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Oak Ridge Form 5: Oral History, Deed of Gift Release for Interviewee

DEED OF GIFT RELEASE FOR INTERVIEWEE
K-25 ORAL HISTORY PROJECT
U.S DEPARTMENT OF ENERGY'S ORAL HISTORY PROGRAM

I, Ken Ziehlke *(Name of interviewee)* residing at 114 Regent Circle *(Address of interviewee)* do hereby permanently give, convey and assign to the United States Department of Energy (DOE) my interviews *(or oral memoirs),* and the recordings, tapes *(audio and or video),* and any transcripts of my interviews conducted on 5/19/05 *(date)* at 104 Inn Ln #113 *(location).*

In doing so, I understand that my interviews *(or oral memoirs)* will be made available to researchers and the public and may be quoted from, published, and broadcast in any medium that DOE shall deem appropriate.

I further acknowledge in making this gift that I am conveying all legal title and literary property rights which I have as well as all rights, title and interest in any copyright which my be secured now or under the laws later in force and effect in the United States of America.

My conveyance of copyright encompasses the exclusive rights of reproduction, distribution, preparation of derivative works, public performance, public display, as well as all renewals and extensions.

I, Bart Callan, *(Name of interviewer or agent for or duly appointed representative of DOE)*, accept the interview *(or oral memoir)* with Ken Ziehlke *(Name of interviewee)* for inclusion into the DOE Oral History Program.

Signature of DOE or its Representative: [signature]
Date: 5/19/05

Signature of Interviewee: K. G. Ziehlke
Date: 5/19/05

Signature of Interviewer: [signature]
Date: 5/19/05

National Educational Technology Solutions LLC

K-25 Oral History Interview

Date: 5/19/05

Interviewee: Ken Ziehlke

Interviewer: Bart Callan

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Name/Org: Gary W. Snyder 721567 Date: June 28, 2005
Guidance (if applicable): CG-SS-4 September, 2000

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[crew talk] Mr. Ziehlke requested that no video tape be made of the interview – only audio. Video feed was blocked.

[1:01:02]

Callan, B.: Okay, we'll start out with the hard questions. Let's go ahead and, again, state your name and spell it out for me so we have it preserved on tape.

Ziehlke, K.: My name is Ken Ziehlke, Z-I-E-H-L-K-E.

Callan, B.: How old are you and where were you born?

Ziehlke, K.: I'm 77. I was born in northern Wisconsin, town called Medford and I came down here in 1950 after I graduated from college, University of Wisconsin.

Callan, B.: At the University of Wisconsin, what degrees did you obtain? What degrees did you get?

Ziehlke, K.: I received a Bachelor's degree in Mining and Metallurgical Engineering. Was -- that was the title of the major at the time and currently, I suppose its Materials Engineering or something similar.

Callan, B.: How old were you when you graduated?

Ziehlke, K.: 22.

[1:02:10]

Callan, B.: Why did you come to work at K-25? What attracted you to come? How did you hear about it?

Ziehlke, K.: In college there were industrial interviewers who made the rounds of all the engineering colleges at least, maybe all the colleges in the country. At the time, in the early post-World War II years, there were a lot of industrial recruit -- recruiters because the market had not been filled for a number of years because everybody was in the service. And at the time I interviewed in 1950, the market was almost saturated again and I had 20 or 30 interviews, probably, during my last year in college, and I got responses to a few of them and job offers from 2 of them. One of those was Union Carbide here at Oak Ridge and the other one was in South America, and the salary was the same. I didn't want to go to South America [laughing] for that. And it turned out to be a good decision because it was where I spent almost all my working life.

Callan, B.: How did you like working for Union Carbide?

[1:03:49]

Ziehlke, K.: I didn't have any objections; they were good to me, I suppose as good as anybody was. I don't know whether I could say they were an outstanding employer. They treated me fairly and I tried to do the same with them.

Callan, B.: When you first arrived out here and saw K-25, what were your first thoughts or your first recollections?

[1:04:23]

Ziehlke, K.: It was kinda big.

Callan, B.: Can you describe the building to anyone who's never seen or heard of it?

Ziehlke, K.: Well, at the time, they had a bus line, a bus system that served the town and also the three plants and there were regular buses that went to K-25, and I think maybe I took the bus. There was a terminal where the parking lot is now that serves Portal 4 and that was sort of central to the plant. You could access the whole plant from Portal 4 with a ½ or ¾ mile walk, I suppose. And I can remember the appearance of the bus depot. I can remember the Administration Building which has been torn down in the last couple of years.

[1:05:33]

And the Administration Building was where I reported for work. Personnel was there and since most of us as we came in did not have Q clearances, we couldn't go out into the plant, and we were restricted to certain areas in the Administration Building. We had a young lady as an escort if we wanted to go anywhere in the building that we were allowed to go, but we had to be accompanied by a Q-cleared escort.

Callan, B.: Do you remember what the name was of that room or area where people worked before they got their Q clearances?

Ziehlke, K.: In my -- I don't know if this was universal, but in my case, it was the Bull Pen.

Callan, B.: That's what it was.

Ziehlke, K.: Yeah.

[1:06:23]

Callan, B.: I've heard several people talk about the Bull Pen.

Ziehlke, K.: And there were, I guess, 20 or 30 freshly-hired engineers and a dozen or two young women who were, I believe, later assigned to Purchasing and who rose in the Ad -- Administration Building or the administration area.

Callan, B.: So how long were you in the Bull Pen before you got your Q clearance?

Ziehlke, K.: Oh, several weeks; 4 or 5 weeks, probably. I don't remember exactly.

Callan, B.: Okay. And you commuted to and from work on the bus?

Ziehlke, K.: Some on the bus and after I got used to where I was going, I had a car and so I commuted daily by automobile. Got into carpools of various sorts and maybe only drove once a week when I got into carpools.

Callan, B.: Sort of give me a breakdown of your work history, like what years did you work at the K-25 site and then did you transfer to one of the other laboratories like Y-12 or X-10?

[1:07:42]

Ziehlke, K.: I spent my whole time at K-25. I worked there for 35 years and pretty much all in the same working group.

Callan, B.: That was from what year range?

Ziehlke, K.: From 1950, I came in the fall of 1950 and I left in the fall of 1985.

[1:08:13]

Callan, B.: If people inquired what kind of work was done there, how would you describe it?

Ziehlke, K.: K-25 was the uranium enrichment facility that utilized the gaseous diffusion process. And that's, I guess, about as compact as their -- as you can describe their mission.

Callan, B.: What are some of your most vivid recollections of the time that you spent at Oak Ridge and K-25?

[1:08:49]

Ziehlke, K.: Oh, [laughing] there isn't anything that stands out with bells ringing, but I -- as I said I worked pretty much in the same department, the same function, the whole time I was there. There were variations, but the department title was Metallurgy Department and we did support work for all of the plant operations for the process operation and for all of the auxiliary support manufacturing services. We served the machine shop and the heat treat shop, the barrier plant, all of the sideline operations, the feed plant, the recirculating water system, all of those functions that were auxiliary to the -- keeping the diffusion process in operation.

Callan, B.: Not knowing much about metallurgy, kind of describe to me what sort of things you did.

Ziehlke, K.: Well, we were responsible for primarily, I suppose, equipment failure analysis. There was a lot of equipment that was essential to the diffusion process, which consisted of pumping a lot of uranium hexafluoride through a lot of piping and diffusers where the enrichment took place. And a lot of this was new to the application since the application itself was new. And so it was a learning process for the operation and for everybody associated with it. The equipment, as the years went on, got bigger and bigger and you couldn't always scale things up infinitely, and so new problems would develop and we were responsible for identifying the nature of the problem and coming up with some way to correct it or fix it or get around it.

[1:11:34]

Ziehlke, K.: For instance, the uranium hexafluoride gas was pumped through this vast system with pumps, with pumps that handled gas -- gaseous fluids. And in the K-25, K-27 sections of the plant, which were the initial startup sections of the plant, these were centrifugal compressors; they were one or two stages of fans that fit the UF_6 in along the central axis and discharged it at the periphery at a higher pressure, higher velocity. And those didn't always work the way they were supposed to work because you couldn't always maintain the right pressure differentials, the right flow rates to stay within a stable operating range and so once in a while, an impeller would fly apart because it was being overloaded in some manner or other, and we could, by examining the pieces, determine just what the problem was, whether it was fatigue or whether it was simple mechanical overload or whether it got too hot or whatever. And the corrective measures were generally beefing up the design in areas where it might be marginal or changing materials.

[1:13:29]

When we got to the larger plants, the K-29, K-31, 33 size plants, the centrifugal compressors no longer had the capacity to pump the needed volume of gas and so they went to a turban-type -- multi-stage turban-type pump called an axial flow compressor and the K-29 compressors were an Allis Chalmers design that had been used elsewhere in industry, I suppose, for a few years prior to the time it was applied at K-25. And they selected the materials, and it turned out that the -- the -- the blades that drove the gas were a die cast aluminum alloy, as they had been in Allis Chalmers' original design. And it turned out in operation that this aluminum alloy was subject to mechanical property changes with time a -- as it was exposed to elevated temperatures. And so we developed a modification of another die casting alloy for blades for this pump and that modification turned out to be successful, and it was used from 1955 or thereabouts through the balance of the program. If they're building compressors today, they're using that same alloy for blades.

[1:15:40]

UF_6 is a corrosive gas and there are certain materials that are less subject to corrosion than others by UF6. And material of choice is nickel. And so our process equipment tended to be nickel-plated or, initially, it was nickel-clad. You roll nickel and steel together to get a solid nickel face on the steel structural part and the components were built from that clad stock, but that was -- took a lot of work, it was expensive, and we found that nickel plating, electroplating, was as satisfactory and a whole lot cheaper. And so in all the larger-scale equipment, K-29, 31, 33, the surfaces were steel covered with nickel electroplate. And it's things like that, materials, selection, and application that we did a lot of.

[1:17:02]

Callan, B.: So the compressors deblading? Was that a problem on the axial flows and what --

Ziehlke, K.: Yes.

Callan, B.: -- happened on the centrifugal ones?

Ziehlke, K.: Well, there were in addition to the weld fabricated Monel impellers, which sometimes gave problems, we had a set of higher-speed pumps, centrifugal pumps that used a forged aluminum impeller. And those were subject to creep under the sustained loads of -- the sustained centrifugal loads as they were operating. You'd -- in a lot of this equipment, you would prefer to operate -- turn it on and operate forever, but you had power outages, you had maintenance outages, you had outages for various reasons, and so you'd start and stop, and the conditions of operation would change and one of the conditions was that those centrifugal -- forged centrifugal impellers would grow to the point where they would start rubbing and then they'd fail. And so we developed a heat treatment that took care of the growth problem. An alloy selection in the first place that resulted in a stronger material which wasn't as subject to creep and then a stabilizing heat treatment which made them dimensionally more sound.

[1:18:55]

Callan, B.: I'm just kind of curious about engineering back in the '50s. I imagine these compressors and whatnot, especially like the axial flow, you're probably dealing with very, very close tolerances and whereas nowadays, we have like, Auto CAD tools and this and that to design stuff, how was designing things with real close tolerances? Was it difficult to deal with the issues like that?

Callan, B.: Well, I didn't have a whole lot of contact with the design at that point, and I don't have -- really, I don't have any idea how an engineer came up with an air foil design for the blade. But I know that this air foil was generated by mathematical calculations and the inspection process, once they got into production, measured the profile at a number of radii to verify that it matched the design profile and thus would operate in a stable mode in the design area. Are you familiar with finite element analysis? This is a method of, say, analyzing operating stresses in a part by dividing it into small increments and then studying each of those increments under the loads that are intended to be applied. And this is a snap with computers because they've got software available that can do these incremental divisions and can look at each one of 'em as it's affected by the well, basically rectangles and by the four rectangles that adjoin it.

[1:21:12]

And we had a cracking problem in the brake that served the axial flow compressor and its motor coupled to it. When you shut it off, you have to get it down to zero speed in a hurry because there are all sorts of resonances that it goes through that you don't want to let it coast through because it starts vibrating and you might shake it apart, so you put a brake in between the two components. And this brake is a shoe or a pair of shoes on a drum, just like an automobile break except the reverse. It's not internal expanding; it's external compressing. And when you slow down all that mass, that brake gets awfully hot and there were development programs on selecting linings, brake linings for that brake, but it always, as I say, got hot and sometimes it got red hot. And this would result in cracking of the drum. And we got concerned about running the drum at the operating speeds and -- with those cracks in it.

[1:22:41]

And so we -- finite element analysis was just invented at the time that we observed this problem and Lockheed had a shop, an office, in Huntsville where they worked for NASA. And they were pioneers in finite element analysis. And they did a finite element analysis on this cracked brake drum for us, which said that the cracks weren't really of much consequence, and so that we could -- so we could safely operate with the cracks as long as we didn't -- we -- we limited the cracks in size and we would inspect periodically, and then when they'd get to a certain level, we would machine -- we'd re-heat treat the drum and machine the cracks out and then put it back in service un-cracked.

[1:23:52]

But this finite element analysis was done by hand with slide rules and sketchbooks and not many elements compared to the current computer software approach where you can divide an item like that into thousands of elements and get real detailed pictures. Lockheed was able to divide it into hundreds of elements because the calculations took so long. Each one had to be calculated individually. So we --.

Callan, B.: I wasn't familiar with finite element analysis, but it did make me think of getting familiar with residual stress. I was doing a project for a company that they had a computer device that they could use to measure residual stress in like a weld, for example. Was that anything that was a concern?

[1:25:00]

Ziehlke, K.: Well, that was probably done with finite element analysis because that's how you would look at a weld and at the adjacent surfaces by breaking it up into small components and then looking at each one of those and picking out which ones had the highest stresses.

Callan, B.: Okay, so it is related then.

Ziehlke, K.: Yeah. Uh-huh. (affirmative)

Callan, B.: That's what it made me think of.

Let's see. Let's talk a little bit about the work environment out there and what was it like working in a secret facility?

Ziehlke, K.: I suppose after we got used to it, we didn't pay a whole lot of attention. There were, in the -- the security system has changed considerably over the years, but in the 1950s, we had the plant subdivided into various security level and security subject areas. The lab area was different from the barrier plant area, was different from the manufacturing. We had a converter manufacturing area which was separately classified, and the operations -- diffusion operations area was behind its own fence. All of these were separate fences and your badge had a letter code on it and you'd have to show your badge when you entered any one of these areas, and it had to have the proper letter to admit you to that area. And they had three or four or five different letter codes. I remember my badge had an "A," an "L," and an "R" on it. And those got me in to most of the areas in the plant. I'm not sure whether they got me into the power house, but I could get in there by calling ahead and asking for clearance.

[1:27:14]

Callan, B.: I want to go back a little bit and talk about compressors because I'm just kind of curious. You seem to know quite a bit about them. I had heard that one of the major causes of the deblading problems on axial ones is that the blades were so heavy that there was actually a sag in the shaft, like, if they were shut down for a period of time, that the shaft would actually sag a little bit. When you started them up, because the tolerances were so close, it would cause them to deblade. Was that a real frequent cause of deblading?

Ziehlke, K.: No. As I recall it, well, shut down and start up were critical times in operation of a compressor because, as I say, you need a stable operating mode, your gas through put has to be proper, the velocity and the pressure differentials and all of that have to kind of balance out because if you -- well, you know what happens, say, with a water pump if you block off the exit. It starts hammering; it makes noises. It's not operating in a stable mode. And you want to avoid that with the compressors, too, because when they start shaking around, those blades are not real sturdy structural members and so you have to treat them with caution. And this shaft sagging was probably only in one compressor design. The K-29 compressor had a long rotor and a long shaft and the supports, well, it -- it did sag. And I don't know how many de-bladings were due to that, but more they were due to the off-target operation in start up and coming up to speed and in dropping back down to zero, down to rest.

[1:29:47]

Callan, B.: Hold that thought. We need to flip out tapes real quick. The tapes only run 30 minutes at a time.

[End Tape 1, begin Tape 2]

[2:00:18]

Callan, B.: How often did deblading issues or compressors go off line?

Ziehlke, K.: I guess it may have depended on things like management policies. We -- I always had the impression that they had more problems at Portsmouth than we did at K-25, but they might argue that. We had a compressor shop that rebuilt de-bladed compressors and they were always busy and they always had 3 or 4 or 5 of them in process at any time as I -- as I recall it. I don't know what this would translate to as a failure rate, but we had, like, 1,500 of these all together for 600 stages in K-33 and 640 in K-31 and I don't know, 300 or 400 in K-29. And each one of these had an axial flow compressor, so.

[2:01:51]

And at one time, I knew what the mean time between failures was, but I've forgotten that. But it was a significant problem and we did -- one of the things that I did when I first came in to the Metallurgy Department was develop a fatigue testing system for compressor blades so that we could evaluate production lots for soundness and evaluate different designs and different chemistries. We did all 3 of those functions on a routine basis for 20 years or more, from the mid-'50s to probably the mid-'70s. And in the later years, those were mainly for -- to evaluate mechanical designs and in the earlier years, they were chemistry and production lot verifications.

[2:03:19]

Fatigue was a major problem. I don't know how much of a problem it was as far as initiating deblading failures because you -- all of the blades were subject to fatigue damage and so when you'd have a deblading, you'd look at fractures and you'd see fatigue evidence in -- in any compressor that de-bladed. Unless it was brand new and failed on start up, but fatigue was a -- something that occurred during compressor operation, and with, as I say, we would've liked to have turned things on and kept 'em going that way forever because at that stable operating level, the fatigue didn't -- the fatigue damage didn't seem to be harmful to the compressor. It could handle the gas loads that it needed to handle, even though a lot of the blades were cracked. The cracking -- the fatigue was a problem only in specific rows of blades. Some of the blades were never bothered by fatigue. Some were always bothered by fatigue.

[2:04:55]

Callan, B.: Did most of that occur during start up and shut down?

Ziehlke, K.: Probably so, yeah.

Callan, B.: Same thing as like in an automobile, I guess.

Ziehlke, K.: Yeah. Most of the wear and tear is in starting.

Callan, B.: I had a follow-up question for you and it just popped out of my mind. Oh, earlier you said how often failure issues would happen related to the management.

[2:05:29]

Ziehlke, K.: Oh.

Callan, B.: What's the relationship there? How is it related to how the plant was managed? I guess if they weren't managed as well, were they shut down more often?

Ziehlke, K.: Probably with reference to things like whether we were going to take a cell off stream for maintenance or keep it running. That's a sort of a vague feeling that isn't substantiated [laughing] by anything.

Callan, B.: I was just curious.

Back to the working conditions and working environment of the facility. Did you have any difficulty communicating with family and friends being that you were working in a secret facility?

[2:06:22]

Ziehlke, K.: Management attitudes, personnel attitudes are considerably different today than they were 50 years ago. 50 years ago, we couldn't go out to the plant for lunch. We had our cafeteria and our branches of the cafeteria throughout the plant, so there were a lot of places we could go to eat. And one of the places we couldn't go to eat was outside the gate. And I don't know if that was a rule or just something that I observed that nobody did, but nowadays, you wanna go out to eat, you can go out to eat.

[2:07:16]

Another thing that I had the idea was discouraged was use of the telephone for other than business purposes, and that included calling home, although there was never any barrier to calling home if I felt that I needed to call home, but that was just one of the things that you didn't do. And I suppose that would've been the case if you worked in a weld shop downtown. You wouldn't call home unless you really had to because that was something that you didn't do in the 1950s work environment.

Callan, B.: That was better, don't you think, or not?

Ziehlke, K.: Well, I was --.

Callan, B.: You must've done a lot of work.

Ziehlke, K.: Yeah.

Callan, B.: [laughing]

[2:08:09]

Ziehlke, K.: And I don't think it bothered anybody because that was the way things were. We didn't look on it as being oppressed, anyway.

Callan, B.: I don't know for me these days, got the cell phone on me all the time and it doesn't matter what I'm doing. If someone calls on that cell phone, I'm like forced or compelled to answer. If for some reason I don't answer it, then whoever's calling is going to assume something's wrong and so [laughter] it's hard to be productive for a good long period of time because you have these distractions all the time. I tell people sometimes I wish I lived there in the '50s and I hate the god that ever invented cell phones.

Ziehlke, K.: [laughing] That's the spirit!

Callan, B.: [laughing]

Were there other important rules to follow around the plant?

Ziehlke, K.: Well, one of the major rules was that we didn't talk at home or outside the plant about what we did inside the plant. And I don't think there was anything except that sort of a general caution. I don't know that anybody ever monitored something of that sort and certainly, we could ask our neighbors if they had gone to work that day or if they hadn't and if anything had happened at work.

[2:09:42]

And this business of classification and what you could talk about where, under what circumstances has had, oh, different or differing emphasis from time to time. I guess you've seen the security movies about talking with the guy sitting next to you at the bar about what you did at work. And I -- I wasn't aware that any of that ever went on. But in general, we were discouraged from talking with -- in a social environment about what we did in the work environment.

Callan, B.: What was your supervisor like and what were your co-workers like? Did everyone pull their weight?

Ziehlke, K.: Yeah. I -- in the last half of my term of duty at K-25 from 1970 on, say, I did a lot of -- relatively, a lot of traveling in relation to procurement, things that we bought on specifications. I was not an inspector or a vendor surveillance sort, but I was a technical advisor to those people and to Engineering. Engineering wrote the specifications and then the surveillance people lived at the manufacturing site and watched what was being made to assure that it met the specifications, and if there were problems in meeting the specifications and in meeting the schedule and that sort of thing, then Engineering would call on the technical people for support, and I was one of those that went out into the field to look at problems and get out of production difficulties that inhibited delivery of the parts.

[2:12:14]

And since I was, by my job responsibilities, familiar with a lot of the production equipment, I knew what could be done by way of deviating from the specifications and still obtain a usable, functional part for us. And so I always felt free to -- and this was probably well outside of my job description -- I felt free to mark up Engineering drawings at the vendors' plant and tell them you can do this and you can do that in violation of the specification. And I'd sign that off and then I'd come back and tell Engineering what it was I had done to their specifications. And I never had any problem with that. They were always happy to change where it was required for production and it was supported by proper technical analysis. As long as they could document their changes, there was no problem in changing specifications as you went along.

[2:13:29]

Callan, B.: Sort of like hot running them over, I guess.

Ziehlke, K.: That sort of thing except that you had to be sure that that got into the drawings and the specifications to follow because otherwise the auditors wouldn't be happy; they wouldn't be following specifications if the specifications hadn't been changed to match what they were doing.

And you could do a lot of this because it's exceedingly difficult to write specifications for -- you write 'em for the manufacturer when you aren't sitting right on top of his manufacturing process. You don't know in real detail what he can do and he doesn't know in detail what your requirements are as far as functionality is concerned.

[2:14:33]

We had a problem with a part that we were buying for the barrier plant for barrier production. And we were -- this was a part that went through a furnace and it was a high-temperature alloy that was manufactured exclusively by the metals company that Union Carbide had. Who was that? They were -- they were located in Kokomo anyway.

Callan, B.: Gary will know.

Ziehlke, K.: And they had a contract with the Navy for manufacturing this material for a Navy application. And they were filling our requirements with part of that contract that didn't meet the Navy's specifications. And our procurement engineer had sent me pieces of the material for metallurgical analysis, and we knew why -- our -- our scrap rate was awfully high. And the part was classified in some manner and so we had to buy all of the material that we put through the fabrication process and then throw away most of it. And this procurement engineer found that these people had licensed the alloy to another manufacturer and he contacted them and they had a somewhat different production process that wasn't subject to the problems that the originators' process was. And it gave a lot cleaner material. And so we switched our contract to this new producer and saved millions of dollars in scrap that we didn't have to purchase because all we had to purchase then, we got essentially 100% yield out of it. All we had to purchase was what we needed instead of what we -- what we needed and messed up besides.

[2:17:16]

And it was things like that, these field changes -- I wasn't the only one that did that. I wasn't the only independent operator in the system.

As -- in that 20 years of flying around the country and looking at all sorts of manufacturing operations, I got the impression that DOE was getting it's money's worth out of the people it had hired here. At least -- as well as most manufacturers and better than a lot of them. We got -- we had a more dedicated, more conscientious workforce than most manufacturing operations did, manufacturing operations that were in business to make money.

[2:18:23]

Callan, B.: That's good. So you weren't out here making $2,000 hammers and $4,000 screwdrivers.

Ziehlke, K.: No. No.

Callan, B.: [laughing]

Ziehlke, K.: We could show them up in a lot of cases. We -- our shops did a little bit of prototyping and we could -- I thought once we got established, we could do things better than the people that we hired to do 'em for us, the outside vendors.

Callan, B.: Let's talk about the period of operation that you were working there. You said you started in 1950, so I guess that's when the expansion program was going on. Did you want to explain the expansion program and what was its purpose, what was the mission of the facility?

[2:19:24]

Ziehlke, K.: Well, that was when we -- I suppose, the late '40s and early '50s were when we began to realize that we weren't going to get along with Russia on the world stage, that we were in competition with them, that they were a threat to us. Anyway, that was when we felt that we had to increase our production of atomic weapons, and so we had to increase the capacity of the U^{235} enrichment. And K-29 was the first of those expansion plants, and I believe it was -- had just been fully on stream about the time that I came. It would've gone on stream in 1949, maybe early 1950. K-31 was, I believe construction was finished and they were bringing it on line a unit at a time. And K-33, I think, they were just breaking ground for K-33 when I got here. They may not have -- it may have started a few months later, but they -- the people that I knew in the lab were leaving for Paducah. Several of the people in Metallurgy had been assigned to the Paducah plant and they left in '51 and '52. And Portsmouth, Goodyear Atomic was hiring people for the plant at Portsmouth in probably '52, '53, '54, and a lot of their technical people came into the technical, the lab division at K-25 for familiarization with the process and for training and getting ideas on how to set up similar facilities at Portsmouth. So we got -- we knew a lot of the Paducah personnel and we knew a lot of the Portsmouth personnel from that training interaction. And we also traveled among the three plants because all of our -- since the plants were similar, the problems were similar and we did a lot of consulting with the other two groups.

[2:22:34]

K-33 finished, got on stream probably in '54 or '55. And that was about the time that the Portsmouth plant was also fully on stream.

And we continued that interaction for the balance of the program, too. We consulted with each other on mutual problems.

Callan, B.: From the interviews that I've done, it seems to me that an important part of the expansion program was to make the overall process more efficient and less energy intensive. Initially, when we're talking about K-25 operating and there's a lot of energy within enriched uranium, but it requires a lot of energy to enrich the uranium. I'm trying to think of what the statistical number would be, the yield of energy that was put into the process versus the energy that you're getting out of the process, but I don't know if initially --.

[2:24:06]

Ziehlke, K.: Are we making any money?

Callan, B.: Right. [laughter]

Ziehlke, K.: Well, I -- as far as reactor fuels, which I guess we have to confine our thinking to -- as far as reactor fuels are concerned, we can get a whole lot more out of the enriched material than what it cost to produce it. We can -- I don't know what production rates are and they're probably classified anyway -- but certainly we had enrichment capacity at the three plants to do everything that we had ever wanted to do with electrical power production over the next 20, 30, 50, or 100 years. So there must've been a considerable markup in energy availability there. I don't know if -- see, we, I guess, produced for reactor feed -- for most of the life of the plant, I don't know when we quit producing weapons-grade material, but K-25 could do that and Portsmouth could do that. Paducah could not.

[2:25:46]

Paducah was always an intermediate or a lower stage in the enrichment cascade. They did enrichment on the level of a few percent, and they could produce reactor feed. They were in a position where they used -- they used the starting feed at 7/10 of 1% U^{235} and enriched it. They also used K-25 tails as feed and we took it from 7/10 of 1% on down as far as 2/10 of 1%. And anything above 2/10 of 1%, Paducah could enrich also. And that's why Paducah ended up with most of the storage -- tails cylinders, which were a concern for us the last several years of K-25 operation.

But, yeah, we get a considerable markup in the energy availability from the power that we put into the separation process.

[2:27:28]

Callan, B.: And K-25 ran primarily off of the electricity generated at the power house, correct?

Ziehlke, K.: Initially, the power house was constructed because the design of the process required variable-speed compressors. And the way we got variable-speed compressors was by putting out different from 60-cycle current. And that was what the power house was designed to do. It was to give us power that was different from what we could get from TVA.

[2:28:12]

And I don't know if we ever operated that way because they found as soon as they got the system on line that they didn't need that speed variation -- variability, and so they always operated at 60-cycle power.

I don't remember what the capacity of the K-25 plant was. It was on the order of dozens or hundreds of megawatts, probably dozens of megawatts. By the time we planned to build K-33, TVA built the Kingston Steam Plant to furnish power for K-33 or for maybe all of K-25, the complex. And Kingston's capacity then was 2,000 megawatts. And I guess, K-25 used it all.

[2:29:28]

There was a statistic floating around that K-25 used something like 10% of all the power generated in the country. It was a staggering amount anyway. And the process has always been a major power consumer. And that was why the centrifuge process was so attractive, because it only used like 10% of the power to produce the same amount of enrichment.

[2:30:03]

Callan, B.: Hold that thought. We have to switch out tapes again.

[End Tape 2, begin Tape 3]

[3:00:19]

Callan, B.: These aren't really on my interview questions. I'm just curious and we're having an interview with a conversation anyway.

So Kingston was a big power plant, correct?

[3:00:30]

Ziehlke, K.: Uh-huh. (affirmative)

Callan, B.: And was it a coal power plant?

Ziehlke, K.: Yeah. Uh-huh. (affirmative)

Callan, B.: Why do you suppose when we have these facilities that are enriching uranium and making fuel rods, how come a reactor was never built to supply the energy for them?

Ziehlke, K.: Well, I would sort of assume that we tried that several times and they all got canceled after a while, like the latest one being the breeder reactor. That would have produced all the power that we needed and produced fissionable material for more power besides. But I don't know the answer to that question.

It does seem like, well, there were considerations of that sort tossed around and there was a plant designed to do that. There was a conceptual design and quite a bit of engineering work done on setting up a diffusion plant with a reactor for power, on site, up on the northern shore of Lake Superior back in the '60s, I think. I don't know how serious that thought was, but there was a few million dollars invested in that idea. And I suppose there may have been others, too. I think there were desalination plant designs that included their own power reactors.

[3:02:38]

Callan, B.: Desalination? Is that a similar process to the gaseous diffusion process?

Ziehlke, K.: No. Let's see, I think that's just a water boiling system where you capture the steam and condense it into purer water and discard the saltier water.

Callan, B.: It depends on what they're using it. I forget what the process is that you're talking about, but they also use reverse osmosis.

Ziehlke, K.: Yeah. There are a number of ways to extract salt from water and those two are reasonably efficient, I guess, at least some people can afford to pay for 'em. There are desalination plants that furnish city water in the Arabian Peninsula, for instance. And there are designs, conceptual designs, and maybe more advanced designs for doing that, [laughing] all up and down the coast of the United States. And they would -- they're rather power intensive, too, if you're going to do this electrically.

[3:04:06]

And we did a little work on materials development there and the materials of choice for desalination plants are copper-nickel alloys. There are cupra-nickels which are copper rich end of the spectrum. 90 copper, 10 nickel; 80 copper, 20 nickel; and 70 copper, 30 nickel are all used in desalination plant tubing, in the heat exchangers.

Callan, B.: I know a little bit about diesel, too, working on some projects with Sandia Laboratories and they're really pushing forward diesel technology to make it more efficient so that it --

Ziehlke, K.: Well, it --.

Callan, B.: -- can be a reasonable alternative for fresh water drinking supply.

Ziehlke, K.: That's something that has to come and there are areas, if we're gonna have more people, we're gonna have to have more water. And water seems to be a problem in a lot of areas.

[3:05:19]

Callan, B.: I'm surprised you think about that, being from Tennessee. [laughter] I'm from New Mexico, so we're very aware of the water issues. [laughing]

Ziehlke, K.: Well, everybody -- everybody upstream from you uses the Colorado River and it doesn't have anything left when it gets down to your area. [laughing]

Callan, B.: Actually, we have the -- the Rio and Texas has a claim to it, the Indian tribes have a claim to so many acre feet of water per year, so there's only so much that we can even keep kept up in reservoirs.

Ziehlke, K.: And you are probably not very high on the list of priorities, either. There are probably a lot --

Callan, B.: (indiscernible) priorities are way down there.

Ziehlke, K.: -- a lot of people that are ahead of you --

[3:06:06]

Callan, B.: Right.

Ziehlke, K.: -- with their claims.

Callan, B.: Agricultural use, basically the tribal compacts, the compacts that we have with Texas, those are all of a higher priority than any domestic or municipal use for the surface water that we have in our state [laughing]. With the little amount that we have, we call it the Rio Grande and it's something that's quite a bit smaller than what you folks out here call a creek. [laughing]

Ziehlke, K.: That terminology varies as you go around the country.

Callan, B.: Yeah.

Ziehlke, K.: We have rivers up in Wisconsin that would be, maybe, unnamed creeks here. [laughter] Well, up in Wisconsin, they're cricks.

Callan, B.: Right.

What would you say is your most challenging assignment that you had at K-25?

[3:07:01]

Ziehlke, K.: Oh, I don't know. Every one of them was challenging as it came along and satisfying as I got rid of it because I'd solved the problem. And I don't know that any one of them stands out that -- that one with the high-temperature material, the alternate supplier was sort of a triumph because we got one up on part of the Union Carbide Corporation membership. We couldn't deal with 'em.

They -- they wouldn't talk to us until we had the contract with their competitor. And then they wanted to talk and by then, we'd solved the problem; we didn't have any need to talk anymore. But that was just because it saved a lot of money.

Every one of the day-to-day problems was interesting while it went on and real satisfying when we came up with an answer and found that the answer, indeed, corrected the problem.

Callan, B.: I have some broad perspective questions here. Describe what future generations should remember about K-25.

[3:08:41]

Ziehlke, K.: Be careful where you throw the scrap. [laughing] 'Cause you're gonna have to clean it up.

[3:08:52]

I was associated with some of the scrap disposal areas. We had a junkyard over in the power house area where a lot of contaminated material, equipment, parts, junk, ended up that we then had to go in and segregate and clean up, not me, but the clean up contractors. And I'm sure that those things could have been more efficiently handled if we had been a little more insightful at the time we were generating the scrap. We're -- we're more aware of that sort of thing now then we were then, and there are areas that were properly handled. We had some -- we buried a lot of trash and buried some contaminated materials, and those were all legal at the time they were done, and some of them were done better than others.

And we -- we ought to be aware of the sort of footprint that we're leaving on the areas that we travel in because that footprint is going to be visible after we're gone. And we ought to make sure that it's -- we ought to try harder to make it innocuous.

[3:10:47]

One of the areas that I have been associated with for the last 20 years or so, maybe longer than that, is this idea of what to do with how to store, how to take care of depleted uranium hexafluoride. I had input into the design and materials in the storage cylinders and in the storage yards themselves, and I've been concerned with that since we first started setting aside the tails material and at that time, not knowing what to do with it, but knowing that it was a resource that we might need in the future. The reason that we kept that material on hand, the Europeans, the Japanese, other people who are in the enrichment and reactor feed business, don't allow tails material to accumulate. They have limits on the amount that they can accumulate and then they have to take some steps in order to make it disappear. And what they do is convert the UF_6 tails to oxides and then I don't know what they do with the oxides, but they're stable in the general environment. That's what they were before we dug 'em up. And so, I suppose we can put 'em back the same way except that they're a little bit modified in isotopic ratio.

[3:12:45]

We, on the other hand, had always looked on this as a resource and in fact, we were going to use it as feed for the breeder reactor. We were going to use it as feed for the centrifuge program. We were going to use it as feed for the laser isotope separation program, and all of those got cut out from under the contemplative thinkers. And we end up with -- now, we've still got the material and we don't have any applications for it. We've got 10 and 14 ton, mostly 14 ton cylinders of depleted UF_6 to the number of 65,000, I think, times 12 or 13 tons average. And that's a lot of stuff. And there are contracts now for constructing plants to convert the hexafluoride to oxide and then to store the oxide. And that's a project that is kind of vast in scope. That's -- I -- I forget the result of multiplying 60,000 by 12 or 13 tons, but it's a lot of tonnage. And it requires, currently, a lot of acreage for just setting the cylinders down.

[3:14:37]

And while they're sitting there, they're corroding and some of them are exposed to relatively harsh conditions and they have been known to corrode through the cylinder wall and then we expose the solid UF_6 to the environment. And fortunately, it tends to correct itself because it converts, it reacts with the environment and scabs over and maintains containment, but you still have some leakage, you still have some HF release to the atmosphere, you have uranium compounds that are soluble that are released to the groundwater system. And these are problems that we shouldn't have to face. And I've participated, as I say, these last 20, 30 years in developing systems to contain, to retrieve, to salvage the cylinders that do corrode through. And there've been probably a dozen of 'em at the three locations. And 12 out of 60,000 isn't bad, but it's something that we shouldn't have to cope with, and it costs a lot of money to cope with it because when we find a cylinder with a leak in it, then everybody gets concerned and we scurry around and try to figure out how to -- how to get rid of it, how to contain it, how to handle it. These are interesting, but they are problems associated with getting back to where you were -- aren't near as much fun as problems that occur, say, during development of a process. It's not as easy to go back as it is to go forward.

[3:16:56]

Callan, B.: Those are really all the questions that I had for you. Are there any other topics that you wanted to expand upon before we wrap up our interview?

Ziehlke, K.: No. How -- how many interviews do you have scheduled? Do you have --?

[3:17:15]

Callan, B.: By the end of this week, we're going to have over 70.

Ziehlke, K.: And these are all people from K-25?

Callan, B.: Yes. And I've got up in the living room, Jennifer, she's got the list of all the people we've interviewed so far if you want to.

[3:17:30]

Ziehlke, K.: Yeah, I'd be interested in seeing the names.

Callan, B.: Sure!

Ziehlke, K.: And maybe even sic you on to somebody. [laughing]

Callan, B.: Okay, yeah, we could definitely use suggestions because we're actually kind of getting to the end of the list and if there are additional people that we need.

Ziehlke, K.: This isn't alphabetical, is it?

Callan, B.: It's --.

Ziehlke, K.: I've had a thing all my life about being at the end of the line. [laughing]

Callan, B.: Actually, it sort of is alphabetical because it's sort of [laughter]. We had a spreadsheet developed, so whatever the sort was on that spreadsheet. It was probably alphabetical was how we were going through the phone calls. [laughing]

Ziehlke, K.: I guess it's a handy way to do it.

[3:18:21]

I was -- I spent a year or so in the Navy after high school, before college, and I was beginning to get awfully conscious of that alphabetical order. And once during boot camp, the master at arms, he was aware of that as a problem, too, so he was gonna start picking from the end.

[End of interview]