THE DEPARTMENT OF ENERGY ORAL HISTORY PRESENTATION PROGRAM

OAK RIDGE, TENNESSEE

AN INTERVIEW WITH BILL MANLY

FOR THE

OAK RIDGE NATIONAL LABORATORY ORAL HISTORY PROJECT

INTERVIEWED BY

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FEBRUARY 14, 2003

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STOW: Today, we're talking with Bill Manly. Bill came to Oak Ridge National Laboratory in 1949 with a degree in metallurgy from the University of Notre Dame, and he joined the Metallurgy Division here and spent his entire career with ORNL. He has a long and distinguished history at ORNL and a lot of good stories to tell. Bill, you came to ORNL in March of 1949, I believe.

MANLY: That is correct.

STOW: What were the circumstances that brought you here?

MANLY: Okay. My major professor at Notre Dame knew a guy at Johns Hopkins, and he told my professor, "Hey, they're starting a new Metallurgy Division down at Oak Ridge National Laboratory" He said, "Maybe you should send your guy down there." Well, my major physics professor said, "Well, Oak Ridge is over with these days. I wouldn't go there." But, anyway, I came down for an interview and liked what I saw, so I decided to join the Oak Ridge National Laboratory Metallurgy Division, and, as you say, I arrived here in March of '49.

STOW: Had you heard of Oak Ridge before that?

MANLY: Just a little bit. I'd heard about the atomic bomb when I was on a ship between Pearl Harbor and Guam. Like I said, we had a skipper who was a nice guy. He put us ashore, and we had a beer bust for two days -- in and out. That's the first time I heard about the atomic bomb. And, when I heard about Oak Ridge, I only heard about it in kind of a negative way from a physics prof. But, it was much better than what I had heard from him, when I got down here to see what it was like.

STOW: Well, you say it was much better. What were living conditions like for you when you got here?

MANLY: Could I tell you about how I got my house?

STOW: You can tell me anything you want.

MANLY: Okay. Well, when I was down here for an interview, people told me about the rules for getting A, B, C, or D housing -- and what rules you had to follow.

STOW: Yes.

MANLY: To get a three-bedroom house, which is a D house, you had to have two children of the opposite sex, and one of them had to be over six years old. Well, after I went through the interview, I decided, "Well, I guess maybe I would like to come here." In my exit interview with the personnel people, he said, "What house do you want to put your name on?" I said, "A D house." He said, "Well, didn't you hear what I told you about it?" I said, "Yes." He said, "Don't you know a man could marry a woman who already has two children of the opposite sex -- and one of them over six years old." So, that's the way I got my D house.

STOW: (laughs) Did you meet your wife after you got down here?

MANLY: No, sir. She was working for my major professor at Notre Dame. That's the way I got to meet her. And, I hate to say this, but I dated her on a dare from a friend of mine ... an ex-Navy

guy. He said, “You couldn’t date that girl.” So, I said, “Well, we’ll see whether we can.” So, I did and our dating led to a marriage.
STOW: (laughs) And a D house too, no doubt.

MANLY: And D house, yes. Yes, very good.

STOW: You won on both counts there.

MANLY: Right.

STOW: What were the projects, or what project was it that you were on when you got here in 1949?

MANLY: Okay, very good sir. When I first got here, we had the Clinton slug problem and the Hanford slug problem. And, we were also worrying about the ductility of beryllium and what to do with it. So, my first job was working on the Clinton slug problem and the Hanford slug problem. And, most of the problem was that we weren’t canning the uranium correctly, and the cans would fail a little bit and terrible oxidation would result. That was the Clinton slug problem. So, we used what is called an aluminum-silicon brazing alloy to make the heat transfer between the slug and the can. That stopped that. The Clinton and Hanford slug problem was due to the fact that under radiation and heat transfer, the uranium would expand.

STOW: Yes.

MANLY: Okay. We figured out a special heat treatment for the uranium so we’d get to what is called a “phase and quench” and then use the aluminum-silicon dip. And, that solved the Hanford slug problem.

STOW: But were the Hanford slugs canned in aluminum, also?

MANLY: Yes, sir -- both the Hanford and Clinton slugs were.

STOW: And that work, of course, was the basis for an awful lot of what evolved into the Metallurgy Division expertise in welding and metallurgy?

MANLY: Well, yes. That really started in the Aircraft Nuclear Propulsion, or ANP, program in the mid-1950s, which we’ll get to here in a little bit. And, then the other problem we first looked at was the low ductility of beryllium, which was used for the moderator [to low down neutrons emitted by uranium undergoing fission]. As a matter of fact, when I joined the division, the director John Frye said, “I want you to find out what’s wrong with beryllium and why it can’t be ductile.” I had to deal with beryllium at that time, in the Aircraft Nuclear Propulsion Program, in the ORNL gas-cooled reactor program, and later on in my career with Cabot, where I headed a beryllium division. So, what’s interesting to me is that I’ve been tinkering with beryllium for decades, and it’s still not ductile.

STOW: Have you ever been concerned about working with beryllium. I mean, we know today that it’s very toxic or can be. And, even back in the 1940s they knew that.

MANLY: That is correct. Well, we were fairly careful about it. The big thing you had to worry about was the dust. ...

STOW: Yes.

MANLY: ... or the fumes. As long as we were very, very careful [to prevent dust or fumes from spreading], for the most part, I didn't worry about beryllium. There for a while, they also told us if you get beryllium in a cut, it was also bad, but that turned out not to be true.

STOW: Well, when you say beryllium, I think automatically of Y-12.

MANLY: Yes sir.

STOW: Now, did you do any work over at Y-12 with beryllium?

MANLY: No, I did not. But, in the Materials Test Reactor, which was one of the first big projects for the Laboratory, the beryllium reflector moderator had to have big cooling holes in it. The people at Y-12 drilled the deep holes.

STOW: How deep do you mean?

MANLY: Well, I would say the holes were a good thirty or forty inches deep along the length of the beryllium piece.

STOW: Well, one of the projects that really underlay a good bit of your career was the project dealing with a reactor for aircraft propulsion.

MANLY: That is quite true.

STOW: That started when, about 1950 or so?

MANLY: Originally we had a program called NEPA, which stands for Nuclear Energy for Propulsion of Aircraft. And, it was started by, not the U.S. Air Force, but by the United States Army Air Corps, and it was run by Fairchild Engine Corporation.

STOW: All right.

MANLY: And, then, in 1948, the Lexington Report by MIT staff came out. It told the Atomic Energy Commission that it made sense to think maybe a possibility existed to fly an airplane with a nuclear power plant. After the Lexington Report, our first real start of work on the nuclear aircraft was under way here at Oak Ridge. It focused on looking at the various coolants. We looked at all kinds of liquid metals, such as sodium, a sodium-potassium dimer, and lithium. And, we also looked at a few molten salts as potential coolants for the aircraft reactor. I think this work really started the Metallurgy Division. The first thing we did was run various small-capsule tests to see the compatibility of various metals with each other and with various coolants. We used iron capsules primarily for the containment of the sodium. Then, we'd put various metals or alloys inside it. Then we learned of the existence of "dissimilar metal transfer." What happened is that some of the other material would go into solution and then alloy with the iron, recoating it.

STOW: Okay.

MANLY: We'd make individual tubes of the metal that we were checking and that way we didn't get the alloy. But, then we found out about another phenomenon called dissimilar metal mass transfer, or thermal gradient mass transfer.

STOW: Right.

MANLY: And, we made thermal-convection loops, which have a hot zone and a cold zone. In certain metals we observed "mass transfers" from the hot end to the cold end.

STOW: Who's "we?" Who were some of your coworkers?

MANLY: Okay. Well, in the early days John Frye was the director of the Metallurgy Division. Bob Crouse was in charge of metallography. A G. H. Anderson was in charge of mechanical metallurgy. Ed Boyle had the back end of what we called the melting and casting operation. Gene Banker was an administrative assistant. And, Gene Stansberry of the University of Tennessee was the consultant to the Lab for a long time. And, when we got ready to do a lot of stuff for the ANP program, a new crowd came in. People like Jack DeVan, Clyde Hamby, Bob Clausing, Don Douglas, Ray Trotter, Gene Hoffman, and Jim Weir. And, then the Air Force sent people down here. I had on my staff a Captain Merrill Whitman and Jim Hill, whom we all know about in this town. He was very prominent in the Aircraft Nuclear Propulsion program in those days. And, Major General Donald Kern was in charge of the program. He put the people I mentioned around in various and sundry places. What happened was that, when the Lexington Report came out and the Atomic Energy Commission took over, then NEPA disappeared. Some of the people came to work at Oak Ridge National Laboratory. The first company that was hired at the Atomic Energy Commission was General Electric, up in Cincinnati. They took over a lot of the people from NEPA, and some of the GE people came to Oak Ridge National Laboratory. Then, the General Electric people wanted to look at what we call a "direct-cycle" reactor, in which the air goes right through the reactor out to the engines.

STOW: All right.

MANLY: And, the people at the Laboratory, especially Dr. Alvin Weinberg in his brilliance, felt that this was not the best way to do things, because you had to worry about the temperature coefficient of reactivity. He said that he would rather see [a reactor design] where the fuel would expand and help you with having a negative temperature coefficient. So, we were looking for a better coolant than air for the reactor proper. So, we worked and worked on this. We did come up with an Aircraft Reactor Experiment that Ed Bettis was in charge of. The ARE ended up with uranium oxide fuel in stainless steel cans, which were cooled by a molten salt consisting of mixed fluorides -- zirconium fluoride and sodium fluoride. It was a molten-salt coolant.

STOW: Yes.

MANLY: Then later, of course, we tried using the fused salt fuel for a reactor. We worked hard on that. About this time, Pratt and Whitney came to the Lab and looked at what we called the indirect cycle, while GE was looking at the direct cycle. Okay?

STOW: All right.

MANLY: And, a lot of people from Pratt and Whitney came down and joined our staff here at the Laboratory. Some of those people stayed around and have actually retired from here instead of going back to Pratt and Whitney.

STOW: Now, we know that we never did fully develop an aircraft with a nuclear reactor as a power source because of a bunch of problems there, including the weight of the shielding. As you

look back, what do you think were the major reasons why the government never really did successfully get an aircraft off the ground?

MANLY: The power versus weight ratio [was less than ideal].

STOW: Yes.

MANLY: You mentioned the shielding, which posed an interesting problem, though. We knew we couldn't shield the crew compartment completely.

STOW: Yes.

MANLY: So, we shielded as much of the reactor as we could. We had a crew shield around that, all right. And, that brings up a fellow named E. P. Blizzard ...

STOW: I've seen the name.

MANLY: ... And, he started the Tower Shielding Facility, which still exists here. And, we worked with him on various kinds of shielding materials. In the crew shield, you wanted to have a material that when it accepted a neutron, it was kind of gentle, what would come secondary. Okay?

STOW: Yes.

MANLY: So, we looked at an aluminum-lithium alloy as part of the crew shield. The interesting play on that alloy was the company that we dealt with up in Michigan. Aluminum-lithium is not the easiest thing to melt and cast. The company had a fire and lost its foundry.

STOW: (laughs) Well, there were many benefits for ORNL that came out of the nuclear aircraft program, even though we didn't get an aircraft off the ground. We got the Tower Shielding Facility out of that. Some reactors were developed as a result of that. Can you expand on that a little bit?

MANLY: Yes, right. Well, first of all, I'd like to beg the question just a minute and say, as far as I'm concerned, the Aircraft Nuclear Propulsion Program built the Metallurgy Division. All right?

STOW: You think so? All right

MANLY: Strictly, I know so.

STOW: Good.

MANLY: In those days, when the division started, we didn't have a welding or brazing laboratory. We didn't have a nondestructive testing group. We didn't have a corrosion group. We didn't have a powder group. As a result of the needs of the Aircraft Nuclear Propulsion Program, we built all those kinds of laboratories.

STOW: All right.

MANLY: Pete Patriarca was in charge of the welding and brazing lab. Jerry Slaughter worked for Pete. Sloan Bomar and George Adamson were in powder metallurgy. Nondestructive testing was led by ??? Allen and then Bob McClung.

STOW: Okay. I know that name.

MANLY: And, we had to have a nondestructive testing group because the tubing that we used for heat exchangers and radiators was only ten-to-fifteen millimeters thick. So, you had to be pretty darn right that the tubing had no flaws.

STOW: Yes. I understand.

MANLY: So, another result of the ANP program was the creation of the reactor engineering group. Those engineers learned how to pump fused salts and liquid metals, how to build big thermo-convection loops and big pump loops, and how to make the valves work. So, that's why the metallurgy and reactor engineers here got a heck of a break out of the Aircraft Nuclear Propulsion Program.

STOW: Of course, there was the Reactor Chemistry Division too, wasn't there?

MANLY: Yes. The Reactor Chemistry Division. Warren Grimes and his teams came up with various fluoride salts [as coolants for molten salt reactors]. Yes. And, I might say that there was always a little "friendly" competition between Warren and myself.

STOW: Who won most of the time?

MANLY: Well, I think it was a draw.

STOW: You begged a question a moment ago about some of the reactors and other technologies that grew out of that program. Tell us a little bit about that.

MANLY: Well, we already talked about the Aircraft Reactor Experiment. Then along came the Molten Salt Reactor Experiment, or MSRE. That was led by Walt Jordan and later H. G. McPherson. We built the famous Molten Salt Reactor Experiment, proving the point that you could have a nice liquid [molten salt coolant in which the nuclear fuel was dissolved], bring the reactor molten salt to a high temperature [at a low vapor pressure, and make power. It was a very good experiment. [The higher temperature increased efficiency and the lower vapor pressure enhanced reactor safety and lowered the mechanical stress on reactor components.]

STOW: Now, at least one famous alloy came out of that program, didn't it?

MANLY: Hastelloy N. The story behind Hastelloy N was that we were using stainless steel and Inconel, a nickel-chromium alloy with a little bit of iron that was added to take in the chrome.

STOW: All right.

MANLY: The trouble was that the fused salt would extract the chromium [from the tubes used to carry the molten salt coolant in which the uranium tetrafluoride fuel was dissolved]. The chromium would react with the uranium tetrafluoride (UF_4) to make chromium fluoride, a reaction that was temperature sensitive. So, you could actually mass transfer chromium from a hot zone and deposit it in a cold zone. So, that [situation motivated us] to find a better alloy. We

knew the alloy we needed had to have a certain strength, a certain oxidation resistance, and the ability to handle fused salts. Well, in those days, I was very close to the people at International Nickel Company's research lab up in New Jersey. The INCo people made arrangements for me to go up and talk to the guy who really knew the alloy business. He and I came up with six alloys that I brought back to the Lab, and we did various tests with them. I saw we needed to adjust the chemistry a little bit. So, the last alloy we made was what we called INOR-8. "IN" stood for INCo and "OR" stood for Oak Ridge.

STOW: For Oak Ridge. Okay.

MANLY: And, a guy at the Lav who did a lot of the work was Hank Inouye. He did an awful lot of the day-to-day development and testing of Hastelloy-N or INOR-8 -- whatever you want to call it.

STOW: Well, Hastelloy is used commercially, fairly widely today, isn't it?

MANLY: Hastelloy is, yes. Hastelloy-N also got a place in the Navy reactors as a canning material for the pumps, because of its magnetic characteristics.

STOW: Early technology transfer out of ORNL, right?

MANLY: That is correct, sir.

STOW: You have had some involvement with tech transfer over the years, have you not?

MANLY: Yes, I have.

STOW: Can you expand on that?

MANLY: Well, I did it when I was here. We tried to get various companies involved [in developing our alloy into a commercial product]. I'd tried to get Hayne Stellite involved in our alloy development without a lot of success when I was here. And later, I was able to take care of that. But, INCO did a lot and we worked also with the tubing companies. The famous tubing company we worked with is Superior Tube Company in Morristown, Pennsylvania. We worked with them to make really high-quality tubing. We also worked with an extrusion company up in Michigan to make tubing blanks from INOR-8, or Hastelloy N.

STOW: Well, Hastelloy is a big alloy today. Much bigger now than it was back then.

MANLY: Oh, yes. Right. That's quite true.

STOW: You mentioned Alvin Weinberg a moment ago, and said, "... in his brilliance." Did you have a lot of interactions with Alvin?

MANLY: Well, I was put through my paces at our annual and monthly meetings.

STOW: He sat down in front...?

MANLY: He was right down in front and he always had the questions to ask, including the hard ones.

STOW: Did you have the answers?

MANLY: For the most part, I had good answers. He was quite a man. I'll always have great respect for him.

STOW: A man of great foresight.

MANLY: Well, he really was. He really was.

STOW: Yes, very much so. In 1957 the Laboratory got involved in a fusion energy project called Project Sherwood.

MANLY: Yes, sir.

STOW: You were involved with that, I think?

MANLY: Well, I was, briefly. I can't think of the name of the assistant laboratory director who came over from Y-12, but what happened is that he took me aside one day and said, "I want to tell you about Project Sherwood." So, he proceeded to tell me about it and said, "I want you to go to a meeting up in Washington, D.C. They're worried about how to get the energy out of the blanket." [A fusion reactor blanket, which can be made of lead and lithium, removes heat from the plasma fuel for power generation, serves as a shield to protect humans and components from radiation, and produces tritium as a fusion fuel (from neutron bombardment of lithium).] And, I said, "Fine, I'll go up there." So, I went up to Washington for what was supposedly to be a two-and-a -half-day meeting. I was supposed to talk on the half day. Well, all we talked about was radiation damage to the wall and other wall problems [resulting from interactions between the wall materials and plasma fuel]. And, so, the meeting ran over to the next day, and the guy who wanted me at the meeting said, "Hey, sorry about that." I said, "Hey, don't worry about it. You take care of the wall problems, and we'll take care of getting the energy out of the blanket on Sunday afternoon." That kind of hung around with me, I guess.

STOW: There's a story that the name Project Sherwood came about as an answer to the question, "Would you like to have cheap energy forever?" – a reference to the fusion process of producing energy.

MANLY: Right...

STOW: ... and the answer, of course is, "Sure would."

MANLY: "Sure would." That's right.

STOW: Any truth in that that you know of?

MANLY: I don't know that for a fact. No sir. All I know is that after I got back from there, they wanted me to have some metallurgist follow the fusion reactor business. So, I picked Bob Clausing, the youngest metallurgist we had. I would say we're still twenty or thirty years away [from having a commercial fusion power plant].

STOW: From fusion energy ...?

MANLY: That's right. At least that.

STOW: Do you think that we will get there at some point?

MANLY: We'll eventually get there, I think. Yes, we'll eventually get there. It's probably thirty years away, though.

STOW: All right. What happened after the Aircraft Nuclear Program? Where did your career go at that point?

MANLY: Well, about that time it was kind of cooling down. Members of Congress had been over to England and saw the wonders of the Magnox carbon dioxide–cooled, graphite-moderated reactors. And, they came back and decided we really should develop gas-cooled reactors in the United States. Well, Bob Charpie as team leader took Bud Perry, Mike Bender, and me up to Washington. That trip started work here in Oak Ridge on the gas-cooled reactor program.

STOW: And, you were manager of that, weren't you, for a while?

MANLY: Yes, from 1960 to 1964. After Bob Charpie left, I took over the management of the gas-cooled reactor. Yes.

STOW: The building for the first gas-cooled reactor project still sits out there in the 7000 area, right?

MANLY: Yes. I pointed out to my driver, "Take me out there today to where the EGCR, or Experimental Gas-Cooled Reactor building is."

STOW: But, that reactor never ran, did it?

MANLY: No, sir.

STOW: How come?

MANLY: Well, by that time, the politics changed. Other people were taking over reactor projects and private enterprise was looking at them. That was a time when General Atomics came along and [expressed interest in developing gas-cooled reactors]. Also, what changed was the way we handled the fuel for gas-cooled reactors. We started looking at pyrolytic graphite-coated fuel particles in a graphite matrix, which got to be a big thing. The United States worked very closely with a German, Herr Doctor Professor Shulten, who was in charge of the reactor over in Germany on this thing. And, it was interesting to note that Union Carbide had a fuel element plant down close to Lynchburg, Tennessee, the home of the famous Jack Daniels whiskey distillery. Carbide's plant there produced the fuel elements for the German pebble-bed reactor.

STOW: So, by the time our gas-cooled reactor got built and completed, it was outmoded?

MANLY: It was outmoded.

STOW: Yes. Right.

MANLY: The other interesting thing about the Experimental Gas-Cooled Reactor was that the British about this time were coming along with what they called the Advanced Gas-Cooled

Reactor. And they stated that the AGCR was going to use beryllium tubing. Well, I never could get excited about the beryllium tubing, so I asked Bud Perry this question: If we could use beryllium instead of stainless steel for tubing, how much reactivity would it save, and what is it worth? So, we did the calculations, and after going through that exercise, I bet people all over the world -- in Australia, Canada, France and Germany -- that there would be less than ten percent beryllium tubes in the British Advanced Gas-Cooled Reactor. I won those bets.

STOW: You had as much foresight as Alvin Weinberg almost.

MANLY: Well, I just knew how difficult it is to make beryllium tubing.

STOW: I understand. I understand. In the mid '60s, your career shifted a bit and you left Oak Ridge for a while, as I understand it.

MANLY: Right. I left here in'64.

STOW: All right. Can you tell us a little bit about what went on in your career at that point?

MANLY: Well, I'll tell you why I left, okay?

STOW: All right.
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MANLY: I was supposed to be on a team for the Atomic Energy Commission looking at various fuel element plants. I was supposed to leave at 7:00 the next morning, and, lo and behold, that night at dinner, I got a phone call to tell me I couldn't go because I had a conflict of interest because I consulted for Carbide on its Lynchburg fuel element plant I told you about. So, that night, I guess I drank one to many martinis -- I tried to find Clarence Larson, and, when I finally found him, I said, "Clarence, if Carbide wants my services, they'd better have a job for me, but no later than July the 1st. Well, they moved me out before then.

STOW: All right.

MANLY: So, I went to Carbide in New York. At that time I was director of materials technology for Carbide out of New York. Then, various things happened. The vice chairman of Union Carbide decided, after he was given Haynes Stellite to run and found out some of the things I used to say about it, that Haynes Stellite needed to be brought up to the twentieth century.

STOW: Yes.

MANLY: So, the next thing I knew, I was looking at all the various research labs that Carbide had in my [search for capabilities] that might be useful to move to Haynes Stellite. So, I gave a briefing to the vice chairman of the board; Bob Riney, who was the head of Haynes Stellite, Fred, who was executive vice president; and Bob Charpie, who was there. I gave a briefing for about two hours one Thursday. On a train home that night, Charpie said to me, "Manly, you oversold."

STOW: (laughs)

MANLY: Well, anyway, they just decided to move me out to Haynes Stellite and take care of all those things I said should be done there. So, that's how I got out to Haynes. And then, later on, what happened is that Carbide in its wisdom decided it was going to start what is called a Materials System Division, which basically was a good idea. The only thing is they took the

wrong people to run it. And so, pretty soon, the next thing I knew was that I was back living in Chappaqua, working in New York, trying to put together this Materials System Division. After about nine months of trying with various people, the management -- thank God! -- made up its mind to forget about it, and I was sent back to Kokomo to run Haynes Stellite for Carbide.

STOW: Was that a common practice at the time -- for Carbide to pull scientists and engineers from the Laboratory here and put them into corporate positions?

MANLY: I think the two people who did the most of that were Bob Charpie and Bill Manly -- because we knew people in industry.

STOW: Yes.

MANLY: And so, we took a lot of people out of here. I took a lot of people out of here to go to Kokomo, Indiana. We knew what their guys could do. We didn't have to waste any time.

STOW: Yes. Well, when did you end up back here at Oak Ridge then?

MANLY: Well, I didn't even come back here till 1986 when I retired from Cabot Corporation.

STOW: A long period in there then ...

MANLY: Well, what happened was that Cabot approached Carbide to sell Haynes Stellite to Cabot. As part of the sale, I had to go to Cabot for three years. So, I've jokingly said over the years, "I was sold into slavery to the Cabot Corporation, but it was pretty damn good slavery."

STOW: (laughs) Can't argue with that, can you?

MANLY: No sir.

STOW: All right. You've rubbed elbows with a number of people that are quite famous in science and engineering. You've mentioned a few of them. Do any stand out in your memory as individuals that really influenced your career, or that you have extremely high regard for?

MANLY: Well, I already mentioned Alvin.

STOW: Yes...

MANLY: And, the other one was his great honoree ...

STOW: Eugene Wigner?

MANLY: Eugene Wigner.

STOW: Yes.

MANLY: I didn't know him, of course, very well, but the thing is that Wigner was the person who said to the Laboratory, "You need a Metallurgy Division." So, I always thought how wonderful it was that he was smart enough to convince the Lab managers that they need a Metallurgy Division. I always thought H. G. McPherson was quite a guy. He came down here

from Carbide's Carbon Division [to provide his expertise on the graphite used for the Graphite Reactor]. And, he was here for the Molten Salt Reactor. So, I had a great respect for him.

STOW: What in McPherson's behavior and education stood out to make him an influence on you?

MANLY: Well, he really knew the graphite business.

STOW: Did he?

MANLY: He really did. And, he was -- how would you say it -- an easy going manager. One person we didn't talk about – and I should have -- was Ray Briant. He was brought here to run the Aircraft Nuclear Propulsion Program. I worked with him and I had great respect for that man. He was really good.

STOW: He was brought here from where?

MANLY: I think he came from Johns Hopkins. I don't remember for sure.

STOW: Okay, an academic position.

MANLY: You're right. But he ran the Aircraft Nuclear Propulsion Program. And, unfortunately, he passed away, and when he passed away, then the ANP Program was run by Walt Jordan and Sylvan Cromer.

STOW: Okay. You were not here in the early '70s. You'd gone off to Carbide at the time.

MANLY: Yes, I left here in '64.

STOW: And, I think I know the answer to this, but in the early '70s, the staff of ORNL's Metals and Ceramics (M&C) Division [the replacement name for the Metallurgy Division] got very much involved with the Emergency Core Cooling System (ECCS) hearings that were set up by the Atomic Energy Commission.
Were you involved in any way with that, or have any insights on that?

MANLY: No, sir. I had nothing to do with that.

STOW: Okay. I thought that might be the case. You've gotten a lot of awards over the years. You received an award from the National Research Council, with a three-year appointment to the Army Science and Technology Board. You've gotten an ASM International Award with a 1987 Medal for Advancement of Research. Perhaps the most prestigious award you received was the National Medal for Technology in 1993 from the Department of Commerce. And, you were awarded an honorary doctorate in engineering from Notre Dame.

STOW: Does any one of those stand out in your memory as your best ever?

MANLY: Well, you didn't mention that I was elected to the National Academy of Engineering. That was probably the biggest surprise I had. The other award that was a real surprise was my honorary doctorate degree from Notre Dame. I knew about the National Medal for Technology. The news spilled over to me from my secretary and from Gene Hoffman and Gerry Slaughter. I

heard too many things I wasn't supposed to hear, I guess. So, it wasn't a big surprise when I heard about it.

STOW: Well, you realize, you're the only ORNL staff member to ever get that award.

MANLY: Well, it's due to people like Gene Hoffman, Gerry Slaughter, and Lou Pyatt, my secretary. They are the ones that deserve it.

STOW: Well, it always takes more than one person. No question about that. Let's talk about academics just for a moment. You received a master's degree in metallurgy at Notre Dame and then an honorary doctorate. Where'd you do your undergraduate work?

MANLY: I started at Antioch College in Ohio and then volunteered for the Marine Corps, which sent me to Notre Dame as kind of a holding pattern ...

STOW: Okay.

MANLY: At the time, I could take various courses to get my commission at Quantico.

STOW: When in your career did you know you wanted to go into metallurgy or a similar field?

MANLY: At Antioch College. I was a co-op student and I worked at Battelle Memorial Institute in Columbus as a co-op student.

STOW: All right.

MANLY: I worked for a guy by the name of E. C. Cronan, whom I'll never forget. And, he had me doing centrifugal casting of brass and bronze, as well as some work on magnesium. One day he said to me, "Why the hell do you want to be a chemist? What do you want? Why don't you be a metallurgist?" I said, "Well, what the heck's a metallurgist?" He said, "What you're doing now." So, when I went back to college, I talked to the professor in charge of the chemistry department.

STOW: Yes.

MANLY: And, I said, "Hey, can we have a course in metallurgy?" So, he was nice enough to add a special course in metallurgy to the department. Boy, I aced every exam in that course, I'll tell you.

STOW: And, here you are.

MANLY: And, here I am as a metallurgist.

STOW: It's funny how life hits little curves like that every now and then and takes funny twists.

MANLY: Right.

STOW: As you look back on your career, especially your career here at Oak Ridge, is there any single incident or single accomplishment that stands out that you're most satisfied with and most proud of?

MANLY: I'm most proud of the fact that we built a Metallurgy Division at Oak Ridge National Lab.

STOW: Oh, yes.

MANLY: And, I would say that working hard to recruit the right people and get the right equipment so that we had a number one Metallurgy Division was the key accomplishment of my career here at Oak Ridge.

STOW: If you look back and take the present day M&C Division and look back to even before you came here to 1943, you can see some strong ties between what goes on in the M&C Division today and what the challenges were back in 1943, when they were building the Graphite Reactor and forming the cans to encapsulate the uranium. Do you have any thoughts on that and ties that people might be interested in, to relate our present strengths in M&C back to the very early days?

MANLY: Well, we did a lot of work on ways to handle uranium, such as extrusion and heat treatment, which we then followed through on. Probably the more important work we did concerned beryllium in those days, because that work followed through in our many, other products. We really cut our teeth, so to speak, on the Materials Test Reactor.

STOW: MTR.

MANLY: The MTR. And then, the other issue, of course, was that in those days, you used 93 percent enriched uranium in the early research reactors.

STOW: Yes.

MANLY: At the first "Atoms for Peace" conference that the United Nations sponsored in Geneva, Switzerland, the organizers thought about having a reactor over there. It was going to be called the Eisenhower Reactor. The only stipulation was that uranium with 93 percent enrichment could not be used. We had to go down to 20 percent enrichment. So, that meant we couldn't make a uranium-aluminum alloy as our sandwich. It had to be uranium oxide and aluminum. We learned quite a few lessons because you've got to be really careful how you handle the fuel elements so as not to get them heated up too much. If too hot, the aluminum and uranium oxide would react with each other, and if that happened, more than a few failures would result. So, it is interesting to note that the last fuel element we made was done the night before the airplane took off for Geneva with the reactor.

STOW: (laughs)
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MANLY: We came awfully close.

STOW: Right down to the wire. We still do it today like that.

MANLY: I'm sure that's true.

STOW: Did you go over to Geneva?

MANLY: Not that time.

STOW: You went over in '58?

MANLY: Jack Cunningham went over to Geneva that year, and he should have because he was the one in charge of making the uranium-aluminum fuel plates.

STOW: Yes. That reactor was a real hit, wasn't it?

MANLY: It really was a hit. It really was, yes.

STOW: I think we left it over there with the Swiss. They bought it from us, didn't they?

MANLY: We did. We did, yes.

STOW: And, then we went back in 1958 ...

MANLY: Yes, I was in on that one.

STOW: Were you? Tell us a little bit about that.

MANLY: Well, that device demonstration was on fusion.

STOW: Yes.

MANLY: So, I went over to Geneva because I had been exposed to fusion. And, Bob Charpie, who was in charge, said to me, "I want you to go." So I went. And, the interesting thing to me was that, also at that particular time, a famous president of the University of Notre Dame was there to represent the Pope. I had the pleasure, for two days, of showing him around the whole fusion exhibit. So, that was kind of a highlight in my life. When I went back to Notre Dame, I could always relate to him about things like that.

STOW: Was that the exhibit that supposedly took ten hours just to see the United States part of the exhibit?

MANLY: That is true. That is true. It was all about fusion energy.

STOW: Now, we were locked deeply into the Cold War with the Soviets at that time.

MANLY: Yes, we were.

STOW: Were you tracking what was going on in metallurgical development in the Soviet Union?

MANLY: The answer is yes. That's about all I'll say.

STOW: You can't tell me anymore than that? Would you have to shoot me?

MANLY: No, no. We used to keep track of various people.

STOW: Yes.

MANLY: It was interesting that at the Geneva conference, you'd meet those guys and pretty soon, you'd see a sign that they know who the hell you are.

STOW: Yes.

MANLY: And, I'm sure I did the same thing when I found out who they were.

STOW: Amazing.

MANLY: We knew each other and something about their careers. But it was a lot of fun.

STOW: Would they share information with you?

MANLY: Up to a point.

STOW: Up to a point, huh?

MANLY: Just like we would do, up to a point.

STOW: Were you briefed before you went over there by the governments?

MANLY: Yes, and, also what to try to find out.

STOW: As you look back on your career -- and I asked you a moment ago about things that you felt especially proud about -- can you think of anything that you wish you had accomplished but didn't, or you tried to do and failed at it?

MANLY: When I was here at Oak Ridge, I was going to graduate school to get a Ph.D. degree. I already had my thesis topic picked out and was working on that. The topic was the effect of the environment on the mechanical properties of metals. But, by that time, I was getting too tied up with work, so I never got my thesis done. So, you might say my biggest disappointment was that I didn't go ahead and get my Ph.D. But, Notre Dame did give me an honorary doctorate later on, so I guess it's okay.

STOW: And, very richly deserved, no doubt.

MANLY: I hope so.

STOW: Are there other things that we need to touch on here -- individuals that influenced you in one way or another?

MANLY: Well, let's see.

STOW: Or, topics that we haven't discussed?

MANLY: Well, I mentioned Jordan and McPherson. We mentioned the Tower Shielding Facility. The other guy that should be mentioned in connection with the Gas-Cooled Reactor Program is Leroy Jackson of the local Oak Ridge Operations of the Atomic Energy Commission.

STOW: All right.

MANLY: Because he really did an awful lot in furthering the interest here in Oak Ridge in the Gas-Cooled Reactor Program. I remember Leroy. He and his wife and two children used to walk by my house on New York Avenue on the way to the drug store practically every evening. I got to see him both as a father and as an administrator.

STOW: Do you still live in that D house?

MANLY: No sir, I don't. I left there in 1964.

STOW: Is it still standing?

MANLY: Yes, sir. It's still there. What's interesting to me is that the Gas-Cooled Reactor Program at ORNL provided opportunities to send people to various and sundry places. Al Goldman spent a lot of time in England for the Gas-Cooled Reactor Program. So did Johnny Coves, a resident of Norris. Bob Swindeman was sent to Australia with the Gas-Cooled Reactor Program. And, every so often, I see Bob and his wife, and she makes a point of thanking me for sending Bob over to Australia, where he married her and then brought her to the United States. Also, ORNL's High Flux Isotope Reactor, or HFIR, was an outgrowth of the MTR. The fuel elements for MTR, the Eisenhower Reactor, and the swimming pool reactor at the Bulk Shielding Reactor and Oak Ridge Research Reactor -- all those are the same type of technology. The MTR was the "father" of all those other reactors.

MCLAUGHLIN (assistant interviewer): And, a father of major design features that were promoted around the world.

MANLY: Right. Well, let's go back to beryllium. A beryllium reflector to reflect neutrons back into the reactor core could not be made using normal metal-working techniques. We had to cast a big beryllium ingot, machine it to produce chips, collect the chips and powder, and make the billet by powder metallurgy techniques. Using these techniques, Brush Wellman did a nice job of giving the beryllium some degree of improved ductility and machinability. We worked with this company. I also competed with them when I was with Cabot running a beryllium program. They're nice people to compete with. We should remember that the Solid State Division got its start in the Metallurgy Division. Doug Billington, Jim Wilson, George Murray, Oscar Sisman, and Tom Blewitt, were with the Metallurgy Division before part of it became the Solid State Division in its own building.

STOW: Go back and explain to us exactly how the Solid State Division got started in the Metallurgy Division. What were the projects that they were working on that got the new division kicked off?

MANLY: Well, I would say a lot of it came from the in-pile reactor studies. Tom Blewitt, Doug Billington, and their colleagues were what we called "long-hairs" because they were doing deeply scientific work, pretty academic stuff. So, the Solid State Division was formed as an outgrowth. The Metallurgy Division nurtured these physicists until they got big enough to go out on their own.

STOW: Was that back when John Frye was division director of the Metallurgy Division?

MANLY: Yes. After John Frye came Jim Weir, then Doug Craig, then Everett Bloom [and more recently, Steve Zinkle and Gene Ice].

STOW: A very distinguished group of individuals. What have you done since you retired?

MANLY: When I retired and went to Kingston, I became chairman of the city's Industrial Development Group. I was pretty active in Bethel Presbyterian Church and also in the Methodist Medical Center of Oak Ridge. I was chairman of the board of Methodist Medical Center for quite

a time and also active in its foundation -- in its money. Also, I worked quite hard with the Community Reuse Organization of East Tennessee, or CROET [for revitalizing former DOE properties for hosting industrial firms and creating jobs]. I've also consulted with a bunch of companies, like ATI. I was a consultant for another little start-up company for a long time. I have always enjoyed working in tech transfer. But, I finally decided that due to my inability to get around quickly, it's better if someone wanting to consult with me would come to my home. I've been known to give a little money away occasionally. That's one reason why he has always taken care of me [points to Dave McCoy sitting in room], so he'll get a little bit more money from me for the Methodist Medical Foundation. (laughter)

STOW: You must be right, because he's agreeing with you, shaking his head but agreeing. Do you still do any consulting out here at ORNL?

MANLY: No. If they want to talk with me, they can come to my house. We'll just sit in my house and talk. Some people still come to see me occasionally, and it's fun. I enjoy it. It keeps me active.

STOW: Oh yes.

MCLAUGHLIN (assistant interviewer): I've heard famous stories [about that house].

MANLY: I probably started buying the land in about 1978. I made a deal to buy any other land contiguous with mine. At first it was just a house here and an old barn there. A friend of mine, Ralph Shuster, who used to be a technician in the M&C Division, decided he'd like to live there and take care of the land for me, so I agreed and he did. And, he's still living there, by the way. I put a trailer on the land, and my wife came down in the summer and spent a lot of time here. The corporate plane owned by the Cabot Corporation would fly me from Kokomo to Knoxville on a Friday night and pick me up on Monday morning and take me back to do my duties for Cabot Corporation. Then I built a big gray building that had all kinds of space up above for bunk beds and other stuff. And, down below it had a big place for entertaining and holding conferences, as well as a big kitchen. The building was so big that I had to install exit signs so people could find their way out.

Then I built a great big blacksmith shop with three power hammers and various anvils and forges. We used to have four parties a year out there. We'd have a "hog roast" in the spring for friends of mine from Kokomo and around. We'd roast a couple of hogs and have them for dinner. I also had a "Little Big Band" that Berta Swain [talented piano player] was in charge of. She used to bring her band down, and we'd have a big time down there under a big canvas. Then on the 4th of July we'd shoot fireworks – I've always been a nut about shooting fireworks. I'm worse than any kid. I used to go shoot off an awful lot of fireworks down there on the 4th of July. And then, since I had a swimming pool on my land in Kingston, the church congregation decided to hold a big swimming party at our place in August, after which we'd have a big dinner party for the members of the church there.

Then, the big stand, of course, was Christmas time. A band that was in the Artists-Blacksmiths Association of North America would have their annual Hammer-In and Christmas party. Those are some of the festivities we had. Then, of course, various people would use the facilities -- like the hospital did and various people would use the facilities. So, it was a good life. Then, when I decided to move after Jane died, I decided to move from Kingston to Oak Ridge. I took anything that had to do with blacksmithing and gave it to the Conner Prairies Farms, which is northeast of Indianapolis. So, they got all my blacksmith stuff. Roane State Community College received an awful lot of my art and book. The Jane and Bill Manly Art Exhibit is located at Roane State.

STOW: Was your interest in blacksmithing a result of your metallurgical background?

MANLY: It is interesting how that got started. A friend of mine on the west coast -- a professor out there -- wrote an article about iron and aspects of blacksmithing. And so, I called him on the phone. I said, "Are you sure about this stuff? I have a hard time believing it." So, he sent me a bunch of references. Well, all the references had to do with blacksmithing. So, I started reading all this stuff. People would ask me, "Hey, Manly, what the hell are you going to do when you retire?" I said, "I'm going to be a blacksmith."

STOW: (laughs)

MANLY: So, that's what I did.

STOW: Good.

MANLY: Is that it?

MCLAUGHLIN (assistant interviewer): Tell us about the Boy Scouts.

MANLY: Oh, okay. When I got to Oak Ridge, I joined a Presbyterian church and I noticed they needed a Boy Scout master. So, I was a scoutmaster there from 1949 to 1964, when I left here. At various other places I was a scoutmaster or district chairman. I always had a fond spot in my heart for Boy Scouting. And, I had all kinds of badges and patches. Not too long ago, I gave them all to the Great Smoky Mountains Council. So, down at Buck Toms, is the Jane Manly Scout Museum, which has all the stuff I collected over the years going to jamborees and so on.

STOW: A lot of community outreach, to say the least.

MANLY: Yes.

STOW: Very fine.

MCLAUGHLIN (assistant interviewer): I understand when you retired, a really special [stained glass] …

MANLY: Ray Evans. Yes. In that house, I had stained glass windows, one for Tennessee, one for Indiana, and one for Ohio. And, the one for Tennessee now hangs in Roane State. And, the one for Ohio hangs in the Morgan County Historical Association in my hometown. And, the one for Indiana -- my son who grew up in Indiana, so to speak, and also found his wife there [and] grew up with her – he's got the one on Indiana. A bunch of other stained glass I got. (laughs). That's a funny story. I used to go to all kinds of sales. Every weekend I'd have to go to a sale some place. And, a guy by the name of Don Marshan -- one of my best friends up in Kokomo, who passed away – went with me to one of the sales where they were displaying all kinds of stained glass windows. And, they were selling so cheap. I said, "Well, gee, this is terrible." So, I bought them all. And, we went up to pay and the lady said, "We won't take a check." And, Don Marshan said to her, "You'd better plan on another sale tomorrow then." So, she let me write a check for them.

STOW: Thank you, sir.

MANLY: My pleasure.

STOW: A fascinating interview.

MANLY: I hope you got what you wanted.

----------END OF INTERVIEW----------