NASA JOHNSON SPACE CENTER ORAL HISTORY PROJECT
EDITED ORAL HISTORY TRANSCRIPT 7

WILLIAM S. MCARTHUR, JR.
INTERVIEWED BY JENNIFER ROSS-NAZZAL
HOUSTON, TEXAS – 17 APRIL 2018

ROSS-NAZZAL: Today is April 17, 2018. This interview with Bill McArthur is being conducted at the Johnson Space Center for the JSC Oral History Project. The interviewer is Jennifer Ross-Nazzal. Thanks again for joining me this morning. I definitely appreciate it, especially with your injury. One of the things we didn't talk about [last time] was training in the different suits [for International Space Station (ISS) Expedition 12]. I know you used an EMU [extravehicular mobility unit], but you also used the [Russian] Orlan spacesuit. Can you talk about training with those and in Russia on the suit for EVA [extravehicular activity] training?

MCARTHUR: Training in Russia versus training in the U.S. I think really could be the subject of a book all on its own. It's just such a fascinating topic.

If we want to concentrate a little bit more on the EVA aspect, something that's good to remember is the suits look—they look different. You look at them, and it's easy to say, "Yes, there's the Orlan. Yes, that's the EMU." But the reality is the environment in which they operate and the functions they perform, they must at least be 99 percent the same. We'll sometimes talk about the differences, although what I think is often more striking are the similarities.

If you work backwards, you're in the suit and you're outside, both suits are bulky. They have a lot of mass. That means, as you're moving around in the suit, you're moving essentially two of you around. There's that similarity. The importance of staying always positively attached

to the Space Station for both suits is very similar. That paradigm of always being tethered, or before you release one tether to make sure that you've attached another tether, is the same.

If there are spots in the suit that rub you, then those are going to become pressure points, and they're annoying regardless of what the suits are. Regardless of how massive the suit is, you're in microgravity. Really you float around, you have some sense—this is a bit of a contradiction—of constrained freedom. And for both suits, they are so much easier to work in when you're in space than when you're in the water. Maybe that contributes to that sense of freedom, that the vast majority of things that you do are easier to do when you're out in space.

The real first training I did in the Orlan was when I was the DOR [director of operations] in Russia. I don't know if it was part of a formal agreement or what, but everyone knew—it may not have been official yet, but it was pretty common knowledge I was going to be assigned to an upcoming Space Station increment, and I would need to be trained in the Orlan. So even while I was a DOR I started doing some Orlan training.

One of the things that I really have to give credit to the Russians about is that their assumption was that because I had done a couple of successful EVAs in the U.S. suit—I think they treated me in a very positive way. They treated me with the respect that you would afford to someone who had successfully demonstrated the ability to do something. I think it's a little bit like an experienced pilot. Other pilots treat you with respect, even if you're about to fly an airplane with which you're not completely familiar. They assume that you've demonstrated some basic level of skill that makes you part of the club and ready to maybe advance a little bit further.

Some of the things about the suits that are pretty well documented is that the Russian suit is designed for—once it's ready to don, it essentially is complete. The backpack is open, the gloves are normally already installed. You wriggle into the suit, you can close the back door, if you will,

yourself and lock it all yourself. It really is a suit designed for self-donning. Realistically, it's always easier to have assistance when you don or doff a spacesuit. Even though the Russian suit is designed for self-donning and self-doffing, I think you would only see that happen if in fact there weren't a second crewmember to provide assistance, which would be an off-nominal situation.

The U.S. suit, [there are] multiple pieces. You put on the trousers, and you wriggle into the hard upper torso. They have to be joined, then you have to install the gloves, and then you have to install the helmet. Of course all of that is integrated in the Russian suit. The advantage that gives to the U.S. suit is it allows the U.S. suit size to be adjusted. There are many more ways to adjust the size of the suit so that it fits more snugly than the Russian suit does.

The Russian suits, it's all integrated. You control the size by these straps, these tapes if you will, that control the length of the legs, the length of the arms. I don't know how many different size gloves we have for the U.S. spacesuit. The Russians only have two or three different sizes, like small, medium, and large. To control the size it's really the overall arm/glove length, so that if you need to you can push your hands into the fingertips. The fit of the U.S. suit is very snug. The fit of the Russian suit is much looser, roomier.

Then couple that with the fact that the Russian suit operates at a higher pressure. Now you have a suit that the fit isn't as snug, so that means the suit itself feels bulkier. It's at a higher pressure, so just from the pressure it is stiffer. I had a sense that I had more agility and dexterity in the EMU than in the Orlan.

Does that matter? It matters in the actual execution of the tasks in that, as a general rule, tasks for a U.S. EVA are designed to accommodate the limitations of the suit. Tasks on the Russian segment, tasks in the Orlan, accommodate limitations in the Orlan. If the U.S. gloves allow you

greater dexterity, then the interface that the crew uses can be perhaps a little smaller, can rely on having a little more hand dexterity.

For the Russian Orlan, the tools are designed based on an understanding that maybe you can't turn a small-diameter knob. It has to be something a little larger. For that reason, it seemed that the tasks were of equal difficulty, or very similar difficulty, because it's a much more complex system when you define a system as the individual, the suit, the tools that the spacewalker is going to use, the equipment with which the tool is going to interface.

If all of that is part of the planning process, then it falls within the scope of what is not just possible, what is reasonable for a well-trained astronaut or cosmonaut to do. Whether it was in the NBL [Neutral Buoyancy Laboratory] or the [Russian] Hydrolab, whether it was doing EVAs in the Russian suit or in the EMU actually on the vehicle—going from one environment, from one set of equipment, to the other, there was always that sense of familiarity. The switches are in a different place. It's okay, but they're still pretty simple. Got procedures, know what to do with them.

I always found it interesting that, rightfully so, I know the Russians afforded me personally—and all the people that I saw—afforded us a lot of respect based on the fact that we were experienced astronauts on Shuttle missions or whatever it happened to be. I would like to think that we afforded a similar level of respect to cosmonauts when they were training.

ROSS-NAZZAL: That's a lot of good detail about the suits. I know you talked last time about the concerns about going out for a spacewalk and only having two crewmembers, and the challenges of getting ready. One thing we didn't talk about was the EVAs themselves. I wonder if you want to talk about those two EVAs that you did do.

MCARTHUR: They were a lot of fun. They were hard, but they were fun. You get such a tremendous sense of accomplishment.

For me, there was nothing I did—launch maybe. Launch kind of defines you as being an astronaut or not, I guess. What made you really feel that you were—and I don't mean this to be gender-specific—but what made me feel like a spaceman was putting on a spacesuit and going outside.

There was an old '50s TV series called *Men Into Space,* and it had a profound effect on me when I was a little boy growing up. On one of these obscure cable networks they have started running these episodes again. What I remembered from my youth was that the main hero was Colonel [Edward] McCauley. I remember as a little kid having a Colonel McCauley astronaut helmet, and it said McCauley on it.

By golly, being in an environment in which you have to wear a spacesuit to me always was, I think—me wearing a spacesuit, now my self-image was that of a man in space. I think if I'd been a young woman, hopefully I would have enjoyed *Men Into Space* as much.

There was one episode which I would love to show the Astronaut Office as a whole one time, because of how it just so powerfully captured the stereotyping of a woman's place even in space. Although in some respects it was very positive, but I think it would elicit howls of protest today. But again it's not a man-woman thing. It's just that putting on a spacesuit to me is one of—and I think I've gotten off on a tangent in answering your question, but it was just something I found.

I would say, having done spacewalks, [they] are probably some of the things in my astronaut career of which I'm proudest. You go out, and generally I found that the tasks were

easier to perform in space than they were in the water, whether it was the NBL or the Hydrolab. And that's a good thing, it's a good thing. You really want the training to be more difficult than the actual task.

You don't want it more difficult simply because it's not in space. You really would like there to be similarities in the areas, and it be such a good analog to physically doing the spacewalk that the things that are difficult are things which, if you can master them in the water, means that the same tasks aren't going to be easier simply because you're in space. But will be easier because just being in the water, being on the ground, required you to really develop a high skill-level.

Back to our EVA. We knew the ground was worried with this issue that there would be no third crewmember to help us. One, that meant preparing for the EVA was going to be more physically demanding, be more challenging. Then they would worry if there were a problem with us coming back in. The incapacitated crewmember scenario where you come back in, your crewmember can't help you unsuit. So you've got to get unsuited, then you can help your colleague. And then you can remove the suit from your colleague and provide any medical care that might be needed.

The EVA was planned to be short. I think the plan was for it to be only five and a half hours instead of a nominal six and a half hours. We got everything done in the equipment lock, which was the larger diameter first part, or inner part, of the airlock. Then we transitioned into the crew lock and we were closed in there, and we started depressing.

Then we realized something was wrong, that the depress rate wasn't high enough. Something wasn't right about the way the crew lock was depressurizing. The ground asked about a valve, which was in the equipment lock. They said, "You said you opened this; we noted that you opened this valve." Rick [Richard M.] Linnehan was the CapCom [capsule communicator]

and I said, "Rick, I got to tell you, I don't remember us talking about this valve at all." We discussed it for a few minutes, and they finally realized that this valve must not have been in the correct configuration. So we repressed the crew lock, came back in. Sure enough, the valve was not configured correctly. We reconfigured it and went back in and continued with airlock depress.

Now we've lost like an hour. This has taken a good bit of time. The ground says, "What we're not going to do is we're not going to extend the EVA. It was going to be five and a half hours. It's going to be four and a half hours now." That was pretty disappointing. I was pretty disappointed in that because it meant we were going to lose some EVA time. Of course that meant somebody had made a mistake, and you just hate that. We got out and we started doing our work.

Let me back up a little bit. It is really cool when you open the hatch, and you look out. That is just so cool; it is just so cool. Doors open. The Space Station—and it still does—it was kind of flying in airplane mode, which means that the hatch opens down toward the Earth. So you look out and you can see the Earth going by you. That's just cool, that's just too cool. It's also fun. Unlike in the NBL, you can grab the edge of the hatch, and as much as you can somersault without gravity, you kind of flip yourself out. It's real easy to get out. It's just so nice to finally be out, and you start doing your work.

We were really pretty methodical going through the tasks. Our first task was to install an external TV camera, and we did that. There were a couple of subtleties in the way that the stanchion—the post that the camera was attached to—the way it mounted to the Space Station structure that provided the opportunity for error. I was focusing. I was trying to be very, very careful. There was an easy mistake to make. They warned you about it, so I was concentrating really hard on trying to avoid that mistake. Everything went well, so we were really tickled when we were done out at the work site and we were moving back inboard. The ground said they had

activated the camera, and it was working. If you could wipe your brow, you'd do that, but you can't.

I'd like to go back. When I talked about the valve being misconfigured, of course when something like that happens Mission Control really wants to try and understand what happened. When we were debriefing, Rick Linnehan said it was his fault, that he had verbalized the step and had checked that it had been done without actually confirming that he had heard us acknowledge the step. To this day, I think he was just taking one for the team. You know we're trying to do this in a mixture of English and Russian, and that somewhere in there there'd just been a miscommunication. I thought it was really very generous of Rick to shift the finger of blame away from the crew.

Anyhow—so it's kind of cool. We'd been all the way out on the port side of the Station because it was the P1 [truss] lower outboard camera. It was really one of the big reasons we got to do the spacewalk at all, because it was an important camera for one of the first post-Return to Flight Shuttle missions. It was a very important camera view to install one of the truss segments, so that's why we did that.

Then we came back in, and we were going to then go to the starboard side to remove some failed component out there. It was about a suitcase-size computer that was out there that had failed. I was a little bit ahead of Valery [I. Tokarev], and so while I was waiting for Valery to catch up with me, instead of stopping at the work site I went all the way to the far right end of the Station so I could say, "Well, I've been all the way to the left. I've now been all the way to the right. Okay."

We removed that ORU, that orbital replacement unit, put it in the airlock, and then at this time the P6 truss was on the zenith part of the Station. It had, at the end of it, this device that was

intended to basically dissipate the electrical energy that would build up in the Space Station as it traveled through the Earth's magnetic field. It needed to be removed because it was going to interfere with another component when the P6 truss got moved later. I believe that was when the interference would occur.

Now Valery and I went all the way to what was then the top of the Space Station. When we get up there, we remove the FPP (floating potential probe). We removed it, and there were two options. We could disassemble it and bring it back inside. They were worried about doing that because they thought that some of these probes that would dissipate the electrical potential due to exposure in space would suffer from embrittlement. They might snap, and you'd have a jagged piece of metal that could cut the suit, so they didn't want us to do that.

The plan was for me to jettison it. To my knowledge, we had never intentionally jettisoned a piece of equipment by hand, at least on the U.S. side. The Russians had done that before. It was cool. They even had me, inside the Station before we did the EVA, take objects that were about the same mass and practice what it would feel like trying to push them away at a certain velocity. Then there were a certain range of angles that I had to jettison it in, because what you didn't want was for it to come right back around and recontact the Station. That was a lot of fun, just pushing this thing away. I think I referred to it as the "longest Hail Mary pass in history." I tried to come up with some quip or something.

ROSS-NAZZAL: I was wondering, did you practice throwing footballs on the ground or something at some point.

MCARTHUR: About that time I looked down and I noticed something floating away from us. It looked like something that was circular floating away. Reported it to the ground, had no idea what it was. Looking at subsequent helmet cam [camera] video, it turns out it was a little ring. What we did is—to keep the camera lenses, when we use them inside, from scratching windows—we would take a filter ring, and the filter would be removed and just screw the ring in. It would be like a little bumper.

What you could see is when you opened up the camera cover you could see that the ring had somehow become unscrewed, had backed off from the lens. It's probably crew error for not checking it well enough. Oh, well. It had come floating out, and it's in the annals of history somewhere as another piece of something that got lost from the Space Station during an EVA.

I said they told us they were going to shorten the spacewalk. Fortunately, all the tasks went according to plan. They all went well. We even had get-ahead tasks; we completed those. I would like to think because things were going well. They were looking at our metabolic rates, and it looked like we weren't overexerting ourselves. So they let us stay out the full five and a half hours. We did all those tasks.

I think when we came back in, after we got unsuited, we found out the toilet wasn't working. That was inconvenient. That's another story. I did find out that the undergarment that we wore—I found out that it certainly held enough to take care of me for a day.

What we did find out about a week later is—up until that time we thought we were going to do a second spacewalk maybe a few months later. I don't know whether they were so worried about the risk of doing a spacewalk with just two people—maybe it worried them that we made that mistake with the valve configuration, or maybe because we did all our get-ahead tasks—but

they canceled our second. They said, "You guys did all that we needed you to do, so we're not going to schedule another EVA."

But fortunately we did another one in the Russian suit.

ROSS-NAZZAL: Can you talk about that one and the differences?

MCARTHUR: Sure. The content of our whole mission changed so much because of the foam that was shed on STS-114. We weren't doing any of the tasks, it seemed, that we'd actually trained for.

Golly, I'm trying to remember. One thing that happened—one day, just as we were about to lose contact with the ground, an alarm went off. I'd just gone into the potty. I stick my head out, look up at Valery, and Valery is talking to the ground. The ground basically says, "We're about to lose comm [communications] with you. No actions required. We'll talk to you when we get back."

It turned out there was something called a trailing umbilical system, or TUS. When the mobile base system, which is part of the [Canadarm] robotic arm—the mobile base is the little railroad car that moves back and forth along the truss that the Canadarm2 can be based on, and normally is. While the little railcar, if you will, the mobile base system (the MBS) is moving, it's got two cables that trail out behind it, trailing umbilicals, for it to have power and command. If it's going in one direction the cables will retract; if it's going in the other direction the cables will play out.

One of the cables had just cut off. What you don't want is for a TUS cable to get jammed and not be able to move the mobile base system. The systems include a guillotine, a cutter, that

just cuts the cable. One of the cable cutters had activated, and it's not supposed to. It's obviously not supposed to activate on its own, but it had.

So we then picked up what was going to be a hybrid EVA in which we went out of the Russian airlock in Russian suits. Our first task was to go forward along the Russian segment, go onto the U.S. segment, go up to the S0 truss—the very front of the truss where the mobile base system was—and to try to safe or deactivate the remaining cable cutter so we wouldn't suddenly be without the ability to move the mobile base system.

That definitely was going to be required for future assembly missions, so that was going to be one of our first tasks. The other tasks were, I think, to deploy some sensor packages and things that the Russians had. Oh, and we did a lot of photo work. We were doing a lot of photo documentation around the aft end of the service module, where the little reaction control jets are for the service module.

We also had an experiment on that one called Suitsat [Suit Satellite-1], or Radio Skaf or Radio Skafandr. We took one of our old spacesuits, and the Russians—they will launch a spacesuit. They will use it some number of times, and then they just throw it away. They don't bring it back and refurbish it the way we do. This was a spacesuit whose useful life had ended, so we attached some radio equipment to it. The radio equipment was to broadcast repetitively a message recorded by young people from countries around the world, in their native languages, of world cooperation. Based on [the idea that] "here you have the International Space Station where you have all these countries that are working together," so it was world cooperation and peace. We attached all this equipment onto this spacesuit, then filled the spacesuit with dirty clothes and towels so it looked a little bit like a person. Our actual first task was to jettison the suit. I think it was the first task.

Now, way back when, way back in 1993—even before that. For years, our children go, "Mom, Dad, can we have a dog?"

Mom's answer always was, "No, we're going to move in a year or two, we're not going to get a dog."

We move to Houston. "Mom, Dad, can we have a dog?"

"No, you can't have a dog. Let's wait. Dad is trying to be an astronaut, we'll see."

Dad gets selected for the astronaut program. "Mom, Dad, can we have a dog?"

"Well, let's wait until your dad's first mission," this, that, and the other.

So when I'm on orbit—and I think we did a ham radio contact with the girls' elementary school. I think our younger daughter, it was her turn to ask a question. It's like, "Dad, can we finally have a dog?"

So we got a dog. We adopted a little terrier mix, she weighed about twenty pounds. We named her Laika, name of the 1957 Laika, the spacedog. Laika was a good little dog. She pretty much had her way, and she did what she wanted and was pampered. My brother, to this day, thinks that she was one of the best dogs that he ever knew.

A Monday in August was when I left for Russia to do final training and preparation for launch. Well, that Friday Laika died. Kind of sad, but she was twelve years old; it's okay. Laika was gone.

We knew she was sick, so my younger daughter took her to the vet. She was there making the decisions about the dog. They did an operation to try to take care of the dog. She didn't make it. My daughter explained to them, "Well, Dad is getting ready to go fly in space. This is his dog. We think he would like it if he could spread her ashes out before he left."

So they put a rush on, had her cremated, so I did that. Along the sidewalk outside by our house where I would take her for her walks, I went and spread most of her ashes. But I kept just a pinch of her ashes, and I put it in a double Ziploc bag, the little bitty Ziploc bags you get with cheap jewelry or something. So I put her ashes in a little double Ziploc bag, smuggled her ashes from Houston to Moscow, and smuggled her ashes from Moscow to Baikonur [Kazakhstan], put her ashes inside my spacesuit, smuggled it up to the Space Station. I put her ashes in the left glove of the spacesuit that we jettisoned. So that was part of that EVA.

It's interesting, and the video is kind of cool. There wasn't a good camera angle that you could actually see where we came out of the hatch. The best camera angle had the Russian airlock, blocked the hatch itself. Here you can see one of us working on the outside, and then suddenly you see the spacesuit drifting, sort of tumbling away.

The U.S. flight surgeon who was on duty in TsUP [RKA (Russian Space Agency) Mission Control Center], in the Control Center in Moscow at the time—dear friend of mine, Shannan Moynihan. Shannan had looked at the timeline. She saw Suitsat deploy, and she said, "Well, they're going to deploy something. We'll see." She's looking at the video, and suddenly she sees a spacesuit tumbling away. Evidently, she found it quite alarming. When I give talks today, the story I tell the audience is that the ground didn't know. We just did this all to play a joke on them. I have a lot of fun with that.

But anyhow, then we transitioned to the forward end of the U.S. segment and did the work that we could to protect that remaining TUS cable. What we really wound up doing is taking the TUS cable out of its bracket where the cutter would have been able to sever it. I took a wire tie and tied it off to the side, so it couldn't be damaged. I think on STS-121 they replaced those mechanisms, and when the mission came back Piers [J.] Sellers—it's so sad Piers isn't with us

anymore. When they came back, Piers Sellers brought back that wire tie that I'd used to safe the TUS cable. He brought it back and gave it to me in a presentation in the Astronaut Office. That was a real nice thing for him to do.

Then we went to the very aft end of the service module, and we did all our photo surveys there. That meant between the two EVAs we'd gone as far right as you could, we'd gone as far left as you could—well, we'd gone as far to port as you could on the Station, as far to starboard on the Station, as far zenith on the Station as you could, and as far aft on the Station as you could, in our two spacewalks. I thought that was kind of a neat thing to have done.

They were concerned because we had been doing a lot of work around where the little rocket nozzles were, the thruster nozzles on the aft end of the service module. They were worried that our gloves would be contaminated by any fuel oxidizer reaction products back there. We had set up a couple of little towel caddies, so we had these like terry-cloth face towels. We used those to wipe off our gloves, to make sure that if there were any contaminants on there we'd remove them, and then we just threw the towels away.

Then when we came back in—I'm glad I'm retired now, I can tell all these stories—Moscow basically said, "Throw these gloves away. We're not going to use them anymore." What we did instead is we put our gloves in multiple Ziploc bags, put them in our return to Houston bags.

I called the ground and told Sally [P.] Davis, who was the lead flight director—actually I called her on the phone, so nobody could hear what we were talking about. I told Sally that we were going to send our gloves down, so if anybody was going to have conniptions about it to let me know, but we wanted those gloves.

So I now have the gloves I used for that spacewalk. It was interesting. When we came back, I was having one of our weekly videoconferences and I told my wife and the girls, said, "Look, I've got these gloves."

My girls go, "Well Dad, what are you going to do with them?"

I said, "Well, maybe I'll donate them to the West Point [U.S. Military Academy] Museum [West Point, New York] or something like that."

They go, "Oh no you're not! You're going to give them to us. We're going to keep those gloves."

ROSS-NAZZAL: Nice family heirloom. How big was the Station at that point when you were up there?

MCARTHUR: Oh, gosh. What I think we say now is the interior volume is about the same as a five-bedroom house. It was about the same as—I think we said three-bedroom house, and I'm not certain if it was even that big. The Columbus Orbit[al] Facility (COF)—the Columbus module wasn't there. Kibo, the Japanese module, and all its components were not there. There've been a couple of additional Russian modules attached.

The trusses were S1, S0, and P1 were there. The additional truss elements, what—P4, can it really be that many? I know there's no P3. Of all the big modules that have the big solar arrays, only one set of the U.S. solar arrays was up there at the time, and it was mounted up on the zenith instead of out on the port side where it eventually wound up.

ROSS-NAZZAL: You mentioned the flight control teams a few times in this interview. I wonder if you can talk about your relationship with flight control, being on Station, and how close that relationship was.

MCARTHUR: I wanted it to be very informal, and I think it was. There were a couple of times when there would be a little bit of friction, but for the most part I really tried to find opportunities to talk to specific flight controllers. Like on Saturdays, if I was running on the treadmill I'd ask them to try to get one of the young flight controllers to get on the radio so we could just chat a little bit.

One of the things I really wanted us to do was not talk in code. I mentioned that I think Rick Linnehan took the blame for the confusion on that valve, just to keep it from the crew looking bad. I always thought, in particular during the Shuttle Program, we had a tendency to be so worried about things that might reflect badly on anyone, crew or the ground, that we would talk around an issue instead of just be very blunt, be very specific, and say, "Did this happen?"

I remember once—and I may have mentioned this before—on STS-58 I was supposed to close the payload bay doors. For some reason, I was doing it all by myself. I later became a big fan of, for important tasks, always trying to have two crewmembers doing it, just to preclude making a mistake.

We were getting ready to close the payload bay doors, which normally is done on the day before landing. But on this day, because we had a number of animals on board—we had a number of rats on board that were part of the suite of experiments—we waited until the last minute to close the payload bay doors. As I'm going through the procedure, the ground says, "Stop. Don't do anything else about closing the payload bay doors."

John [E.] Blaha was the commander. Of course he's now immediately getting nervous because you got to close the payload bay doors before you can come back. We can't do a deorbit burn unless payload bay doors are closed. I think Shannon [W.] Lucid and Dave [David A.] Wolf were pretty excited, because if there were a problem with the payload bay doors they might get to do a spacewalk to fix it. I don't know if they really wanted to do that, but that's what they would have done.

I'm looking at it trying to understand what the ground is concerned about. The procedure was interesting. On the controls there were two switches that were called payload bay mech power switches, payload bay mechanism power switches. It basically powered up the electrical buses that controlled most of the equipment in the payload bay, to include the motors to close the payload bay doors and drive the latches and things like that.

As I'd gone through the procedure, the first step said "verify," check, "payload bay mech power switches off." When I read that step, I took them to on. A little bit later there was a switch that is "payload bay doors close." If the switches had been on and I'd taken the door motor switches to close, the doors would have closed. Everything probably would have been okay because that's the way the system was designed.

But with experience over the years, we had discovered that if you followed that procedure—no, no, no, no, no, no. It was Ku-band antenna stow. It wasn't the doors close, it was Ku-band antenna stow. If you then took the Ku-band antenna to stow, the antenna would move into the right position. These gimbal locks would go into place, and the antenna would stow. That's good.

We had discovered though that you could get in a situation where the gimbals wouldn't actually lock, or wouldn't move far enough to lock, the antenna would try to stow anyway. So we

modified the procedure. It was leave the power switch off. Now when you get down to put the antenna in stow, the antenna will move where it needs to be. The gimbals will lock, but it won't actually move to the stow position. That way if there's a problem you'll see it, and then you can figure out what to do.

If the payload bay mech power switches had remained on, it probably would have been okay, maybe not. The ground sees that their telemetry says these switches aren't in the position we think they should be in, and so they say, "Stop." Now, I think a good thing would have been to just say, "Bill, what position are these two switches in? If they are on, please take them to off and proceed."

As a matter of fact, a real good friend of mine, Bob [Robert C.] Doremus, was the flight controller who was trying to deal with all of this, and he was the one that caught that the switch wasn't in the right position and alerted the flight director. As I'm reading the procedure, I finally see that I've made a mistake.

So I say, "Well hey, ground, how about if I take the payload bay mech power switches to off, and pick up in step five and then continue with the procedure?"

"You have a go." But what I could see though is that people worried about, "We think the crew made a mistake." But how do we say that without asking the crew, "Hey, did you make a mistake?"

I tried to avoid that. I didn't want us to get into those type of scenarios on Station. I really wanted us to be really upfront. If we wanted to do something different, say that we needed to do something different. I know sometimes I got a little maybe testy and not as patient with the ground as I should have been.

And it was interesting—we ran fairly high levels of CO_2 [carbon dioxide] when Valery and I were on Station. We just simply won't run CO_2 levels that high anymore.

ROSS-NAZZAL: How high are we talking?

MCARTHUR: I think we were at I want to say five-and-a-half, six millimeters. Whatever units the carbon dioxide measurement device was, we would run five, five-and-a-half, even sometimes up to six I think. Now they're below four.

I noticed shortly before the Expedition 13 crew came up we activated the CDRA, the carbon dioxide removal assembly. The Russian Vozdukh, which removes CO_2, was running. So we drove the CO_2 levels lower in anticipation of having three more crewmembers on board for a week, and I noticed that I had a sense of euphoria. Not ridiculously so, but still this sense of well-being and happiness that was noticeable. It dawned on me that it may have been related to the CO_2 levels.

Then I also started thinking back about times when I would find myself becoming irritated either at Valery or at the ground for really no good reason. Instead of just being direct and professional, perhaps being a little bit sarcastic or allowing annoyance to creep into my tone of voice.

Sure enough, after I'd been back a couple of years and we were really looking at what CO_2 levels we needed when the Shuttle was docked to Station—down there kind of low on that list of symptoms of elevated CO_2 was irritability. I'd like to think that's why I was irritable. Or I was just irritable.

ROSS-NAZZAL: What was your relationship like with the Russian flight controllers?

MCARTHUR: It was good. Valery was really the buffer between me and [the team]. I would talk to them when I would be doing procedures on the Russian segment, and I had some procedures that I would do on my own without Valery's engagement. It wasn't that close personal-type of communication, just because my Russian wasn't good enough to have those informal chitchat.

ROSS-NAZZAL: We have a few minutes. You had a visitor for a very short time on your Expedition, and that was businessman Greg [Gregory H.] Olsen. I wanted to ask about his inclusion and what his responsibilities were.

MCARTHUR: Right, wow. How much time do we have left?

ROSS-NAZZAL: We have about fifteen minutes. I don't know if that's enough time.

MCARTHUR: I might be able to do it. First, I consider Greg one of my dearest friends now. I just think the world of him.

If you go back, 2001, I was the DOR when [entrepreneur] Dennis [A.] Tito flew with the Russians. The NASA Administrator at the time, Dan [Daniel S.] Goldin, was adamantly opposed to Dennis Tito flying with the Russians. You look at it at the time—the Russians needed two qualified crewmembers to operate the Soyuz. Just like when Valery, Greg, and I flew, it was a very similar situation. You could do something with that third seat.

The Russians, they could have flown another cosmonaut and gotten more flight experience for their people. They chose instead to sell those seats on—I don't know if I would call it the free market because they could set the price for whatever they thought they could get out of it. So they did. My recollection was that the Russian government provided the Russian Space Agency like two hundred million dollars to support the work they did.

Now, there were other sources of income, but two hundred million dollars. Dennis Tito paid twenty million dollars. That's a 10 percent boost to their budget. If our budget this year is twenty billion dollars for NASA, that'd be like someone just giving NASA an extra two billion dollars. What would we do with two billion extra dollars? We probably wouldn't be able to spend it, but we'd sure like to try.

It was really important to the Russians. For these reasons of international relations and politics, it was something that NASA adamantly opposed. When I was the DOR it created problems for me, being the senior NASA person in Star City. Matter of fact, almost got me fired, but anyhow.

ROSS-NAZZAL: We'll have to come back and talk about that next time.

MCARTHUR: Yes, we can come back and talk about that later. If the Russians were going to put somebody in that seat, there was not a lot we as the Agency could do about it. We couldn't really veto it. What it did provide was an opportunity to create a distraction for the crew, to create stress within the crew. That just made no sense in my opinion whatsoever. Greg has an autobiography he wrote, *By Any Means Necessary! [An Entrepreneur's Journey into Space]*. Besides [the fact that] he says some really nice things about me in it, I enjoyed reading it because I thought it did

tell a lot about Greg and how that came about, and a lot about his youth and a lot about his background.

It seemed to me that there was going to be somebody in the third seat. We could be pretty sure it was not going to be a NASA astronaut, because I just didn't think we were going to pay for it. The Russians were selling them to the Europeans, maybe the Japanese. The Japanese, the Brazilians. Civilians like Greg.

My thought was, "Hey, look. We're going to fly with this guy. First, out of fairness to him we ought to make this"—just out of self-preservation, "we ought to be a crew." By golly, it'll make the mission not only more pleasant for us, but it makes it safer for us. By golly, if Greg is going to be there, it would be unconscionable to not treat him the way we would want to be treated.

He's a great guy, he was a great guy to fly with, he's a smart guy. He's got a PhD, self-made multimillionaire, very successful, hardworking. Very generous, I mean he treats people well. If you met him and you were in a social environment, I'm not sure you could possibly guess how wealthy he is. Not because he is so wealthy, because he just doesn't act that way. He's a very humble guy.

By golly, Valery and I decided that this is our crew, and we're going to treat each other like a crew. So one of the things I insisted on right away is that the Star City [Russia] American community embrace Greg. He was part of our socialization. When we'd get together and have group dinners, we always included Greg.

I would make little comments, like how hard it was to get good red wine over there. Greg has got a farm in South Africa where he grows grapes. He produces wine, so he would have wine sent from his vineyard through the South African embassy in Moscow, and Greg kept us in good red wine.

I made a comment one time about "I bet the wine would be better if we had decent wineglasses," and a box of Riedel Crystal wine goblets shows up. I got to be careful [here]. That sounds like he bought his way in, and that really wasn't it. What it was is he looked at what were areas or ways in which he could make a unique contribution to that community of people who were getting ready to fly in space.

Then there'd be things like we had books called *konspekts*. The *konspekts* basically—the folks from then MOD [Mission Operations Directorate] were the RITIs (Russian integration training instructors). They really worked hard over the years to build these basically study guides, or these study books, about the various Russian systems we would need to learn, whether they were ISS systems or Soyuz systems. There would be these various systems, and on one page it would be in Russian and the other page it would be in English.

So we had all this neat stuff that we could use to study with. Then the answer would be, "No, you can't give Greg a copy, because he's paying the Russians for the stuff he needs. And if they're not giving it to him, then he hasn't paid us for it, so don't."

It's like, "Are you kidding, look how quickly I can steal a copy and make sure he has one." He's a hell of a nice guy, really is.

ROSS-NAZZAL: What did he do up on the increment? He wasn't there for that long.

MCARTHUR: Of course the third seater has some duties for ascent and on-orbit operation on the Soyuz, but admittedly they aren't really critical. One of the most important things he needs to do there is to be able to operate his own spacesuit, be able to take care of himself, so that the other crewmembers aren't [distracted]. There's some functions like pumping condensate between

modules, which if Greg couldn't do that then Valery would have had to, and then that would be just something else on Valery's plate. He did a lot of photo documentation.

Then during the week or so we were together on orbit, he did experiments. Like ESA [European Space Agency], in addition to having at the time their own allocation of time on board the Space Station, they could purchase additional crew utilization time for experiments and things like that. So Greg would do ESA experiments. He did have his own program of doing some educational things.

So it's not a matter of you go up there and you just look out the window the whole time. The Russians were very interested in utilizing the time he had available to help them meet their other contractual obligations.

ROSS-NAZZAL: Well you did it, and I think we have one minute to spare. I think this might be a good place for us to stop, and we can pick up next time.

MCARTHUR: Cool.

[End of interview]