NASA HEADQUARTERS NACA ORAL HISTORY PROJECT
EDITED ORAL HISTORY TRANSCRIPT

LEONARD K. TOWER
INTERVIEWED BY REBECCA WRIGHT
CLEVELAND, OHIO – JUNE 4, 2014

WRIGHT: Today is June 4, 2014. This oral history session is being conducted with Leonard Tower at NASA's Glenn Research Center in Cleveland, Ohio, as part of the NACA [National Advisory Committee for Aeronautics] Oral History Project, sponsored by the NASA Headquarters History Office. Interviewer is Rebecca Wright, assisted by Sandra Johnson, and we thank you, again, so much for coming over this morning to talk with us. We'd like for you to begin by sharing with us, how did you first begin with NACA?

TOWER: I was a college student at Antioch College, in Southern Ohio [Yellow Springs]. They have a program called Co-Op [Cooperative] Program, where you work part-time, study part-time. Some fellow students had come to NACA here to work, so I heard about it, so I decided that the next quarter—they were on quarter plans—I would go to NACA. I applied, came figuring that I would be here a quarter, and started working as a sub-professional. I was an SP-5 with a salary of $1,800 plus Saturdays. Made a magnificent salary of $2,100, and my job was to help evaluate aircraft engine fuels in small reciprocating engines that were used specifically to evaluate fuels for larger engines that would be in fighter planes. This was fine; I was very insecure in this. I was a third-year student, maybe not even third-year, maybe two-and-a-half-year student at Antioch, so I was trying to learn as much as I could, and was helping to mix fuels, helping to do tests, and so forth.

In the midst of all this, I got a draft notice from my draft board back home in New York State. I told my section head, who was John C. Evvard, J.C. Evvard, that I got this notice. He said, "Well, we'll see what we can do." It turns out, as an SP-5, I could not join the program where they put people into the Air Corps Enlisted Reserve, so John said, "Well, we'll take care of that." John somehow seemed to know all the strings.

He got me a promotion to a P-1. I don't know how this could be because I had no college degree. Got me a promotion to a P-1, and that then made me eligible for this program as a private in the Air Corps Enlisted Reserve, or something like that, and I stayed here. I never went back to college. What did I do? I needed a college degree at some point, so I simply arranged to take a couple of courses by correspondence, and I went to Case Western. It was Case Institute of Technology [now Case Western Reserve University]. Took a course or two there; one was taught on-site here by a Case professor. Ultimately, got my degree in that fashion, and it kept on working, so I never went back to college.

WRIGHT: What year was it when you first came here?

TOWER: That was March 27, 1944. I have now been on the premises here, off and on, for the last 70 years.

WRIGHT: Amazing.

TOWER: We just celebrated; some friends took me out to lunch, about a couple of months ago on that date. I just continued working. The work metamorphosed, and we got into a variety of programs. Some involved working on—this is all a mishmash—fuels for jet engines in the form that they existed at that time. One program that I had early on was testing for a variation of a buzz bomb that was being used by the Germans. This was after the fact; we'd already defeated the Germans but the program went on, and I was doing testing on buzz bombs.

Ultimately, it got more interesting because somebody discovered that there were things like high-energy fuels that could be used in jet engines and afterburners of jet engines to increase their thrust for augmenting bombers for take-off. My function was to do some studies of these fuels. The interesting one that I was assigned to, or evolved into, was mixing magnesium powder with jet fuels, which was then a suspension that could be sprayed into the afterburner of a jet, when jets had afterburners, and used for take-off.

This extremely dangerous project, I can only say it was a wonder that we survived because we were dealing with fine-powder fuels, which were very explosive, and had to devise systems for performing the mixing of these fuels, and then testing them. I tested them in a small simulation of a jet engine afterburner. When this looked very promising, they decided to do this job in a real jet engine, so my assignment was to prepare fuels for this jet engine, for a real jet engine, which was being tested on the ground in a facility here on the lab.

I mixed up probably 1,000 gallons of this mixture—a large amount—which was transported to the site of the experiment, and I devised a system for feeding this into the engine. The test was performed with the real jet engine. It was probably one of the most spectacular tests ever performed here. A cloud of white smoke went out over the airport. The second test was then performed, and only in the second test, the engine that was used to perform the test was augmented with water injected into the compressor of the engine. The second time we tried this experiment, the engine did not ignite immediately, and so, powder came out into the air.

Abe Silverstein, the director, witnessed this. The engine finally worked, but he decided that was extremely dangerous, so it was never performed again. I can only say these tests were really spectacular. In the first one, the afterburner, which was cone-shaped, almost turned spherical. It got white-hot, so, of all the tests I've ever seen or participated in, this was the most spectacular.

WRIGHT: It seared your brain, even after all these years, didn't it? It's still there.

TOWER: That was the end of that program. It essentially shut down because fuel could not be bought anymore. The magnesium powder was very dangerous. In fact, it was the cause of a serious accident in which a guy at a trucking company was killed, because the containers they shipped it in broke open and he got burned by the powders. That was the end of that program.

By that time, things metamorphosed. I had a very innovative branch chief who moved a group into essentially—I'm perhaps omitting insignificant details—we metamorphosed into space power. The interest there was thermionic power conversion for use in satellites. By that time, I had gone back to Case, got a master's [degree]. I felt my undergraduate was very shaky, so I got a master's in aero [aeronautics], and got enough education that I could do a little more analytical type stuff. So, I did analytical studies of various programs that came through our office.

Probably a typical one would have been when I analyzed the phenomenon that is now used in halogen light bulbs. I did what I believe was the first analysis of this cycle for halogen light bulbs. It was never published in open literature; it was published as a NASA TM

[Technical Memorandum]. The attitude that was taken at NACA in those days was that we didn't work with literature [scientific journals] on the outside, that we published our own stuff.

WRIGHT: It was internal?

TOWER: Internal, yes, but became a TM or a TN [Technical Note] or something like that. I worked on that. It was very interesting. I'm sure that I did the first analysis of that, and then there were various other analytical studies that I performed. I saw the work that was being done, and then I would pick what I thought was interesting. The branch chief gave me a free hand to do these kinds of things because he figured I was an analyst, so I did those things as I saw as interesting. Some of them, whether they were beneficial in the long-term, I have no idea, but they were very interesting to me. It was a kind of situation does not exist anymore because everything is scheduled and directed, more or less, from the top, in the way I see it. An individual can't pick areas to work on, and nowadays, things have to be justified, in terms of a mission. In those days, there weren't always missions. I'm just thinking when that would have ceased, when that kind of work would have ceased, time-wise, because NACA terminated while we were doing the thermionic work, I think, which would have been 1958?

WRIGHT: Yes, it was phasing out in '58, and officially, October 1, 1958, but I think it was in March, I think they started beginning the transition.

TOWER: Yes.

WRIGHT: If you could, though, before you get out of that, could you share with us what that process was? You found a topic of interest and you knew you wanted to analyze that. What was your process in moving in to the beginning of that thought process, to your analysis? How did you do that?

TOWER: First, I had to be mentally equipped to do it. I studied thermal chemistry on the side, I self-educated myself in thermal chemistry, to the level where I could deal with these things. I've omitted some things, I realize. Before I got to that point, when we were working, there was a whole area that we were working with, as I say, combustion of fuels. I did studies of the thermodynamics of combustion of fuels in jet engines, and in particular where we were burning the magnesium slurry mixtures. That's why I educated my self in thermodynamics—chemical thermodynamics, actually—and that prepared me to do studies of the situation with the light bulb. How did I approach that? I had to start absolutely from scratch. I thought about this. I knew the process worked. Somebody had built bulbs.

In fact, somebody at Nela Park in Cleveland, at GE [General Electric], was working on this. I sent him copies of my reports, but they had done the analysis, why this worked, was what I was interested in. What made it work? I sat down and I thought about the process of the closed system, where there was halogen—actually, halogen could be either iodine in gas form or chlorine—in a closed system, where the filament was very hot. The material was boiling off the filament, the tungsten was boiling off, and the idea was to have a cycle where something carried the tungsten chloride or tungsten halogen as a gas off the filament, and bring it back. The idea was to have a cycle with the tungsten boiling off, being picked up by the chlorine or halogens, and being transported back to the filament that was being eroded, and re-deposited. Of course, they’re still making halogen bulbs. I think they’re in my car—I’m not sure. I thought this was very interesting.

My branch chief hired a guy, hired a very well-known professor from MIT [Massachusetts Institute of Technology, Cambridge], to help me out with this, but no. He came here a couple of days and talked, but in the end, I had to do it all myself. I figured out the process and did the mathematics of the cycle, and published it. It took me quite a while because I was starting really from scratch, in terms of understanding this process. That’s how I got involved with that, and I thought, “Hey, that’s pretty interesting.”

Yesterday, I happened to be cleaning house—which I need to do—and I found a bunch of my old reports. I picked this one up and looked at it, and I thought, “Huh, that’s interesting.” In fact, I found other reports I wrote that I absolutely don’t understand anymore. I really don’t understand.

WRIGHT: It’s a good thing you documented it, then, when you did.

TOWER: Yes, I really don’t understand. I did other studies, some of which were I’m not sure very important. Some of those took place after NACA. I went on with this analytical type stuff after NACA terminated. It continued, and then I got into various things, and that’s where I am. Now, I’ve been working for nothing for the last 30 years, no, not quite. I worked for a contractor after I retired from NASA. I retired in ’79, worked for a contractor for eight years, then I just donate my services because I didn’t feel I needed the income anymore.

WRIGHT: How many reports do you think you’ve written?

TOWER: Maybe 30 or 40—I'm not sure.

WRIGHT: You published all of those, either in some form or another?

TOWER: Yes.

WRIGHT: It's pretty interesting, especially when you can go back, after all those years, and take a look at them now.

Looking back at that time at the NACA, and you were talking about this one, you said you self-educated yourself on thermionics. Did you do that on other subjects as well, that you ended up having to do your own self-educating?

TOWER: Mostly no. Mostly, the rest of it was through courses that I took. My education at Antioch, for two-and-a-half or three years, was very weak. Then, I took the courses at Case and found out, well, hey, I'm in fact capable of what the other people were doing. I really felt, when I started, way at the bottom of the heap. All these kids were all educated. They were young. I had just started working at NACA in '44, and they were all very young, and knew all about engines and reciprocating engines. No idea, so I've been self-educating or getting education from there on. It was really a struggle.

WRIGHT: What do you think you learned from the NACA members that had been here for a while? What was the atmosphere for learning and for knowledge exchange?

TOWER: It was good. They had courses, training courses, that you could take. I took many, many. I think even back—this time goes into the NASA days—it started early on, courses in the operation of jet engines. I don't know that I took any of those, but at some point, I took a couple of courses in quantum mechanics. They had fellows here that were teaching courses on site, and they were very valuable. They started in the NACA days, continued on, I don't know whether they still exist now. I have no knowledge of what is done because I'm often in isolation, now. They were educating people on lab time, and I participated early on in a little of that, and the people that were hired in, some of them were very skilled in certain disciplines and were teaching people those things. Particularly in the days of the jet engines, how jet engines work. Maybe I took a course—I don't remember now whether I took courses in that or not.

WRIGHT: Have you always been in the field of engines?

TOWER: No.

WRIGHT: That's just kind of where you started?

TOWER: Yes.

WRIGHT: Could you share with us, where else have you been through these 70 years? Maybe give us some of the highlights of where you really enjoyed working and using your talents?

TOWER: We got into space power, and an issue there was heat transfer. Efficient mechanisms of heat transfer were discovered someplace along the line, so we got into something called heat pipes. I became very interested in that. In fact, basically, I'm stuck in that now because I wrote a code for analyzing heat pipes. About the year 2000 I did an analysis, and extended it and extended it and extended it, to analyze the operation of a heat pipe. This was nothing new, but I formalized it in a fashion that hadn't been done before, and I wrote code. At this point, because it was now my own time, I didn't care anymore. I just kept working on it and working on it and working on it, using the lab space and a lab computer, but not being paid anymore. Did what I felt like, which is basically what I'm doing now.

The only thing is that the code recently became obsolete because of changes in computers, so now I'm trying to update the code to work in the latest computers. It's really giving me difficulty because the code got to be very complicated, and it's so complicated, I don't understand it myself. I know that it works, but I can't figure it out, and I wrote it. For me, what other people my age would be doing would be crossword puzzles or—

WRIGHT: Those math games, sudokus and all those, crosswords and cards?

TOWER: I'm finding this to be still challenging, since I just turned 91 last Sunday.

WRIGHT: Happy birthday.

TOWER: Thank you. I figured I'm possibly performing a service because this could be used again. They're still working on space power and the code that I wrote is useful to people. I want to make sure that it's republished in the modern form, and the same time, NASA can say that they're friendly to senior citizens—which I don't really consider myself.

WRIGHT: I don't think so. Maybe in about 30 years, but I think you're still going. You're talking about it, to make it more efficient, in the heat transfer and the heat pumps: I know you want to update your code, but when you get your code updated, how does it impact space power? How's it going to help?

TOWER: If they are going to transfer heat from, say, a little nuclear reactor or nuclear heat source to a little engine that's going to produce the power, you have to have a mechanism of efficient transfer of heat. A heat pipe is the most efficient transfer of heat that exists because for one thing, it has no moving parts. There's no engine that is required to force the hot fluid that's actually a gas from the heat source to the engine. There's nothing required in that heat pipe—it's a self-contained device that has no moving parts. It's extremely efficient, and is then a candidate for insertion in the system to transfer the heat without requiring moving parts. Not having moving parts is very beneficial because moving parts fail.

WRIGHT: Although missions get changed, there still is a desire for power to explore in space, isn't it?

TOWER: Yes.

WRIGHT: Can you give us some examples of some of the other work that you've done, and how it's been used by NACA or NASA or industry? We know that industry looks to NASA, and for years, looked to the NACA for research information that they could apply for development.

TOWER: How it's used in industry? That's kind of hard to say. What we do is published and what people do with it, I don't know. I really don't know.

WRIGHT: That's right, but it certainly is used to help base for what they have done. What are some of the other favorite things that you've worked on, other than this heat transfer?

TOWER: I'm going back—it's too bad I don't have this stack of all the papers.

WRIGHT: Your cheat notes, yes. I'd like to have seen those. You made a statement earlier about in the beginning, you were able to choose some of the areas that you wanted to research and analyze. At some point, it shifted, where now work was done for a greater mission. What kind of projects were you tapped at certain times? Did you work, for instance, on some of the space programs, or did you work on some things that were exploratory?

TOWER: Most of it was like exploratory. Probably the closest we got to really the large projects was when we were working on fuels for jet engines. We worked as a group, so there would be a group, somebody working on a certain kind of a fuel for a jet engine. I told you about the magnesium slurry business, and somebody was working on basically a metal hydride, I forget what they got, I don't even recall what it was, working next door. I was doing a thermal chemistry for that project, too, doing computations for the combustion of the fuel that was being used in that project, again, to augment thrust for a jet engine. All that kind of work basically came to an end when jet engines got big enough and powerful enough, they didn't need to be augmented anymore by special fuels. That kind of brought an end to that kind of a project. The group I worked with, another test was done here, again, putting a cloud over the airport where they burned the fuel. It was a metal hydride of some kind. I absolutely forget what it was, now.

WRIGHT: You're just lucky you were on the good end of those experiments, weren't you?

TOWER: Yes. I was doing the computations and analysis for some of that, the thermochemistry for some of that project, so those basically were aimed at the Air Force. A large sum of money was spent here on that project, and it was eventually terminated. That's when we got into the work with space power. The boss that we had at that time, the branch chief, was always looking for something defensive, something that he could get his group working on. I've never been a leader—I've been a follower—but I've been a follower in that I went off in my directions, wherever possible, to supplement whatever was being done.

WRIGHT: When you were first in school, back in Antioch, what were you working toward? What did you want to do?

TOWER: How I ended up at Antioch, I don't know. My folks thought that's where I should go. Initially, I wanted to be a railroad mechanical engineer, which is not taught at Antioch. I was accepted at Purdue [University, West Lafayette, Indiana]; never went to Purdue. That's where they were doing railroad mechanical engineering. I went to Antioch to be a mechanical engineer. They had a little engineering department there. I don't know—you've never heard of Antioch?

WRIGHT: I've heard of it, yes, sir.

TOWER: It just folded and it's being reborn, now. The alumni are being actively solicited for money, and we may give them some, I don't know. They closed and reorganized because it was badly managed, for a while. They had huge ambitions and wasted all their money.

WRIGHT: You stayed here quite a long time. You never had any thoughts about maybe taking your skills someplace else?

TOWER: I had solicitations, yes, several times, but by that time, I'd been here quite a few years. I had roots in Cleveland. I married a woman. I was 43 when I got married the first time—not first time, it's the only time, because I'm still married—and then I had kids. Then, when I had kids, when I retired from NASA, TRW solicited me to work in Redondo Beach, California. I thought, "Hey, of all the places I don't want to go, that's the worst place in the world to raise a kid." We had kids that were then just early teens, and I thought, "No, no, no. California, no." That was the end of that.

WRIGHT: What do you think is probably the most challenging time that you've had since you've been here at the lab or the Center? What has brought you challenges in getting your work done? What's some of the most challenging work that you had?

TOWER: Probably when I wrote the heat pipe code the first time. It was challenging because I took parts from all of my education. I took thermodynamics, because it had in it thermodynamics. There was a competitive code done by Los Alamos [National Laboratory, New Mexico], but I put in more mathematical detail than they were able to do. It was challenging in that I was trying to make it as rigorous as possible. I wanted a rigorous code, really worked on that, because I didn't want anybody to say, "Hey, there's something wrong here," or, "there's something wrong here." I had some idea of where they were coming from.

I was especially pleased, a few years ago—more than a few years ago, now—the Navy had a program someplace, I can't say too much about it because it was classified, but the part that wasn't classified, they had a review of the project the Navy was working on, and Los Alamos was doing the mathematics for their program. I went and I presented my work, and they did me the favor of saying, "The NASA work substantiates Los Alamos' work." They accepted our work as being definitive, see? I thought, well, okay.

WRIGHT: Sounds good. I was going to ask Sandra if she's got a couple of questions for you.

JOHNSON: Yes, you mentioned writing the code, and I was thinking about the changes in technology from the time you started. Computers were women, human computers, sitting there, doing mathematics with paper and pencil. Then, of course, the early punch-card computers, to the point where you're writing code. I know technology changed in all areas, but I thought maybe you'd just comment on that, for a moment.

TOWER: Yes, I remember early on, I knew some computers. A girlfriend of mine was a computer here for a number of years, so I had some insight. I recall the first work that we did was, of course, with just the hand computers, Friden and Marchant calculators, and it was very difficult. The girls, some of them were highly trained. They were mathematicians; they had BAs in mathematics, and did this work. Then, they went to the early IBM computers, something called the 650, and they were doing things. I was on the side and eventually got into doing a little bit of punch-card-type programming myself. Somebody taught a course in computer programming. That's one of the courses that was offered. I learned Fortran programming here from somebody that taught computers. I did some punch-card programming myself. Eventually, got into Fortran, so I do Fortran programming. That was aided by the fact that they had courses that were taught on site to people.

Where they ended up, eventually, then the personal computers came up. I bought one at home, for home use, forced to by my wife. She said, "Oh, the kids need that, they're in high school," so I had to buy a computer, so I bought a computer. Then, I ended up programming in that computer stuff that I brought out here to use. In fact, it's buried in my code someplace, still. Once personal computers came out, then I lost track of what was going on, on the larger scale. I had programs that had to be programmed by somebody on the large machine. When I did the light bulb analysis study, that involved some mathematics that required a computer.

JOHNSON: You mentioned the halogen light, too, and I've heard other people from NACA make similar comments. You said that—was it GE?—they had the technology, but you wanted to know why it worked, or how it worked. I've heard that before from NACA members, that the technology may have been out there, but what they did is figure out the hows and the whys behind it. That just seems like such an interesting atmosphere to be allowed to work in, that you were helping industry, and I assume they appreciated it when you got through, to know why their products were working, but it's just kind of interesting, that relationship with industry that you had.

TOWER: Now, I don't know that that—not to be critical of NASA—really exists anymore. Now, everything is by contract and it's put out, and I don't think people have the time to satisfy those intellectual questionings anymore.

JOHNSON: The value seems to be on a specific goal instead of just pure research.

TOWER: Yes, exactly. It was much freer, say, in the '50s and going into the '60s. In the '60s, then, the going to the Moon came up, then it was huge amounts of money going into a specific program.

JOHNSON: Do you recall working with other groups here on site? I know some of the engineers, when they would come up with research and then they wanted to run tests, they would go to technical services and have them build everything. They would bring in the photographers to document everything. Do you recall working with those groups? Was that helpful?

TOWER: Yes. When I was testing the magnesium slurry program, we had large equipment that had to be built, and they had the technical services people design the equipment that was required for that kind of a test. We were working with design engineers all the time, and other people in our group even got to the point where they built a rocket that was fired at Wallops Island, using fuel that our group developed. It was boron hydride. That was another fuel, boron hydrides were tested by our group, and I did some calculations on the boron hydride. I never ran those experiments myself.

That was a really dangerous period of life right there, when we were handling those fuels, and we didn't really know what we were doing. One day, in the test cells that we use for testing, it was testing boron hydride fuels. The guys were working in the test cell and had just set things up to do a test and had left the test chamber and gone to a control room where they were doing the test. I wasn't there, thank God I wasn't there. I came in the next morning and they'd had a huge explosion, and blew the roof off the building. A foot thick wall got cracked on account of this, so I mean, it was a dangerous period.

WRIGHT: Yes, it was.

JOHNSON: Definitely. That's interesting, because you were doing the testing and you didn't know until you did the test, just how dangerous it was.

TOWER: Nowadays, those kinds of tests are impossible. People now are worrying about what in the old days we figured would have been just like nitpicking.

JOHNSON: Yes, there's standard operating procedure, now.

TOWER: It's critical.

JOHNSON: I appreciate it.

WRIGHT: When you look back over these 70 years, are there other areas that you would like to share with us, or some of the other accomplishments that you would like for us to know about?

TOWER: In broad terms, I covered pretty much everything. I diddled a little bit with physics. At one point, when we were working on thermionics, I did some analytical surface studies that were of no real consequence, except they were interesting to me. The physics of molecules on surfaces, I messed with that but really didn't have the background to do it. It was interesting, and I thought, "Well, gee, sometime when I retire, I'd like to do that," but no, by that time, I'm through.

I wrote two or three papers that were published in the physics journals as letters to editors, and found errors that other people had done, or did the first computation on something or another—molecules on surfaces. This physics of molecules on surfaces, I did that as kind of a sideline. Without really enough background, it was correct, but not really earth-shaking in any sense, but just interesting to me, and tolerated at that time. I wouldn't even start something like that today. You couldn't start it—how would you justify starting it? We were working on engineering studies involving that kind of stuff, so I thought, “Well, this is interesting, I’ll do this on the side,” and did it on the side.

WRIGHT: When you get through with your updating code for your heat transfer, what’s your next project?

TOWER: Next project, I will probably start staying home, because I have deferred stuff at home for a long time. I will have been retired now, as long as I worked, I worked 35 years, when you figure it out, and 35 more years is 70. Except that I did work for Sverdrup Engineering for eight years. That, this is not now involving NACA, but that was the smartest thing I ever did because I met people that I still know, and that I’m still friends with, and that I’m still working with, that I met then when I was a contractor. Actually, that’s why I got started with my code.

WRIGHT: It sounds like you were fortunate to have a little bit of all the things that you were interested in.

TOWER: I’ve had a huge variety of experiences, huge variety.

WRIGHT: We thank you for sharing them with us this morning.

TOWER: Nothing real important.

WRIGHT: I think it's all just a smaller piece of a bigger puzzle that all came together, so we appreciate it.

TOWER: NASA, I feel one thing that keeps me here is that when I started out, I started at such a low level and I was tolerated as an SP-5 at a very low level. I feel, somehow, I owe something back. Now, I'm stuck giving back.

WRIGHT: I think you've given a lot, and just the insight of all that you've seen has to help all of those who haven't come yet to see anything.

TOWER: It's been an interesting place and there are interesting people here, and my best friends are here, still. I, frankly, don't like being around people my age.

WRIGHT: Old people? Yes.

TOWER: They're boring. All they do is talk about their aches. It's unfortunate.

WRIGHT: It's so fortunate for those that are younger that are able to tap into your brain on what's worked and what hasn't worked because analyzing is analyzing. It's not just computer.

TOWER: Some do. There's a young girl here—she's not young anymore; I mean young to me—she's 40, to me, my kids are 45. She has been using my inputs. I think basically what I am now is a senior mascot.

WRIGHT: A go-to guy. "I'll go to him and ask him what he thinks," see? You're still analyzing for them, so that's the good news. Thank you so much for making the travels over here and spending some time with us this morning.

TOWER: Yes, now I got to figure out how to get back there.

[End of interview]