to Bryan [O'Connor]. He was involved in that, and then later went off to work in the commercial field with a company that does probabilistic risk assessment, Futron [Corporation]. Then came back in to be the agency head for S&MA, and has been good. We stay in touch. I'm presently a technical consultant to the local SAIC [Science Applications International Corporation] for S&MA that's still involved in some of the training type materials and case studies as well as supporting this Orion [Constellation Program crew vehicle] standing

review board for S&MA. Bryan, about three months ago, sent out a request wanting to know what all we'd done for the safety of the Soyuz to have astronauts involved.

He's trying to develop what we need to show safety-wise to put astronauts on the commercial vehicles or how to make them safe. He directed the SAIC to have me, because he knew I'd gone all the way back to Apollo-Soyuz. I just finished up about maybe less than a month ago a 50-page report for Bryan that covered the history and what all we'd done. It's called "Soyuz Safety: Lessons for the Future." NASA astronauts on Soyuz, lessons for the future. It covered the history of Apollo-Soyuz, which we'd done a lot.

There was a brief program that NASA had while we still had Space Station Freedom where Congress had directed NASA to go over and work with the Russians to use the Soyuz as an ACRV [Assured Crew Return Vehicle] for the Space Station Freedom program. There was a group of NASA people that actually started working with the Russians on the Soyuz a little bit before we formed the Shuttle-Mir Program. Then shortly there was the Shuttle-Mir Program, which didn't last too long, because Shuttle-Mir was supposed to be just sending Norm [Norman E.] Thagard up one time to dock with the Mir and be up there. Then we'd take a cosmonaut up on the Shuttle, which the first one went up when Charlie Bolden was commander of the Shuttle flight.

Before that program really got going real well, it became what they called the Phase 1 and got extended to where we'd do ten of these missions and get all this training and knowledge that we could relate to Space Station. At that same time, that's when the Russians were going to be a part of the Space Station. It was no longer Space Station Freedom, it was International Space Station with the Russian segment being a part of that.

That report covers the history of that Phase 1 and also ISS. It talks about the fact that a lot of the acceptance we did back then was because the Soyuz launcher and the Soyuz spacecraft had been flown a lot with the Mir, so we knew it was fairly reliable. But we did a lot of formal safety analysis of the vehicles and that was pointed out. The point in the report is that there's a trade. Matter of fact, we have a chart at the back. Says a trade. Depending on if you have a lot of flight experience with like Russians or someone else, then you don't need as much NASA oversight or involvement to assure yourself it's safe to fly. On the other hand, if you have very little flight experience and it's someone brand-new, then you need to have a lot of NASA oversight or review and requirements in place in order to assure yourself it's going to be okay. Of course the basis of this report—and I understand it's been like a best seller up at Headquarters—is using information from that and developing their thing for the commercial operation that they're going to be doing. So in that regard I still stay in touch with Bryan, mainly for action items.

WRIGHT: It's great that you're able to use all your knowledge still from then. I know that you walked in with notes. Are there some other things that you have that we haven't had a chance to talk about?

JOHNSON: No. I believe we pretty much covered it all. I can send it to you electronically or have a copy. It's pretty much what I was using, I went through it.

WRIGHT: I'll take it and put it with your other things. Thank you. It was all very interesting.

JOHNSON: That was my sheet for my memory jogger when I gave my report. I actually covered a lot more with you folks.

WRIGHT: Well, I'm glad, because I figured you'd have more time for more details. This will be good, happy to do that. Thanks again for being here.

[End of interview]