NASA GLENN HISTORY OFFICE
ORAL HISTORY TRANSCRIPT

William Tomazic

Interview by Virginia Dawson
with Dennis Brown
January 23, 2003

One of a series of filmed interviews conducted on January 23, 2003 with former Rocket Engine Test Facility employees for the documentary video "Fueling Space Exploration." Dennis Brown is the videographer.

TOMAZIC: Do you want to see if things are coming through? What else do you need?

BROWN: Just give us your name.

TOMAZIC: My name is William A. Tomazic.

BROWN: And spell it for me.

TOMAZIC: That's spelled T-O-M-A-Z-I-C.

BROWN: And his title?

DAWSON: Oh, yes. What did you do, what was your title when you were here?

TOMAZIC: [Laughs]. It started out, the official title was Aeronautical Research Scientist. And since I worked in the Rocket Lab, I always like to say I was a rocket scientist.

DAWSON: When did you come to the center?

TOMAZIC: I started at Lewis in 1953. I had worked prior year at the Bell Aircraft in Buffalo where I was rocket test engineer.

DAWSON: Okay, he's saying stop.

BROWN: That was a test of perfect open. That's what I want. Let's just do it one more time. I got a better framing on it.

TOMAZIC: Where am I starting from?

DAWSON: Just tell us that you were a research and a rocket engineer. And say [inaudible]

TOMAZIC: Okay.

DAWSON: Do you want the names, too? Aeronautical Research Scientist.

BROWN: One more time. Three, two -- and look. Always look right at her [Dawson]. You're looking right at her, not the camera.

TOMAZIC: Okay, I'm doing that.

BROWN: Three, two, one.

TOMAZIC: My official personnel title was Aeronautical Research Scientist. And since I worked in a Rocket Lab, I always to kid and say, gee, I used to be a rocket scientist.

DAWSON: When did you start at what was then Lewis Flight Propulsion Laboratory? And if you could repeat the question so that, you know, I started at Lewis Flight Propulsion Laboratory.

TOMAZIC: Okay, I started at Lewis when it was the flight propulsion laboratory in 1953. I had spent the prior year at Bell Aircraft where I was a Rocket Test Engineer.

DAWSON: What was your job when you came here?

TOMAZIC: Well, that was in the Rocket Branch.

DAWSON: You have to say my job was, when I came here --

TOMAZIC: Oh, okay.

DAWSON: Or my job was.

TOMAZIC: Okay, my job when I came here was to work on research and rocket propellants in the rocket research branch. And the first propellants we worked with were ammonia and mixed oxides of nitrogen. We had some very exotic propellants in those days. We were trying to find out what really worked. What would be the best thing that we could use in rockets. And we went through a lot of weird stuff--nitric acid, hydrazine, diborane. Oh god, it was a -- it was a tangled mess, believe me.

DAWSON: Where did this work take place?

TOMAZIC: It was place we called the old Rocket Lab and it was a collection of little buildings behind some big earthen domes, dunes. The idea being that if things exploded, we'd be the only ones killed. And the rest of the lab would be protected. And a little office building in front, and that's where we stayed. Our test cells were in the back. At that time, so-called research scientists, research engineer, did pretty much everything himself. When I sat down on my first project, I designed the equipment they were going to use. I operated the cell along with a couple of exceptional mechanics. And we worked together to get the thing done. At this time the rockets were small. Little tiny things. Later on they became much, much larger. And as they became larger, it was necessary now to start to specialize. One man couldn't do it anymore. So, people sort of started diverging into their own areas. The best engineers seemed to end up as the Operations guys. Guys like me, I like putting the data together, making something of it, and then finally writing about it so that the people who needed know would know what we had learned. I like words.

DAWSON: What about testing with fluorine? How did that get started and when did it end?

TOMAZIC: Well, the whole fluorine business was complicated in a number of ways, okay? The reason people liked fluorine as an oxidant is, you understand rockets use a fuel and an oxidant because they don't burn air. So they need something to burn the fuel with. And the people who did the theoretical work, Vearl Huff, Sanford Gordon, they would calculate what sort of performance we could expect to get from any one of these propellants. And when they got through calculating, the best propellant combination by far, head and shoulders above everything else, was hydrogen with fluorine. Fluorine is monstrously reactive. It reacts with anything, anytime, anywhere it's -- it's unbelievably difficult to control. Maybe when Ed comes up he can tell you about some of the fun we had when we were trying to establish -- set up a fluorine system, fluorine ignition system at Aerojet, at California. Nobody believed what that stuff could do.

At any rate, as we proceeded along in the mid '50s, it was decided that we would build this Rocket Engine Test Facility. Much larger than anything we had done before. We're talking 20,000 pounds of thrust. And at that time, the biggest we had done was 5,000. And much of the work was at much smaller engines. And the facility, very complicated one, and I'm sure that Bill or Gene or Ed could tell you a lot more about it, was designed to burn hydrogen with fluorine. Therefore, the key, or the central portion of this facility was this monstrous scrubber. The idea being to wash out the fluorine exhaust gases, react them into, I believe, calcium fluoride, something that was inert and not dangerous. Very complicated facility. So, specialties derived from this, all right? And at this point, I'm not sure where we want to go. So why don't you prompt me?

DAWSON: Okay, yeah, sure. No, this is good. Well, I'd like to find out how -- when you made that transition into the decision to go with liquid hydrogen, liquid oxygen.

TOMAZIC: Well, the hydrogen -- there was never a question about hydrogen.

DAWSON: Well, yeah. But start - I think you should start off with saying how fabulous hydrogen is. You know, why it's so great.

TOMAZIC: Oh, it is.

DAWSON: Well, yeah. But I mean, you know, in a sort of layman's terms. Why it's so great.

TOMAZIC: Okay, hydrogen -- all right.

DAWSON: And then talk about, you know, the decision going -- you know, getting rid of the fluorine and going into the using the liquid oxygen as the oxidizer.

TOMAZIC: Right. As I said, was never --

DAWSON: No, no, you can't start with as I said.

TOMAZIC: All right.

DAWSON: Say liquid hydro -- or you know, whatever.

TOMAZIC: Liquid hydrogen. All right. Liquid hydrogen, there was never a question as to liquid hydrogen being the absolute best fuel on earth. You asked me not to say anything that was too technical, but there are two things involved in a rocket propellant as far as capability. The temperature that you can achieve or the energy that you can derive from the fuel--and hydrogen has the highest energy of any fuel I can think of, 54,000 BTU per pound, gasoline is 18,000. The other thing is the molecular weight of the exhaust products. Hydrogen is the smallest, simplest molecule and will derive, therefore, in the exhaust products, the smallest molecular weight. So the higher the temperature, the lower the molecular weight, the higher the rocket performance. And hydrogen was at the top of the list.

If you mated hydrogen with fluorine, you got monstrous benefits, both in temperature and in molecular weight. But, fluorine can be handled with great difficulty. And at that time, the lab director is Abe Silverstein, and probably the most brilliant engineer I ever knew. I mean, he was one tough son-of-a-gun, but he was brilliant. He could -- he could sit there and go toe-to-toe technically with any expert on any subject at the lab. It was fascinating to watch. And when he looked at the information, the data, and looking at something that was going to work, not just be a hoped for ideal, he decided that hydrogen would be run with oxygen. We would downgrade the fluorine effort and concentrate on oxygen. So the initial work at South 40 RT Rocket Engine Test Facility, was done with hydrogen and oxygen. And the point here was to find out how good a propellant hydrogen really is. How well it cools. How high a performance we can derive from it. And that was the start of the initial work. I'm not sure where to go from there.

DAWSON: I think it's excellent. I think that's good. I think that's all we need, really.

TOMAZIC: Okay.

DAWSON: Unless there was a certain specific research program that you were involved in that you'd like to talk about. But that's really what I was trying to get at.

TOMAZIC: Well, we did run the initial -- we ran some uncooled engines. And then we ran regeneratively cooled engines with hydrogen and oxygen. Now, regenerative cooling is a system whereby the fuel is introduced at one end of the thrust chamber, is used to cool the chamber so it stays together with this 5,000 degree heat inside. And then finally is brought back into the injector and burned. Regenerative means that the heat lost from the combustion to the coolant is regained when the propellant is injected into the combustion chamber. We had some interesting experiences there, and we pretty well proved, yeah, the stuff is great. The performance is great. If you design properly, it cools beautifully. We know how to handle it. We're learning how to handle it. Hydrogen's biggest problem is it's extremely cold. Liquid at 420 degrees below zero. It's also extremely light. Water weighs 62.4 pounds per cubic foot. Hydrogen weighs about 4 1/2, as a liquid. So that's one of the problems with hydrogen. The oxygen was relatively easy to handle compared to the hydrogen. And of course, the fluorine was just out of the question.

DAWSON: I wanted to ask you, were there any other facilities in the United States that could be used for testing liquid hydrogen at the time? Was this facility --

TOMAZIC: Well, Bill Goette would know about that. When did Pratt and Whitney start there -- there were a number of people that had done things. And I think John Sloop mentions them.

DAWSON: Oh yeah, well that --

TOMAZIC: Yeah, there was an extensive effort begun at Pratt and Whitney down in Florida. And in fact, they eventually developed the RL-10 engine, which powered the Centaur. And Bill Goette, of course, was the manager of that engine during its development. So there was some other work being done, but this, I believe at the time was the largest facility thrust-wise handling hydrogen and oxygen.

DAWSON: Great.

NASA GLENN HISTORY OFFICE
ORAL HISTORY TRANSCRIPT

WILLIAM A. TOMAZIC
Interview by Ginnie Dawson
January 23, 2003

The following is not a true transcription of the taped interview; interviewer questions and prompts are not included.

My name is William A. Tomazic. My official personnel title was Aeronautical Research Scientist, and since I worked in the Rocket Lab, I always liked to kid and say, gee, I used to be a rocket scientist.

I started at Lewis when it was the Flight Propulsion Laboratory in 1953. I had worked the prior year at Bell Aircraft in Buffalo where I was a rocket test engineer.

My job when I came here was to work on research and rocket propellants in the rocket research branch. And the first propellants we worked with were ammonia and mixed oxides of nitrogen. We had some very exotic propellants in those days. We were trying to find out what really worked. What would be the best thing that we could use in rockets, and we went through a lot of weird stuff – nitric acid, hydrazine, dyborane[1]. It was a tangled mess, believe me.

This work took place at what we called the old Rocket Lab, and it was a collection of little buildings behind some big earthen domes. The idea being that if things exploded, we'd be the only ones killed, and the rest of the lab would be protected. There was a little office building in front, and that's where we stayed. Our test cells were in the back. At that time, so-called research scientists, research engineers, did pretty much everything himself. When I sat down on my first project, I designed the equipment we were going to use. I operated the cell along with a couple of exceptional mechanics, and we worked together to get the thing done.

At this time, the rockets were small, little tiny things. Later on they became much, much larger, and as they became larger, it was necessary now to start to specialize. One man couldn't do it anymore. So, people sort of started diverging into their own areas. The best engineers seemed to end up as the operations guys. Guys like me, I liked putting the data together, making something of it, and then finally writing about it so that the people who needed to know would know what we had learned. I like words.

[1] Diborane: A highly toxic, flammable and reactive gas. Diborane is spontaneously combustible in moist air and may burn or explode upon contact with halogenated compounds.

The whole fluorine business was complicated in a number of ways. The reason people liked fluorine as an oxidant, as you understand, rockets use a fuel and an oxidant because they don't burn air. So they need something to burn the fuel with, and the people who did the theoretical work – Verle Huff, Sanford Gordon – they would calculate what sort of performance we could expect to get from any one of these propellants. And then when we got through calculating the best propellant combination by far, head and shoulders above everything else, was hydrogen with fluorine. Fluorine is monstrously reactive. It reacts with anything, anytime, anywhere. It's unbelievably difficult to control. Maybe when Ed comes up, he can tell you about some of the fun we had when we were trying to establish, set up a fluorine ignition system at Aerojet in California. Nobody believed what that stuff could do.

At any rate, as we proceeded along in the mid-50s, we decided that we would build this rocket engine test facility, much larger than anything we had done before. We're talking 20,000 pounds of thrust. And at that time, the biggest we had done was 5,000, and much of the work was at much smaller engines. And the facility, a very complicated one, and I'm sure that Bill, or Gene, or Ed can tell you a lot more about it, was designed to burn hydrogen with fluorine. Therefore, the key, the central portion of this facility was this monstrous scrubber, the idea being to wash out the fluorine exhaust gases, react them into I believe calcium fluoride, something that was inert and not dangerous. Very complicated facility.

So, specialties derived from this. At this point, I'm not sure where we want to go...prompt me.

There was never a question as to liquid hydrogen being the absolute best fuel on earth. You asked me not to say anything that was too technical, but there are two things involved in the rocket propellant as far as capability – the temperature that you can achieve, or the energy that you can derive from the fuel. And hydrogen has the highest energy of any fuel that I can think of – 54,000 BTU a pound. Gasoline is 18,000. The other thing is the molecular weight of the exhaust products. Hydrogen is the smallest, simplest molecule, and will derive, therefore, in the exhaust products, the smallest molecular weight. So that the higher the temperature, the lower the molecular weight, the higher the rocket performance. And hydrogen was on top of the list. If you mated hydrogen with fluorine, you got monstrous benefits, both in temperature and in molecular weight. But, fluorine can be handled with great difficulty. And, at that time, Lab Director Abe Silverstein, probably the most brilliant engineer I ever knew. He was one tough son of a gun, but he was brilliant. He could sit there and go toe to toe, technically, with any expert on any subject at the lab. He was fascinating to watch. And when he looked at the information, the data, and looking at something that was going to work, not just be a hoped-for ideal, he decided that hydrogen would be run with oxygen. We would downgrade the fluorine effort, and concentrate on oxygen. So the initial work at South 40, RETF, Rocket Engine Test Facility, was done with hydrogen and oxygen. And the point here was to find out how good a propellant hydrogen really is, how well it cools, how high a performance we can derive from it. And that was the start of the initial work.

We ran some uncooled engines, and then we ran regeneratively cooled engines with hydrogen and oxygen. Regenerative cooling is a system whereby the fuel is introduced at one end of the thrust chamber, is used to cool the chamber so it stays together with this 5000 degree heat inside, and then finally is brought back into the injector and burned. Regenerative means that the heat lost from the combustion to the coolant is regained when the propellant is injected into the combustion chamber. We had some interesting experiences there, and we pretty well proved, yeah, the stuff is great. Performance is great. If you design properly, it cools beautifully. We know how to handle it. We are learning how to handle it. Hydrogen's biggest problem is it is extremely cold. It is liquid at 420 degrees below zero. It's also extremely light. Water weighs 62.4 pounds per cubic foot. Hydrogen weighs about 4-1/2 as a liquid. So that's one of the problems with hydrogen. The oxygen is relatively easy to handle compared to the hydrogen. And, of course, the fluorine was just out of the question.

Bill Goette would know about other facilities in the United States that could be used for testing hydrogen at the time. When did Pratt & Whitney start – there were a number of people that had done things. And I think John Sloop mentions them. There was an extensive effort begun at Pratt & Whitney down in Florida. And, in fact, they eventually developed the RL-10 engine which powered the Centaur. And Bill Goette was, of course, the manager of that engine during its development.

So there was other work being done, but this I believe at the time, was the largest facility, thrust-wise handling hydrogen and oxygen.