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INTERVIEWED BY SANDRA JOHNSON
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JOHNSON: Today is July 14, 2014. This oral history session is being conducted with Richard Kurkowski at NASA's Ames Research Center in Moffett Field, California as part of the NACA [National Advisory Committee for Aeronautics] Oral History Project, sponsored by the NASA Headquarters History Office. The interviewer is Sandra Johnson, assisted by Rebecca Wright and Glenn Bugos. I want to thank you again for joining us today and making your way over here. I want to start today by just asking you a little bit about your background, and maybe your education and training, and how you first learned about the NACA and first decided to come to work here.

KURKOWSKI: I'm from St. Paul, Minnesota, a good place to be from, and a family of one brother and two sisters and wonderful parents. Education was Catholic parochial school, and on to public high school, mechanic arts. I studied under what they called the college prep [preparatory] program, which was good. I had some wonderful teachers, especially in math. Her name was Ms. Eke [phonetic], and she was just one of the best. English teacher was pretty good, too.

Then off to the University of Minnesota [Twin Cities]. I went into general studies there at first, for a couple of years. Then there was kind of a rough period. My father passed away at a young age, 48, which was not old enough. I did find my way into engineering from general studies, and went into the aeronautical engineering department. It was a five-year degree

program at that time. They were trying to make the engineers more rounded, with some programs other than numbers and numbers games. I already had some [courses], those general studies, that I could apply to it, so I got through in four years.

Several notable people have gone through that department—Deke [Donald K.] Slayton, for one. Clarence [A. "Sy"] Syvertson was from the University of Minnesota, and many others around the [NACA Ames Aeronautical] Lab [Laboratory]. A lot of them however, instead of coming here, went to Boeing [Airplane Company] and places like that. I got my bachelor's of aeronautical engineering there. I noticed in [John W. "Jack"] Boyd's [oral history] that he talked about some notable people. One of the notable people there was Jean [F.] Piccard, who was the pioneer in high-altitude ballooning. I had a class from him, so that was good for me.

JOHNSON: It's a good opportunity.

KURKOWSKI: His wife was also very active, and his brother was also into that, then many other adventurous things and inventing things. Then was a good time to be an engineer, 1955. Fortunately there were a lot of people looking for engineers, and I got I don't know how many offers. From industry probably four or five, some I didn't pay any attention to, and two government. The industry was like Sikorsky [Aircraft Corp.] back east [Stratford, Connecticut]. They even flew me out there for interviews, which was very nice. I forget where the others were—with North American [Aviation, Inc.], down south. The two in the government were the Air Force [Research] Lab [Laboratory] at Wright-Patterson [Air Force Base, Dayton, Ohio], and then the other one was [NACA Ames].

Later, George [G.] Edwards worked here. He did go off to colleges, and I guess he went to the University of Minnesota, so he didn't mind going back there to interview people. I had the luck of interviewing with him. I wasn't sure how it went afterwards, but I got an offer. I was married by this time. I'd married in the last year of school, and boy, did my marks shoot up—no more courting. I thought for sure she'd want to go to Dayton, Ohio, because it'd be closer to her family, but she had been out to California for a couple of summers at Stockton [College of the Pacific]. I forget what status it was then, but I guess it's University [of the Pacific] now. She was there for a summer for a folk dance camp activity, and she said, "If I have to go away from home, I want to go to California," so we packed my car and came out.

At that time, there was no funds for travel, so I had to pump gas for a while at the filling station to earn money to fill up the tanks and come out this way. It was a fairly good trip, and we made it, and came in to Palo Alto [California] and settled in at a motel. Then I started at Ames, the job here, the first part of August of 1955. I was assigned to the Unitary Plan Wind Tunnel Division. I'd originally been put into an assignment in one branch, and then they put me in another. I ended up in the 9x7 Supersonic Wind Tunnel Branch.

It was a great place to work, and it was exciting because this was a great facility. A national facility, at that time it was $21 million. What would that be in today's dollars? In the billions. To be put in that facility—it was exciting just to have a chance. The first job was to work with the group just starting up the compressor, getting the flow started. That was exciting, and then I got into helping with the instrumentation, running tubes to get to monometer boards so it could measure pressures on models. I almost killed myself, hanging by the wires and throwing tubes around. I should have had some safety guy around watching me.

We got that, and then we had the first running of the tunnels, and again calibrating, and then we got into testing things. I don't remember what the first tests were, but somewhere along the line there was a calibration that had to be made to make sure how good the flow was through the test section.

JOHNSON: How did you do that calibration?

KURKOWSKI: I didn't do the first one, actually. There was a fellow, I think his name was Norm [Norman D.] Wong, who did the first calibration. They made up a rake, it looks like a rake. That facility was very modern for the times. It was 9 feet wide, 7 feet tall in the throat section, where the flow has been expanded to go supersonic, from 1.5 Mach number [speed of sound] to 2.5 Mach. Then, there's a sting that rides on a plane that goes across from wall to wall, and in the center, there's what they call a stay-holder. You put the model usually on a bar from there, a metal piece. In this case, the model, instead of being an airplane, was just a vertical slab with three extensions and then little cones on the end.

The cones were instrumented so they could measure the front, which is the dynamic pressure, air coming out. Then there were tapered cones, so that on two up and two bottom, there were four more orifices. So you'd have five orifices off of seven of these probes. You'd let them running to the monometer too, so then they'd measure the pressures. You'd set a condition in the wind tunnel, speed and pressure, and then you'd take the measurements. They do it much more efficient now, with electronic devices and things. We'd take pictures of the monometer, and that gave work for computer gals to read those pictures and get the data.

Then, you'd sweep it forward and back. At any one station, forward or back, you could go left to right. You'd map it out, what the flow angles were, because it's hard to make a perfect wind tunnel. You're probably not familiar with how they do the process of expanding the flow, but on this one—normally you squeeze down and then it opens up again, and you have to do it just at the right process. At the throat it's usually near-sonic, which is Mach 1. And then from there, if the expansion is right—it's called a de Laval [convergent-divergent] nozzle, as I remember—the pressure drops further but the speed goes up. There's less molecules, but the speed increases. It usually is symmetrical.

On this one, it's called a moving block. It's a two-dimensional device. The upper part, instead of flat, is curved down and then up. And then the bottom part is curved, but it's on a big sled. It's huge, it's twice the size of this room in length and not quite as wide, and it was on tracks below. You move it forward to squeeze down to make however narrow you wanted to make the throat. The more you narrow it, the faster the speed was coming through the test section. That's a long answer to your question.

JOHNSON: No, that's a great answer, that explains that. That's great.

KURKOWSKI: That was the calibration, and then we were later doing tests. This is one of the tests I ran [demonstrates]. I wasn't by myself, it was a crew, and one of the first models I got involved with was the [North American] F-107 [Ultra Sabre], which is a very unusual aircraft. Instead of having inlets down below, it had them up above. There was a competition between North American doing this, and Republic [Aviation Corporation]. They had one called the [F-]105 [Thunderchief].

Because this was so unusual, North American wanted to test it, like we were doing a lot of in those days, testing for military support. Of course, they in turn helped pay the money to run the tunnel and everything because it was very expensive. When it runs at a high speed, it's running about 300 megawatts, or something like that, which is enough to run a city. That's why they run usually at night. Still, I think now, especially now, because they get cheaper rates. That was an exciting test, to give them their data for that.

The one below [demonstrates] is a program I was involved with. After seven years in the tunnel, I was about ready to move out, but I did this program here with the SST [Supersonic Transport]. It was a look at some configurations and concerns about—out of the four engines, if you had a failure of one of the engines, especially the outboard ones, then you're going to have a tremendous yaw problem, just like they had in the [Lockheed SR-71] Blackbird later. We'd block off some of the inlets and see how much yaw it was causing, and put out a report with a fellow named [A.] Vernon Gnos. He was a very great guy to work with.

Here's another test that I ran, a very unusual configuration called a SUBROC [Submarine Rocket]. It was launched by a submarine, broke through the water, went into air flight, and then went back into the water. It was to go out and kill other submarines. You've probably never heard of it.

JOHNSON: Was that classified?

KURKOWSKI: Yes, that was classified. It was amazing. There it is [demonstrates], going out of the water. In fact, that's at the [Smithsonian National] Air and Space Museum [Washington, DC.

JOHNSON: When was that?

KURKOWSKI: They went in service from ’65 to 1989. That testing would have been before ’62 because I left the wind tunnel, went out to space stuff at that time. It was around late ’50’s, ’59 or thereabouts. That was another test that I got involved in there. Other tests I ran in other tunnels, the 6 x 6.

You know that bird? [Convair] B-58, the Hustler? It was the atomic bomb deliverer, and it had four stations in it. They flew at Mach 2, so they said, “What happens to the guys if they have to get out of it?” They designed an escape capsule for each station, but there was concern about aerodynamics of when they did come out. First of all, they had to do it in the right order. They started in the back and worked forward, and the pilot would be last.

There was some concern at Convair about what the aerodynamics was when these capsules eject. They rigged up some pretty fancy ways to put it partially coming out, and then they had a double-sting: a sting for the airplane, to support it; and another sting to come out and move the capsule at various positions, as it would escape, and measure the forces. I was involved in that program down here on the 6 x 6 [Tunnel]. I worked myself to the bone on that one. I had to take a short vacation after that.

JOHNSON: What kind of hours did you work? I know they ran different shifts on these tunnels—were you working really long hours?

KURKOWSKI: Sometimes. With this one, yes, I overdid it. You can get yourself into a tizzy here, if you try and think you're Superman. I guess I can jump to one of the last tests I ran. I don't know how much you know about the Unitary—maybe that's something else I can go on to.

JOHNSON: Yes, you can talk about that, sure.

KURKOWSKI: Let's do the models, first. The last one I got into was for going to the Moon, of course. This is the 9 x 10 test section, 9 feet across and 7 feet up, see [demonstrates]? For tall people, you had to be careful walking. To get back and forth—here's that slab I told you that supports the model. To go to the front, you had to duck under this. You had a bad back after you worked there a while.

This is a picture, about '61, and this is the Apollo capsule. One of the things they worried about for launch is if something happens to the booster down below, they want to be able to get the astronauts quickly off, and so they put this ejection system.

JOHNSON: The Launch Escape System?

KURKOWSKI: Yes, you've heard about it? Fortunately, they never had to use it. They were looking at different configurations that would do the job. This one had put different extensions on. Again, we were measuring the forces at the various angles, and measuring forces in pitching moments, yaw and so forth.

Then I also ran it with the model of the Apollo Command Module in a different position, the position that it would go through in entry and landing. I think I ran this just at the lower

Mach number, but all three tunnels, I went with the Command Module itself and measured entry dynamics at entry speeds. All the way from 0.7 [Mach] in the 11-foot, and moved it over to the 9 x 7 at 1.5 to 2.5 Mach, and then the one that never runs again, the 3.5 foot, at 2.5 to 3.5 Mach.

JOHNSON: How long would it take when you were moving it around, to set it up, run the tests, get the numbers?

KURKOWSKI: A couple days. There were things that were common between test sections so that made it somewhat better, but still you had to hook up and test.

JOHNSON: To get the results, how long would that take?

KURKOWSKI: Results would come out fast because that was a modern tunnel at that time, and they were hooked directly into the computer building over here.

JOHNSON: Okay, so you were already moving in that direction?

KURKOWSKI: Yes, and we would get them—I don't know if it was at this time period—we were online with the computer, and we got the data back right on the controls section and plot it out. Just about the way they do it now, easier and faster. That was very exciting, to be a part of that.

JOHNSON: You mentioned the usage of the electricity. Did most of these tests run at night, or were they after-hours?

KURKOWSKI: The ones that you wanted to run at higher speed and higher pressures, yes, they did, but they didn't worry so much about it in those days. It was wartime, still, in '55. This is after Korea, but still, we were in the Cold War. There's the Unitary [demonstrates]. Are you familiar with that facility?

JOHNSON: I've heard of it and seen pictures of it. That's about as familiar as I am.

KURKOWSKI: It is unique. It has one motor system. The motor section is in here [demonstrates], and it can either drive the compressor on this side or the compressor on the other. Since I left, they boxed it in for noise purposes. The subsonic one is over here—the lower Mach number, I should say—and then the higher Mach numbers were done in two ways. This is the 9 foot section and the flow goes—let's see, you've got to get it the right way. Yes, it goes out this way, comes around, and this is continuous flow. If they're using this section, then they had turning vanes in here. Big cans turn with vanes in them to direct the flow around this circuit instead of that circuit. Pretty complex. Amazing facility, and very, very good data came out of that for many years.

What's next? I guess that's probably enough for that period of my 38 years here.

JOHNSON: Just to go back, when you first started at NACA, did you have any knowledge of what the NACA was doing?

KURKOWSKI: First glimpse I had of an NACA report was a young friend I used to hang out with in, I guess it was elementary school days. He got the urge to participate in the soapbox derby. He was kind of a perfectionist, and his dad was, of course, advising him. He had the wheels, and they'd have to really polish their bearings and everything so that you'd reduce the resistance. The objective was to make the car as low in drag as possible. I remember he had NACA reports on drag sitting in the shop where he was working, the garage where it was. I looked at that thing, "Holy cow"—numbers and figures—"I would never want to do this kind of stuff." I ended up working for [NACA] 38 years.

JOHNSON: You said you majored in aeronautical engineering—did you have an interest in flying yourself?

KURKOWSKI: Yes, I got introduced to flying—I think I was eight years old. In 1940 in St. Paul [Minnesota], at [Downtown Airport] Holman Field. I don't know whose airplane it was, but it was a Ford Trimotor ["Tin Goose"]. I don't know what year the airplane would have been, but I'm pretty sure I was eight years old. My grandfather, my mother, and I went onboard and sat in the wicker seats and putted around.

I got the bite there, the interest, and then my brother and I would play with models, like you'll hear from many aeronautical people. Of course we'd have to test them, starting with the testing right away, and see how far they'd fly. Then when we got tired of those we'd climb up on the garage roof and make believe that they were coming back from the war, so we shot them and burned them, put a match on them.

My brother got this crazy idea—to get out of a burning airplane you need a parachute, so somehow he got the idea, "I can make a parachute and I can probably jump off the garage," and guess who had to help him? He had a blanket and ropes tied to himself, and I was supposed to launch the parachute, and then he went off. Of course it didn't work, but fortunately he didn't get hurt very bad, just bruised. He only tried it once.

JOHNSON: He learned enough that first time, right?

KURKOWSKI: I guess that's how I got interested in testing. Then in school I learned aeronautical engineering. I took the ground school for flying and soloed in a Piper [J-3] Cub in 1953. At Anoka County[-Blaine Airport] they had a facility up there for training people, but they also used some of the airplanes for chasing high-altitude balloons. I think you could trace those back to Piccard, but the military was using them, and also for weather.

That's where I soloed, at Anoka County in '53, and then I didn't go too far. I didn't get my license yet because I finished school, came out here, and started life out here. So I didn't get back to flying again until about 1960. Finally got my rating, the private rating, in '62, but I've been flying pretty much ever since. I have an instrument rating and commercial rating, and been with this Seagull Flying Club for years and years and years.

JOHNSON: That sounds exciting. You definitely had the bug early.

KURKOWSKI: I've flown across the country a few times. One time, it was fun to go with another Seagull owner and we went all the way over to Cape Canaveral [Florida], and got to see a launch

of Gemini. I think it was the Gemini V mission in ’65. I forget the astronauts that were on board, but boy, did that thing go out. It had a very high thrust away, and it just, poof! No smoke because it was hypergolic fuel that just ignited on contact. That was exciting.

JOHNSON: That’s quite an experience, getting to see that launch.

Had you had any experience with wind tunnels before you came here, or was this all new when you got here?

KURKOWSKI: We had a small wind tunnel at the University of Minnesota, a little over subsonic. It was interesting, but I never ran anything there. I guess some of the graduate students probably did some of their thesis using that tunnel. They had an adjunct facility south of the Twin Cities where they had the high pressure air devices. They actually got some pretty high speed there, and I wanted to work there. Somehow I didn’t get accepted, but there were more sophisticated facilities there, too.

JOHNSON: You mentioned some of those programs, and of course some of them were classified. Do you remember the process to get clearance to work on those projects?

KURKOWSKI: I forgot who does that anymore, but the people come around and check you out, and they go around to people whose names you give to them, or people they think might have known you, and see how bad you were in the past. I guess I passed.

JOHNSON: Yes, I guess you did, if you got to work on this. Were there any other projects during those early years that you can recall that you worked on?

KURKOWSKI: You mean still in the wind tunnel area?

JOHNSON: Yes, in NACA, those first couple of years when you were there?

KURKOWSKI: No, it was pretty much just all in the wind tunnel there.

JOHNSON: What about the transition, when it transitioned from NACA to NASA. In '57, of course Sputnik [Russian satellite], and then the transition a year later? Can you talk about that time period and maybe what the atmosphere was here at Ames and what people were saying?

KURKOWSKI: It was good that Ames was a high-speed research center because that's what it was all about. Measuring how you recover capsules, and of course, during the Cold War, a lot of the work to design ballistic missile systems. The heads would have to go into the atmosphere and not blow up before they got to the target. Who's our famous guy who used to be our Director?

BUGOS: Harvey [Julius] Allen?

KURKOWSKI: Yes, Harvey Allen was very instrumental, and the others. As I said, it got exciting, and the last test that I was involved with was the Apollo Program. Then, while I was in the wind tunnel—I started in '57—a fellow back in Minnesota says, "Don't just stay with your

bachelor's. Go on, get a master's." With his prompting I enrolled in the Honors Cooperative Program, if you're familiar with that. Ames was involved, but also the businesses around Lockheed [Aircraft Corporation]. You could get time off work, and the companies and Ames paid for the cost. That was a very nice program, and after five years—part-time working here and part-time three classes a week—I got my master's in aerospace engineering from Stanford [University, Palo Alto] in 1962.

Somebody in the Unitary had gone over to start working in Guidance & Control—it was probably in support of the Apollo Program—and he says, "Why don't you come on over here and work for Brent Creer?" I said, "Yes, okay," so I went over.

You can tell I enjoyed my term here, and the work and the people. My first project over there was looking at the Command Module, shown right there [demonstrates]. Had a built-in sextant in the Command Module, and you'd go out to sight, to find out where we're at, where the capsule is in the process when getting to the Moon, and there was concern about how accurately you could measure the angles and things.

I was charged to get a simulator made up. It was kind of a funny way to do it, but this is just a scope that they use on a highway, then down at the other end I had a picture of the Moon and a crater, that simulated a crater. There was a sidearm controller down here, a left-right thing, and you had some thrusting you could do, too. So I'd give them some initial conditions, and you were supposed to bring the pip and the target together, press, and that was the data point.

I had some of our pilots, that's Glen [W.] Stinnett there, and they also had some of the astronauts come through. [James A. "Jim"] McDivitt came on and looked at it and gave the okay. They put out a report on how well they could do that, and I got a nice letter from Deke Slayton, who was head of the astronauts, thanking me for that research program.

Then I went on to other simulations and started getting into the problems on the Atlas V [rocket]—if there were going to be—on boost. The program was really started by somebody—I don't know if you remember a name, Don North [phonetic]? He came up and talked to Brent Creer one time, and I think that's how it started. He said, "You have good simulators up here and you've got good support. Could we look into what could be done as a backup in case something happens to the guidance in [Wernher] von Braun's piece down below? You've got everything else up above here to give you the data, all the gyros [gyroscopes] and so forth. It's all digital and we should be able to—if we've got ways to hook it up to the system down below—guide it at least into an acceptable orbit."

That's what I got into, at first just on the upper three stages. Came up with a scheme where you'd follow a program that at a certain time, you wanted to be at a certain speed, and you wanted to be a certain angle to the Earth. It worked out fine, you could just get into orbit. The next step was to say, "What about the whole thing?" Gordon [H.] Hardy was involved with this program, too. He and I, and a couple others, started looking at the whole system. That's right here, they're showing it right here [demonstrates].

We came up with a cab. At first, they were worried that if the astronauts took over the controller, we'd have to worry about g [gravity] force. Gordon Hardy and this other fellow did a program on the old centrifuge that's not there anymore in Building 211—one of the old hangars which was converted into simulating for space—and determined that it didn't look like you really needed to worry too much about the g forces on being able to do the job.

We also worried about the spacesuit. Once the spacesuit's inflated, it's difficult to move things, move around, so they shipped us a spacesuit from Houston, but [Ronald M.] Gerdes was

the only one small enough. That's him right there [demonstrates]. Unfortunately, he's passed away. He was a great guy, great guy. He went through the exercise.

We'd give him random failures, like one engine failure or something went hard-over, at certain times in the flight, and then they'd hopefully realize something's gone wrong. Some of the worst ones, of course, are the subtle ones, where it just goes dead, or there's an open circuit or something, but nothing moves except you're not pitching over, you're not going where you should be going. Put out a report on that and gave briefings—we had support. It wasn't just Ames people, it was people from Houston and also from [NASA] Marshall [Space Flight Center, Huntsville, Alabama], so there was a triad looking at that.

Presented it to the head guy at that time down at Houston. I think his son later was an astronaut. He was the one that had to make the decision on whether to incorporate this scheme into the Apollo program, and they elected to do it.

WRIGHT: George [M.] Low?

KURKOWSKI: George Low, thank you. He gave the go ahead, and now North was looking over this whole thing, and was the interface between Low and us. It was mechanized—not for Apollo 11, though. The first one it was put on was Apollo 12, which is rather ironic because what happened on Apollo 12?

JOHNSON: The lightning strike.

KURKOWSKI: What went bad? The stuff up above. Anything electronic was fine; the analog system down below, von Braun's system, just kept running. Then they got into orbit and they weren't sure if they were going to finish the mission, but they were able to upload backup to the Command Module and get everything running again, continue with it. It was never used, but it was there for the rest of the flights, as far as I know. It was one of the more exciting programs I got involved in.

JOHNSON: It was interesting, the Centers were working together.

KURKOWSKI: This is Frank [F.] Borman [II], by the way [demonstrates], you recognize him. I think that's at your Center, not ours. Any more on that one?

JOHNSON: I was just mentioning that the Centers were working together on that. Was that the first time you'd done that across Centers, on any of the projects you'd worked on?

KURKOWSKI: The things that I worked on, yes.

JOHNSON: Was that very common, to do that, to share information?

KURKOWSKI: When needed, yes, especially if the facilities were the best ones to use, yes. Did that in Flight Research, too, so yes. That's the way it should work. Our biggest competition was with [NASA] Langley [Research Center, Hampton, Virginia], and probably still is. Those don't

always go as smoothly as you'd like. Sometimes they have to be forced, "You will do it." That was another exciting time.

What happened after that? What else did I get into in Guidance & Control?

JOHNSON: You've got on your list "atmospheric turbulence modeling."

KURKOWSKI: Yes, so later on into Apollo, in actual flights we weren't needed, so we went back into aeronautics issues and problems. One of the things that I got into was, as it says, remodeling the turbulence of the atmosphere as well as we could for pilot simulations. There's some feeling that maybe it got a little more jerky than we expected, so we did some tests on that. One of the tests, I worked with the University of Washington [Seattle]. They had some good ideas, and they had some models they came up with.

There was a simulator that was on the side of the 40 x 80 Wind Tunnel over there on the south side, where now we have the vanes. Before the vanes were put in, and the new section was built, didn't have that stuff there. We had a vertical motion simulator out there, I don't know if you've seen any pictures of that. Dan [Daniel C.] Dugan was one of my subjects when we were flying it. We'd program it to move up and down and got some data on it, and then we also did tests in the big simulator down there.

BUGOS: The Vertical Motion Simulator?

KURKOWSKI: Vertical Motion, yes. Did tests there, also. Decided it improved the reality, but it wasn't that critical. It was an effort, but it was interesting. What else did we get into? I think that's when I got moved.

I was moved around a little bit at that time. Maurice [D.] White was the branch chief of the Flight Research group. We were in the space stuff group, and then they put me over there. I think some of that turbulence [work] was over there. Then I was assigned to the Flight Simulation Division, and it was wind tunnels and simulators. There were three of us put in a special group over there to do what you might call advanced planning or special programs. Had some interesting things there. I got into some flight testing, believe it or not, because of that group.

Some programs with [NASA] Dryden [Flight Research Center, Edwards, California], and FAA [Federal Aviation Administration] and NASA got into the wake turbulence issues. Here it is, right here [demonstrates]. I got into what you called Aircraft Safety and Operating problems, and one of them was the wake vortex problem. Another one we looked at was how to detect clear-air turbulence if possible. Also, wind shear issues.

Here are the years '70 to '82, my situation. NASA Dryden had a [Boeing] 727. One of the things that we had been working on for quite a while here in the previous branch, under Brent Creer, is try to figure out how to reduce the noise level around the approach end of an airport. Dallas [G.] Denery was one of the chief investigators on that one, and they came up with what they called two-segment approaches. They'd come in at a normal high altitude, but instead of going on down on a three-degree path, wait a while and go further out, and then come down on a steeper path, 6 degree I think it was, twice the angle.

Dallas got a contract with United [Airlines, Inc.]. They had a 727, and of course we had to pay. Got it down to Dryden and they showed that it would work quite well. Then somebody says, "Okay, normally if you're going a 3-degree path, the smaller airplanes or anybody following knows that they can stay above that path and not be disturbed by wake vortex, if they stay above that 3-degree flight plan. Now you're going to go at 6-degree, and aren't you going to intersect the turbulence, more likely?"

There was an internal battle right here between groups, that "We've got to push this low-noise system," and the other people saying, "That's not safe." [NASA] Headquarters [Washington, DC] finally said—I had to go back to the FAA and give the report on this, and my superiors at that time didn't want to lose the noise reduction program, so I was instructed, believe it or not—I don't want to embarrass some higher-ups. We were flying smaller airplanes, like our Learjet and other airplanes into that area, and the conclusion they wanted me to give, which I gave, was that if there was an upset, it wasn't any worse for a normal approach versus the second or the two-step approach. But that didn't really answer the question.

Finally, there was somebody that was assigned to do the statistics on it. In fact, that was Bruce Tindlay [phonetic], from here. So yes, there's a higher possibility. The two-segment never really got instituted or adopted because of the wake vortex issue. Politics, but internal politics. I'm glad they were honest, eventually. There was a lot invested in the noise reduction, so I can't blame them, but I was in the middle.

JOHNSON: Not always a comfortable place to be.

KURKOWSKI: That was a very exciting program at that time. The clear-air turbulence, I got involved in that. There was a fellow from Colorado—I forget which group he was with—and he used to fly on the [Convair] 990 [Coronado] with the expeditions, and he was in back. He was kind of a support, and he had an infrared device that could look ahead and tell what the condition was. I think he measured mostly CO_2 [carbon dioxide], and was able to determine how turbulent the CO_2 element was.

Of course, it's wrapped in all the rest of the gases, but he seemed to be able to predict that you're going to hit turbulence, and so far ahead, with this device. It was mounted on airplanes. Learjet had it, and then later on they also experimented with the [Lockheed] C-141 [Starlifter]. That was another interesting program. It was not very conclusive that it could be that dependable. It seemed to be sometimes good, sometimes bad. There's kind of the schematic of what was trying to be attempted to see ahead, see where the turbulence was [demonstrates]. That was a good one.

It was some time around that period when I was over there in Building 211, a friend of mine, Remus [N.] Bretoi, who was also from Minnesota and also went to University of Minnesota, was working on Guidance & Control down there. He was studying for his MBA, Master's in Business Administration. He encouraged me to go ahead and get my degree in that too, so I went back to school. It was, again, the honors program with Stanford, and had to get lower beginning courses. The main degree came through Golden Gate University in San Francisco [California]. Mostly TV [television] programs. I went and that took me another few years, going part-time.

In '82 I got the MBA, and then you probably knew John Zoch [phonetic] and his branch. We had worked together on some planning programs, and he invited me, "Would you like to

come over and be my assistant over in [Building] 237?" It's the Systems Analysis branch, because of the business administration degree.

I said, "Sure, let's give it a go." I came over there, whenever my résumé says, whatever year that was. I got involved in the bigger picture of planning, and the tiltrotor course was tested. You know the tiltrotor system? That was tested here for 25 years, so it was a major investment of resources, and it looked like it was going to prove out. It did get adopted by the military. The [Bell Boeing V-22] Osprey has that kind of concept. We were also looking at ways to improve civil transports using tiltrotor, a civil version of a tiltrotor. You could do either short take-off and landings, or just operate vertically. It's more efficient to have a little bit of runway.

There's an artist's sketch of a port right by the tip of New York, the lower tip [demonstrates]. The group did studies like that. We also got into modeling lighter-than-air ships, and different ways to use lighter-than-air concepts. [Frank] Piasecki came up with a device—he said he got a big surplus bag—there was a K-ship [K-class blimp] at one time, and he got it from the Navy, I guess, was leftover from the Navy. He built a girder system underneath that, and then he put two points in the girder system. He had two helicopters out here and two helicopters here [demonstrates]. Sikorsky—just the power part and the roller system were mounted on these two girders. Piasecki was doing experiments and he was getting money from the [U.S.] Forest [Service]. It was meant to do logging and get into places where it's difficult, with rugged terrain, where you couldn't get into it very easily otherwise.

We did some modeling of that system and showed it would work, but what happened on that rig, they didn't build it out of very good material. For the structure to hold the things, they just used irrigation piping. It was light, aluminum, but it wasn't really strong enough. It was

strong enough, but it didn't get into studies about what could happen in dynamics. There was a flight that did it in. They took off and maybe there was a little turbulence, and they got out of phase, and one of the helicopters broke up. Unfortunately, that guy got killed. The other three—there was a guy in each of the rotor systems. They walked away okay, but that was the end of that program.

That was exciting, but not very good, and there were other concepts like that. One up at [Naval Air Station] Tillamook [Oregon], that we did some modeling for. I also got involved in predicting airships like the one that was built in Britain. It was used for high-altitude warning, being able to look far out to warn about later, and later it was used for controlling drug trafficking and things like that. The best part of that one is I got to fly in one of their ships out of Andrews Air Force Base [Maryland] one time. Put me on the right seat, and "Whoa, this is cool." It was like you put it an input and it starts to move.

JOHNSON: A little slower than you were used to, right?

KURKOWSKI: Yes, that was an interesting experience. It went on and on. We also got into emergency medical systems put on helicopters, looking at ways to have the company study better ways to equip the device to the aircraft, and also better ways to use guidance.

Along the way, there were several planning activities I got involved in. One was [*NASA*] *Outlook for Aeronautics [1980-2000]*, which involved—who was the Director?

BUGOS: Hans [M.] Mark.

KURKOWSKI: Yes. You're good. Len [Leonard] Roberts was the head of that. Here's a case of the three Centers working together: Lewis, Langley, and Ames. We went around and saw a lot of the industry and so forth. This is the one I'm talking about here, the *Outlook for Aeronautics* [demonstrates]. That was about a year study, and I was kind of the chief bottlewasher on that one.

JOHNSON: What was the purpose of that study?

KURKOWSKI: This was the 1970s, and they were concerned about "Have we solved all the problems of aeronautics and transportation?" We didn't think we had, and industry, if they looked deep, also felt that there were more things to do. If nothing else, efficiency, higher, faster, on and on. That was put out, and I think it gave some guidance to the research that happened after that.

The other thing I got into later—this is '87 to '88—the FAA wanted to do a study. They were giving a name to advanced aviation system design, and they wanted inputs from NASA and DoD [Department of Defense]. I was selected as the rep [representative] from Ames, and I was stationed in the FAA Headquarters building [Washington, DC] for a year. It was a good duty. We interviewed all the people involved in the aviation system, went to their sites, and tried to stimulate them to think ahead as to what's needed. The emphasis was not so much on configuration and aircraft vehicles themselves, but rather the navigation. As the FAA, that's their forte, air traffic control and ways to do a better job of handling the traffic.

At that time, the military had a very good, precise navigation system. I don't remember what they called it, but it wasn't available to the industry yet. One of the outputs of this was to

really push to release that system so it could be used by industry. That's what all these signals are all about [demonstrates], so that you can not only find out where you're at, but also be able to share data, share information back and forth. "Hey, we got some really bad turbulence." You can do that automatically without even voice, you can just signal back and forth. Even the small aircraft are going to be required to have data systems coming into the cockpit. Again, very exciting.

Yes, that's something I should have looked for earlier [demonstrates]. That was the high-speed research program, looking at testing and supersonic transport designs, figuring out where to put the engines, less interference aerodynamically. Here's the difference between what we were hoping would come about versus the [British Airways] Concorde. The range, 300 miles—we wanted to go up to 5,000 or more. The Concorde had a payload of 100 passengers. We were looking at 250 of the 300. The weight, 400,000 [pounds], versus the new one would be twice that almost.

JOHNSON: Is that this model over here?

KURKOWSKI: Yes. This is the Boeing model that came out of the competition [demonstrates]. The worst problem was weight, of course, and the noise. You had to meet the latest levels of noise restraints on current airplanes. Going faster is always more expensive. That was a very good challenge. I was involved in that, and in fact, I was the main coordinator for NASA. There were many divisions and branches working on that program, and I was the Center guy to coordinate and work with the other Centers—a very challenging program—and then keep management up to speed on everything. That was one of my last efforts here.

This, by the way, is a picture of the Boeing representatives, who were excellent engineers and managers. This guy—he was retired at the time—was a former Concorde pilot. And this is on the vertical simulation, I think. I think that's there, or one of our simulators. That was another exciting program.

JOHNSON: You were on some accident investigation committees, too.

KURKOWSKI: Yes, two of them. One of them was when we were building the derrick here for the 40 x 80. They had the outdoor area where they'd set up testing before they put it in the wind tunnel. They were in the process of building a duplicate derrick to the one that's over next to the tunnel, out there on the open area. There was a foreman who was trying to beat a timeline on when this thing was supposed to be ready to get poured. There were tracks down below the ditches, two ditches for where the rails would be down, that the carriages would ride on. It's a crossbeam, two side beams, a huge thing which could move them back and forth, and put the model where you want it for testing.

He was down in that long trench and putting in rebar, and he was trying to do it lickety-split. This was a rectangular section, so he's putting it here and here and here. He neglected to put in diagonals, and the core came down and crushed him. They tried to get him out, tried to pull it back. They just couldn't. They couldn't work fast enough to save him. That was bad. He kind of made his own coffin. Somebody should have been looking over your shoulder, though.

The other one was the 19-whatever-it-was crash of the [Lockheed] P-3 [Orion].

JOHNSON: April [12], 1973, the P-3 fail, mid-air collision?

KURKOWSKI: Yes, so I got put on as a helper on the investigation committee. I remember at one time, we said, "Well, let's go out and look at the site." I thought, "Can I do this?" I knew at least one of those people on there. There were several photographer guys that used to work in this building. [Geaton P.] Faraone, I think his last name was. I knew him because he had done some pictures for my wife and I for something that we asked him to do. He was on board, and 11 people on board [total], I believe.

It was mainly due to the controller in the tower got distracted by an Army pilot that was trying to get out with an Army [Beechcraft] Twin [Bonanza]. Instead of following directions, he elected to go further down the runway to use more of the runway. He wanted him to do an intersection takeoff because this 990 was coming in, was cleared for the 3-2 right [runway]. Meanwhile, the P-3 was doing touch-and-gos on the 3-2 left. At one time everything was fine, but the controller, because of that guy, later gave a change of instructions that he didn't realize he was doing. He told the Convair to land on 3-2 left instead of 3-2 right. Nobody picked up on it, including there's supposed to be a supervisor there in the tower, and by the time he realized it, they had already started to impact.

Their other problem was the Convair was coming up pretty fast, high angle, and the other one was kind of coming in here [demonstrates], so it's difficult to see against the ground with the Concorde. Dick [Richard S.] Bray did an analysis of that, a very nice analysis, that it was very hard to see him. The instructor in the P-3 was concentrating on the student and not looking around. There also should have been more warning to the 990 of what the other traffic was doing. There's several things, it's not always just one thing.

I understand that he was one of the best controllers they had in the tower over there, but it just happened, human error. Then he went out for training and I heard that he was reassigned back here at Moffett [Field], maybe a year later or something like that. He was in the tower, I understand—I'm told this second- or third-hand—when we got our replacement 990 coming in for landing. Can you imagine what he was thinking?

Where are we? We've probably covered the waterfront pretty much.

JOHNSON: Yes, I think you did a good part of your career. Just going back, again, to the NACA and when you first came here—as a younger person and newly married, were there social activities? Do you remember any of the things that were going on at Ames at that time? A lot of people talk about the NACA as being a family.

KURKOWSKI: You mean like I was on the Ames Entertainment Committee? Yes, I was.

JOHNSON: There you go, that's what we're looking for. Yes, talk about that for a minute.

KURKOWSKI: I was a party guy, I guess. I used to organize parties for the Unitary people. One of the big, fancy parties was over at—the bottom of the [San Francisco] Bay here, a restaurant down there. What's the name of the little city down at the end of the Bay?

BUGOS: You mean San Jose?

KURKOWSKI: Near San Jose, but there's a small town over there. There was a restaurant run by this couple. I don't know if it's still going or not, but people [would ask], "Why do you want to go there?" A good price and good Italian food, so they had a good time. We organized some other things too, of course. I know, reading Jack Boyd's, he talked about the family things, including Santa Claus coming in on the helicopter and things like that. I guess we were doing it at that time too, so yes, that was an interesting way to meet people, and also other groups within the Center, so that was good.

BUGOS: Niles?

KURKOWSKI: No, Niles is across the Bay. Alviso. Alviso, yes. It's the pride of the South Bay. There's a saying, but I won't say it.

JOHNSON: Okay, we'll have to look for that one. Also during that time in the transition from NACA to NASA, was there a change in the way the work was assigned? I know a lot of the work was research-driven because individuals had a chance to pick research and do different things that they wanted to do research on. Once NASA was formed, and of course we were going to the Moon and all of that was happening, it was more of a goal-oriented research. Do you remember any sort of change?

KURKOWSKI: I think we were already on that path beforehand. There was more money, and more opportunities to contribute, so that was good.

JOHNSON: So it picked up more than anything?

KURKOWSKI: But the emphasis, of course, was space rather than aeronautics. The things had to come back down through the air, so aeronautics was still needed.

JOHNSON: It was still important. What do you think would be your most significant contribution during your time here?

KURKOWSKI: I think the work on Saturn V [rocket] program, I'd have to say that.

JOHNSON: What do you think was the most challenging thing you worked on?

KURKOWSKI: Saturn V.

JOHNSON: Still the Saturn V?

KURKOWSKI: Yes. I don't know how many years we worked on that—at least two, three?

JOHNSON: And it was rewarding, too. I was going to ask Rebecca if she has any questions.

WRIGHT: I just have one. When you came here in 1955, do you remember what your expectations were, and do you feel like they were met, working here at the Center?

KURKOWSKI: I think George Edwards, my interviewer, gave me a pretty good idea, but no, it's never quite what you expect. He described—it wasn't Silicon Valley yet—the Valley of Heart's Delight, and how nice it was to live here. I was looking forward to that, and that turned out to be very true. I had access to information about the facility. Not as much as you have now, with zip-zip-zip on your computer, but yes.

Certainly I didn't expect what a facility that the Unitary Wind Tunnel Plan was. I think people that build submarines made that tunnel because it's built like you have to make for a submarine, except the pressures hold on the inside, and it's the pressure coming from the outside, from the water. You're purposefully pressurizing so you get a higher Reynolds number, more accurate, more added data that can be matched to real flight.

WRIGHT: You joined such a prestigious organization when you got here. Ames had already been able to do great research. Do you feel like, as a new person, the way that the organization was set up here, your ideas and your recommendations, your discoveries, were treasured and honored as much as anyone else? Do you feel like even if you were a new person, you were contributing just as much as others?

KURKOWSKI: There was a little paragraph in Jack Boyd's [interview] that I identify with, "All these people are so much smarter than me." Remember that? Yes, I felt that, and boy, I felt I was very lucky to be here, and I enjoyed the challenges that they provided. I just admired what good people they had here.

WRIGHT: Did you find it very nurturing, that they were helping you?

KURKOWSKI: Yes. You had to ask. You didn't want to screw up.

WRIGHT: Thank you.

JOHNSON: Glenn, do you have anything?

BUGOS: Just a few about the Unitary, again the NACA. Some of the people that would have been your managers, I'm guessing Smith [J.] DeFrance, Ralph [F.] Huntsberger, Jack [John W.] Parsons. Who were the people that were managing you, and how often did you interact with them and what did you learn from them?

KURKOWSKI: Everybody reported to our branch chief, but there were mentors within the group. Usually, a junior engineer was put with the more senior person. In my case, that was Vernon Gnos that did that fighter testing. Then, when I was doing other things, had a fellow named Dick [Richard] Madison we worked with on turbulence programs. I forget who else I worked with, but then as I got more senior, I was pretty much on my own, except for reporting to the assistant branch chief. It was pretty much within the branch.

I always admired DeFrance. I was just reading more today about his background, and he was an amazing guy. What he did to help build this thing, build the big facilities and then manage very successfully, and guide the younger people—I think very admirable.

BUGOS: The Unitary was very specifically designed to help the military services and commercial aircraft manufacture, so a lot of what you would have been doing is interacting with the aircraft firms that were coming in to get their aircraft tested. What was that like in the NACA days, as opposed to the NASA days, for example? Really close interaction with the military services? Did you see a lot of them around? Were they working hand-in-hand with you?

KURKOWSKI: Again, because there was more money—more money not just for the government facilities, but also to industry—there was more activity and more chances to do some exciting things. How it's set up for a particular test—the branch chief or assistant branch chief would assign somebody who they thought was senior enough to make sure that the test went properly and they got accurate data out of it, and then that person would interact with whoever was the head of the group that came in to get the data.

They usually brought their own models, and they brought their people that worked with the models to make changes. You were always looking at modifications on the model to see which is the best configuration, which one gave less drag or the most lift, and/or better characteristics. There was that direct interplay, and then it was up to myself to then afterwards get that data out through the system and package it and get it to them as soon as possible. Of course, now they can do it electronically pretty much. Does that answer the question?

BUGOS: It does, thanks.

KURKOWSKI: There were a lot of people—in fact, I made a list today. I noticed on Jack Boyd's, the question was what notable people did you get to meet in your career? I've got several pages,

and the bottom line on this thing, I just thought, "Well, yes, I most admire DeFrance," because of what he had done. I don't know, do you want to go into this? Are you going to run out of time?

JOHNSON: Sure, if you have some that you want to highlight, that would be great.

KURKOWSKI: One of the top is the most unusual. I shook hands with Werner von Braun. He wasn't the best-loved person because of what happened at Peenemünde [Army Research Center, Germany], the slave labor. He was part of the Nazi Party, but what he did for our NASA program—it was December of '74, and we were celebrating that Pioneer 11 [robotic space probe] was flying the closest to Jupiter. Some of the activities were at Rickey's [Studio Inn and] Hotel in Palo Alto. I don't know how it happened, but we were in the liquid refreshment area, and he was all by himself, and I was by myself, and we started talking. We were talking about spacesuits and how we had this hard suit that we put a lot of time in. I said, "That's the way to go."

He says, "No, it's really a combination of those two." And that's the way they did it, they did do a combination of some hard parts and softer points.

That was a highlight in part of my career, and then all the people that came to participate in this program about the Saturn V—Borman, Neil [A. Armstrong] didn't come by but I met him later. McDivitt is the one that helped me with the sexton-sighting thing. Stuart [A.] Roosa, Charles [M.] Duke [Jr.] actually came here and worked with us for a time on the backup control system. Gene [Eugene A.] Cernan—he was the last one to walk on the Moon—he was in our building down there many times, looking at sexton-sighting with a handheld, so an even more basic system backup. That was nice to be able to meet him. And I got to meet [A.] Scott

Crossfield. Of course, he's died now. You heard what happened to him in the Cessna 210? He tried to fly through a thunderstorm. It didn't work very well.

One of my other jobs was working on a concept that after the Navy moved out, to use their big Hangar 1 down here as an Air and Space Center, with educational displays and programs. This program is in the 6 x 6, it's called "Ames Aerospace Encounter" [demonstrates]. That was supposed to be a precursor for what was going to use Hangar 1. I was working with the city people, and then we had a committee appointed. We were looking for shakers and movers, and we had Jim [F.] Cameron.

I got to meet Jim Cameron, of *Titanic* [film] fame, the director. Sally [K.] Ride was on that committee, and others, including our county assessor. I didn't understand why they ever picked him. That's some I just pulled up, that maybe in case you asked the same question you gave to Boyd. Fun, fun.

JOHNSON: Is there anything we haven't talked about that you'd like to talk about, or anything we haven't touched on?

KURKOWSKI: Can't think of it. Just an interesting sideline, it was interesting how the budget would go up and down, like everything does. It was interesting that when the budget was low, we were called aeronautical research scientists. When the money came in, then we were just aeronautical engineers, research engineers, not scientists. The word "scientist" compensated for less money.

JOHNSON: For not having the money, yes.

KURKOWSKI: In theory, until you had to make the payments and had a house. Thought I'd pass that on.

JOHNSON: Thank you for adding that. We appreciate you coming by today.

KURKOWSKI: Thank you.

JOHNSON: Thank you.

[End of interview]