DOE/EH-0467

HUMAN RADIATION STUDIES: REMEMBERING THE EARLY YEARS

Oral History of Health Physicist Carl C. Gamertsfelder, Ph.D.

Conducted January 19, 1995

United States Department of Energy
Office of Human Radiation Experiments
September 1995

FOREWORD

IN DECEMBER 1993, U.S. Secretary of Energy Hazel R. O'Leary announced her Openness Initiative. As part of this initiative, the Department of Energy undertook an effort to identify and catalog historical documents on radiation experiments that had used human subjects. The Office of Human Radiation Experiments coordinated the Department search for records about these experiments. An enormous volume of historical records has been located. Many of these records were disorganized; often poorly cataloged, if at all; and scattered across the country in holding areas, archives, and records centers.

The Department has produced a roadmap to the large universe of pertinent information: *Human Radiation Experiments: The Department of Energy Roadmap to the Story and the Records* (DOE/EH-0445, February 1995). The collected documents are also accessible through the Internet World Wide Web under http://www.ohre.doe.gov. The passage of time, the state of existing records, and the fact that some decisionmaking processes were never documented in written form, caused the Department to consider other means to supplement the documentary record.

In September 1994, the Office of Human Radiation Experiments, in collaboration with Lawrence Berkeley Laboratory, began an oral history project to fulfill this goal. The project involved interviewing researchers and others with firsthand knowledge of either the human radiation experimentation that occurred during the Cold War or the institutional context in which such experimentation took place. The purpose of this project was to enrich the documentary record, provide missing information, and allow the researchers an opportunity to provide their perspective.

Thirty audiotaped interviews were conducted from September 1994 through January 1995. Interviewees were permitted to review the transcripts of their oral histories. Their comments were incorporated into the final version of the transcript if those comments supplemented, clarified, or corrected the contents of the interviews.

The Department of Energy is grateful to the scientists and researchers who agreed to participate in this project, many of whom were pioneers in the development of nuclear medicine. ❑

CONTENTS

DISCLAIMER

The opinions expressed by the interviewee are his own and do not necessarily reflect those of the U.S. Department of Energy. The Department neither endorses nor disagrees with such views. Moreover, the Department of Energy makes no representations as to the accuracy or completeness of the information provided by the interviewee.

ORAL HISTORY OF HEALTH PHYSICIST CARL C. GAMERTSFELDER, Ph.D.

The interview was conducted on January 19, 1995, in Knoxville, Tennessee, by Thomas J. Fisher, Jr. and Michael A. Yuffee from the Office of Human Radiation Experiments (OHRE), U. S. Department of Energy.

Carl C. Gamertsfelder was selected for the oral history project because of his more-than-40 years of practical experience in the general field of radiological sciences and health physics. The oral history covers Dr. Gamertsfelder's long career, focusing on the years spent pioneering the development of radiation instruments and measurement techniques during the Manhattan Project, continuing through the expansion of research aspects following World War II, and concluding with his later work as a consulting radiological scientist.

Short Biography

Dr. Gamertsfelder was born in Elkader, Iowa, on June 6, 1913. In 1935, he received his B.A. (Mathematics and Physics, double major) from North Central College in Naperville, Illinois. From 1938 to 1941, Dr. Gamertsfelder studied at the University of Missouri. During this time, he received both an M.A. and a Ph.D. in Physics. Dr. Gamertsfelder is married and has three children.

Dr. Gamertsfelder began his career as an Associate Physicist at the Armour Research Foundation from 1941 to 1942. In 1942, he joined the Manhattan Project as an Associate Physicist in the University of Chicago's Metallurgical Laboratory. While in Chicago, Dr. Gamertsfelder developed radiation monitoring instruments and techniques, including the first practical neutron monitor. In addition, he was one of 49 individuals who witnessed the first self-sustained nuclear chain reaction, on December 2, 1942.

In 1943, while still on the University of Chicago payroll, Dr. Gamertsfelder was transferred to the Clinton Laboratories in Oak Ridge, Tennessee, where he conducted health physics instrument development. During the startup and operation of the X-10 graphite reactor, he was in charge of monitoring. He also trained Du Pont personnel for work at the Manhattan Project site at Hanford, Washington.

In 1944, Dr. Gamertsfelder went to Hanford, where he served as Senior Supervisor of the Medical Department, a position he held until 1946. During this period, he trained engineers and supervisors in the basic elements of health physics, and developed surveying techniques. In 1946, Dr. Gamertsfelder was appointed Manager of the Biophysics Section of the Radiological Sciences Department at Hanford. He left Hanford in 1952 and joined General Electric's Aircraft Nuclear Propulsion Department as a Consulting Physicist, where his work focused on determining the hazards associated with all powerplants designed by the Department.

In 1961, Dr. Gamertsfelder returned to the Hanford Laboratories, where he became responsible for the planning, advancement, and appraisal of major research and development programs. Dr. Gamertsfelder eventually left Hanford a second time, to work with the General Electric group that was making a power supply (using plutonium-238 as the source of heat to generate electricity) for the Apollo space missions. Dr. Gamertsfelder retired in 1986.

In addition to holding the title of Certified Health Physicist, Dr. Gamertsfelder is a member of the following organizations:

- Pi Mu Epsilon,
- Sigma Xi,
- Gamma Alpha,
- American Physical Society,
- American Institute of Physics,
- Health Physics Society, and
- Inhalation Hazards Subcommittee of the Committee on Pathological Effects of Atomic Radiation of the National Academy of Sciences, National Research Council.

Dr. Gamertsfelder has published many times on radiological sciences research, radiation protection issues, and dosimetry investigation.

Education and Early Employment

FISHER: Good morning, Dr. Gamertsfelder. My name is Tom Fisher. I'm from the Department of Energy's Office of Human Radiation Experiments, and I'm here this morning with my colleague, Michael Yuffee. It's Thursday, January 19th[, 1995].

I would like to take a moment to thank you for taking time out of your day to visit with us for our oral history program.

I was wondering if we might begin this morning by talking a little bit about your early education and your background, and [about] what brought you into the Manhattan Project, and ultimately, to health physics.

GAMERTSFELDER: How far back do you want to go?

FISHER: Start with your school[ing].

GAMERTSFELDER: I didn't start from kindergarten. We didn't have it.

FISHER: Okay—that's fair.

GAMERTSFELDER: I started in first grade in Elkader, Iowa. I went through the first two grades there, and then moved to Decorah, Iowa, where my dad had been a teacher, sometime [prior] to my birth. And my dad was superintendent of schools in Elkader for the two years. And then he was superintendent of schools in Decorah, where I finished my high school education.

FISHER: And then, where did you go on to college?

GAMERTSFELDER: I went to college at the North Central College in Naperville, Illinois. It was a relatively small college. It had been called Northwestern [College]. And then Northwestern University [in Evanston, Illinois] came along, so they changed it to North Central. I guess there were, maybe, 400 or 500 students at the time I was there.

FISHER: And what was your major? What did you study?

GAMERTSFELDER: Oh, I had a double major; in Physics and Math. And I was close to having one in Chemistry.

1261847

YUFFEE: What year did you graduate college?

GAMERTSFELDER: Nineteen thirty-five.

YUFFEE: And from there, you went on to—

GAMERTSFELDER: And I then took some Education courses and tried to find a job teaching. And thank goodness, I didn't find one.

[In the summer of 1936, Dr. Newell S. Gingrich, who earned his bachelor's degree from North Central, visited Dr. Clifford Wall, who was the Physics professor at North Central. Dr. Gingrich was interested in talking with potential students for the graduate school at the University of Missouri, where he was to be one of the Physics professors. I was interviewed by Dr. Gingrich. And a few weeks later, I received an offer to be a research assistant for Dr. Fred Uber, who was involved in a genetic research program with biologists who were irradiating corn pollen with ultraviolet radiation.[1] I had a lot of practical laboratory experience; built some equipment, helped in some experiments, and did some of my own.]

And the next year, I was given a job as a graduate assistant in Physics, in which the assistants were the ones who ran the laboratories for the Physics courses that were being given.

YUFFEE: And that was at Mizzou?[2]

GAMERTSFELDER: That was at Missouri. And that meant that we didn't have full time to work on graduate things. I got a master's degree by testing the linearity response of the [x-ray] film, when augmented with a fluorescent screen. [The nonlinearity was probably useful for enhancing some x-ray pictures, but it was not useful for our purposes.]

GAMERTSFELDER: And so—and then, for my doctorate, I did a lot of analyses of diffraction patterns of liquids to determine the arrangement of atoms around another atom, in various liquid elements.

YUFFEE: And where did you get your Ph.D.?

GAMERTSFELDER: I got the Ph.D. at Missouri in 1941. Getting a job was done by getting letters of recommendation from my professor, who wrote to several different places. I had ended up with two offers, [each for] $200 a month.

YUFFEE: Wow!

GAMERTSFELDER: That's a good one. There were a few 225-dollar [opening]s, that I heard about. And I ended up at Armour Research Foundation in Chicago. That was an interesting place. [Two other Ph.D.s from Missouri, Dr. Frank Trimble and Dr. Ernest Landen, were already on the staff before I got there.]

FISHER: What did you do there, what type of work?

---

1 nonionizing electromagnetic radiation having wavelengths in the range of approximately 5 to 400 nanometers, shorter than visible light but longer than x rays

2 *slang*—the University of Missouri

GAMERTSFELDER: Oh, all kinds of things. Mostly—to start in with, I worked with the people who were running various projects. And the projects ran from tearing [worn rubber] off tank treads to put new rubber on them, to watch-springs for Elgin Watch Company [in Elgin, Illinois]. And I was included in the conversations they were having when that contract almost died. Their problem was making a hairspring out of a nonmagnetic [alloy].

[The normal hairsprings are made, five or six at a time, from slightly flattened wires spirally wound, in contact with two other wires over most of their length. The normal, magnetically susceptible springs are easily separated. The nonmagnetic springs, in about 50 percent of the time, are stuck to neighbor springs, making them unfit for use. A meeting was arranged for the purpose of canceling the contract.]

The guy working on it had tried all kinds of things, and nothing worked. He put different atmospheres in an annealing oven, and vacuums, and powders. And he had stayed up all night the night before the meeting. And he changed from ac [(alternating current)] to dc [(direct current)], or the other way around, in an oven he was using to treat the thing with.

When the meeting was called to order, the researcher was asked to report on his most recent work. And without saying anything, he took a small bottle out of his pocket, shook it vigorously a few times, removed the cork, and dumped the contents on the table. And there were hairsprings—

FISHER: Everywhere?

GAMERTSFELDER: All over. So that changed the whole tenor of the meeting. They ended up hiring him.

YUFFEE: *(laughs)* Not surprising.

GAMERTSFELDER: [Dr. Ernest Landen, whom I mentioned earlier, had contracts to study the spectra of combustion gases in diesel engines. He had a single-cylinder engine directly coupled to an electric motor, which served as a starter for the engine and as generator to dump power back into power lines. Light from the combustion chamber was conducted through a pipe with quartz windows and lenses, which was inserted into a hole drilled in the wall of the combustion chamber. It took careful design and construction to get the quartz hot enough to stay clean [by burning off deposits], and the metal tube to be cool enough to maintain its strength [by staying within its elastic limit]. A successful design was obtained and used. Dr. Landen eventually went to the Caterpillar Tractor Company.

I did get a small contract of my own with a company which was making photograph needle tips with an osmium-ruthenium alloy which, when worn with use, developed an extremely smooth surface, thus slowing the rate of wear. The company was investigating the use of these materials as bearings in very sensitive meters. X-ray diffraction patterns proved the needle tips were true alloys, and not just a compacted mixture. [The contract came to an abrupt end when the owner and major experimenter died].

And, while I was [at Armour], I went to a[n American] Physical Society meeting that was [held in] Chicago. A lot of people were at the meeting, and there was a lot of talk about things that were possibly going on down [on the south side of town,] at the University of Chicago. They were collecting [many of] the nuclear scientists in the country, and these people at the meeting included some. They were—they knew, generally, that what they were working on was, essentially, getting power out of the [atomic] nucleus.[3]

And there was a story going around about that it was being encouraged by the Russians, because it got the good scientists away from doing something else that bothered them more.

[While I was a graduate student, I went with Dr. Gingrich (my thesis adviser) to visit Dr. Ernest [Omar] Wollan, who was at Washington University in St. Louis. When I found out that Dr. Wollan was then at the University of Chicago, I made contact with him and arranged for an interview.

The interview with Dr. Wollan was interesting and useful, and ended with a nonofficial offer of a position, pending a security clearance. At that time, I and my management were not satisfied with my position at Armour, and there seemed to be no prospects for the near future, so I was terminated. A few days later, my security clearance for a position at the University of Chicago arrived[, and I started work there].[4]

YUFFEE: Did he make an overture to you about a job?

GAMERTSFELDER: Yes.

FISHER: And this would have been in the spring, or in the fall, of 1942?

GAMERTSFELDER: This would have been in the fall of '42.

FISHER: I see.

Position at the University of Chicago

GAMERTSFELDER: And he made an offer that I accepted. And I was given to understand that when I got there, I would be working under H.M. Parker,[5] who was, at the time, working at the Swedish Tumor Institute [at Swedish Hospi-

---

3 the positively charged mass within an atom, composed of neutrons and protons and possessing most of the mass but occupying only a small fraction of the volume of the atom. Physicists sought to release enormous quantities of energy by splitting the nucleus of a hydrogen atom, generating a chain reaction.

4 Today, clearing a scientist to work in such a highly classified environment would require many months of background checking.

5 For more than a half-century, Herbert M. Parker was a leading force in radiological physics. He was codeveloper of a systematic dosimetry scheme for implant therapy and the innovative proposer of radiological units with unambiguous physical and biological bases. He made seminal contributions to the development of scientifically based radiation protection standards and helped the Hanford Laboratories achieve prominence in radiation biology, radioactive waste disposal, and characterization of environmental radioactivity. For his inside view of the maturation of medical physics and the birth and evolution of the parallel field of health physics, see R.L. Kathren, R.W. Baalman, and W.J. Bair; *Herbert M. Parker: Publications and Other Contributions to Radiological and Health Physics:* Columbus, Ohio: Battelle Press; 1986; ISBN 0-935470-36-0; 864 pages.

tal, Seattle, Washington] with Dr. Simeon T. Cantril. And they were using radiation to treat people with cancers, things of that type.

FISHER: It's interesting, Doctor, that you say that there was discussion, among your colleagues at the meeting, that there was something going on involving radiation.

GAMERTSFELDER: Oh, yes. Well, what they knew was: nuclear scientists were going to the University of Chicago. They didn't know any more than that.

FISHER: Oh. So the rest of you were all speculating, gossiping?

GAMERTSFELDER: Yes. Well, that's what those meetings are for.

(laughter)

FISHER: Well, I guess you're right about that. So what were you hired to do, in the fall of 1942?

GAMERTSFELDER: Well, I was hired to work on instrumentation, and what other things that were coming up. The instruments that were available in the lab that I was working in, were things which were suitable for measuring radiation in a place where you irradiated people [for cancer treatment (using x rays)]. And there was a survey instrument that was calibrated in R [(Roentgen)][6] per minute, and our general area of work is milli-R [(thousandths of an R)] per hour.

YUFFEE: That's right.

GAMERTSFELDER: So there was a big difference. There was some really good instrumentation for making precision measurements of doses and Roentgens; an R meter which would read up to a total dose of 50. Well, this was Roentgens at that time.[7]

FISHER: Right.

GAMERTSFELDER: And then they had some pocket chambers of the kinds which, I think, are still being used.

FISHER: Like the pencils [(pencil dosimeters)]?[8]

GAMERTSFELDER: Yes. And they're sensitive and fairly accurate.

YUFFEE: So you were—were you designing—trying to help them design something?

GAMERTSFELDER: Well, I don't know that "designing" was right. [We were] trying to find some things that could be used to do other things. And then [we sought to learn], "How do you take care of doing it for lots-and-lots of people?"

---

6 a unit of radiation dosage equal to the amount of ionizing radiation required to produce one electrostatic unit of charge of either sign per cubic centimeter of air; named for Wilhelm Konrad Roentgen, 1845–1923, German physicist, who discovered x rays in 1895 and received the Nobel Prize in Physics

7 a measure of the ionization of air by radiation, *not* a unit of absorbed dose to tissue

8 small electrically powered air condensers having a capacity of one to two cubic centimeters. Dosimeters are portable devices for calculating absorbed dose of radiation.

And we had Geiger counters.[9] That was one of my early jobs—calculating what kind of a dose you got from neutrons.[10] It's a simple calculation to find out what the collision cross-sections for neutrons of various energies were, with hydrogen.

YUFFEE: How many people were in this group with you, working on this?

GAMERTSFELDER: Well, at that time, there were: [an Englishman who had been working in Seattle,] Herb Parker; Karl Morgan[, a physicist and mathematician from North Carolina];[11] [Du Pont chemist] Jim Hart, and Robert Coveyou *(phonetic)*, who I think was a mathematician without any physics training.

FISHER: Who were some of the folks that you were working with in the early days back there?

GAMERTSFELDER: Well—

FISHER: —other than Parker and Cantril.

GAMERTSFELDER: Let's see. I—there wasn't anybody, really, for a little while. Then they started bringing in some people from Du Pont[12] for, essentially, getting them some experience.

Jim Hart, I think, was the earliest one. And he was the one that ended up running personnel meters down at Oak Ridge.[13] Somewhere along the line—oh, my brain ain't working.

FISHER: That's all right. I can't remember what I had for dinner last night, Doctor.

(laughter)

GAMERTSFELDER: No, he was a physicist from the University of Kentucky. Why can't I think of his name? [Dr. Pardue].

FISHER: Well, it will come, it will come. We're just trying to get a flavor for some of this stuff.

---

9 portable instruments for detecting ionizing radiation and measuring dose rate

10 elementary particles found in the nucleus of most atoms and having no electrical charge

11 A related account of the work and personalities of this instrumentation group can be found in "Determining Safe Doses for Ionizing Radiation at Chicago (1943)" and "Developing New Dosimetry Instrumentation" in DOE/EH-0475, *Human Radiation Studies: Remembering the Early Years; Oral History of Health Physicist Karl Z. Morgan, Ph.D.* (June 1995).

12 E.I. du Pont de Nemours and Company constructed and operated the Hanford site in Washington state from 1943 to 1946 for the Manhattan Project. The X-10 facility in Oak Ridge, a pilot reactor and plutonium production plant, was also built by Du Pont. Du Pont and the Harshaw Chemical Company of Cleveland produced uranium hexafluoride on a scale sufficient to keep the vital isotope separation research going.

13 During World War II, the Manhattan Project had built a vast complex of highly classified facilities in and near Oak Ridge, Tennessee, to process uranium for use in atomic bombs. The Atomic Energy Commission assumed control of these facilities upon its creation and, today, they belong to the Department of Energy.

The First Reactor, December 2, 1942

GAMERTSFELDER: Yeah. And then a guy by the name of Landsverck got there. He invented the Landsverck[-Wollan] electrometer, which was an improvement over the Lauritsen electro[scope (for measuring gamma exposures)] we had.

Besides working in the lab, I was present when they ran the first reactor.

FISHER: Well, we want to talk to you about that.

GAMERTSFELDER: I was monitoring gamma radiation[14] with an ionization chamber that Compton[15] had used in some balloon flights all over the world. It was arranged so that it had a compensating little chamber in it with a bit of radioactive material in it to cancel the normal radioactivity readings from the brass that the chamber was made of.

It seemed to work reasonably well when they first got the first criticality,[16] and when they made a prolonged run at some low power, the things started going backwards. It turned out, the bit of radioactive material was uranium.

FISHER: Can you tell us a little bit about what it was like; December second, 1942?

GAMERTSFELDER: Well, it's about the way people tell it. There was—the squash court was—I hadn't seen a squash court before in my life, and inside it was this pile of graphite blocks.[17]

There was canvas arranged around the sides of the thing and, I think underneath. That was intended to evacuate air from the system, because they knew that [nitrogen] had a fairly good neutron cross-section and figured they might have to get rid of the air in the reactor to make it operate.

But as they were taking readings with—on some counters[18] that were stuck in the pile,[19] they would pull out a control rod [used to regulate the rate of fission]. This control rod was a wooden stick with strips of cadmium stuck on it. And move it out a few inches and the counting rate would go up and then level off. Move it a little bit more, the counting rate would go up and level off.

---

14 highly penetrating photons of high frequency, usually 10^{19} Hz or more, emitted by an atomic nucleus

15 Dr. Arthur Compton, University of Chicago, a key member of the scientific team that established the Manhattan Project. Early in 1942, as part of the emerging effort to develop an atomic bomb, Dr. Vannevar Bush, head of the National Defense Research Committee, appointed Compton to be one of three program chiefs with responsibility to run chain reactions and develop weapons theory. As a result, under Arthur Compton the Metallurgical Laboratory at the University of Chicago became a critical research facility for the Manhattan Project.

16 an event in which a fissionable material undergoes a chain reaction

17 Stagg Field was the University of Chicago's football field. Laboratories below Stagg's west grandstand became the site of the first self-sustained nuclear chain reaction achieved by a team led by Dr. Enrico Fermi on December 2, 1942.

18 devices used to count the rate of radiation emissions from radionuclides

19 an early form of a nuclear reactor, an apparatus in which a nuclear-fission chain reaction is sustained and controlled

And somewhere, getting near noon, [Dr. Enrico] Fermi[20] was around. And they called things off and went and had lunch.

FISHER: Mm-hmm. Well, that's fair.

GAMERTSFELDER: Then they came back about 1:00 [p.m.], started in on again, quickly got up to that point that they had been, started in doing it. And Fermi [is doing calculations] with his little six-inch slide rule, and he says, "It ought to go."

And it [(the rate of radioactive decays per minute)] went, and it went up, and it went up, and it went up, went up, went up, went up. And they decided they were there [(they had achieved a self-sustained nuclear chain reaction)] and turned it off.[21]

Dr. [Eugene] Wigner[22] had been standing around the edge of the group with his hands behind his back; [he] brought forth a bottle of wine with a kind of a straw-basket–type thing around it. And they had some little tiny [paper] cups, and everybody present got a sip of wine.

FISHER: Was there a presence, or the feeling that something extraordinary had happened?

GAMERTSFELDER: Yes. That was—they were celebrating. They knew it worked. The pile wasn't finished [(construction wasn't fully completed)].

Oh, on the back, on the other wall away from the balcony, was another door looking in on the squash court. And there was a kind of a gangway over to the top of the pile, and that's where the "suicide squad" was located. They had some bottles of neutron poisons,[23] solutions they were going to run in and pour down into the pile if necessary.

FISHER: I see.

YUFFEE: And how did they get the name, "suicide squad"?

GAMERTSFELDER: Well, they would be going towards the place you wanted to get away from.

(laughter)

FISHER: And they knew that? I mean, there was that danger, that element of danger?

GAMERTSFELDER: Well, that was a possibility, yes. They recognized things might have gotten out of hand, or that they didn't know about all of the parameters

---

[20] Italian-born physicist under whose leadership the Chicago researchers produced the first sustained nuclear chain reaction on December 2, 1942.

[21] On that day, the pile generated one-half watt of power (heat). Ten days later it achieved 200 watts.

[22] Eugene Paul Wigner (1902–95), U.S. physicist born in Hungary; one of a number of European scientists who had fled to the United States in the 1930s to escape Nazi and Fascist repression. For discussions of Wigner's years at Oak Ridge, see the Morgan transcript.

[23] substances containing elements (such as cadmium) whose nuclei absorb neutrons, and thus decrease the efficiency of a nuclear chain reaction

necessary for really running a reactor. They had run—they had a lot of test piles which were, maybe something like that; square.

FISHER: It's a couple of feet across.

GAMERTSFELDER: Maybe eight feet tall, or something. They had a radium-beryllium source, which was being used in experiments all over. I think everybody who had some measurement or other to make, that wanted some source of neutrons, would get that.

And the guy who was running the elevator also ran a car around if people wanted to go to the store to buy something, or go to another building. He said [that] he knew when the thing was in the lead pot, and when it wasn't.

FISHER: Mm-hmm.

GAMERTSFELDER: He *didn't*, because they never told him.

FISHER: What kind of security was there, under the stands there?

GAMERTSFELDER: Well, they had guards. You had to wear a badge. And your badge—I don't know whether they had films in the badges yet or not.[24] If they didn't, you were carrying a film (a dental film) in your pocket. And we had personnel meters; the pencils.

One of the early experiments was the one [in which] we were trying to measure neutrons with a pocket chamber. We had made some special chambers. And we coated the inside with paraffin, and then put as thin a layer as we could on top; getting something so it would conduct a little bit of electricity. I took them over. I was going to use cyclotron[25] neutrons on the things. [The electrodes were supposedly made out of aluminum. Well, evidently they were not: When I took them into the cyclotron, those things flew out of the box and were standing at attention inside the magnetic field of the cyclotron.]

FISHER: Wow.

GAMERTSFELDER: We did the experiment later, after we got some real aluminum [electrodes for] the chambers. But that wasn't a good enough way of measuring things.

Tenure at Oak Ridge and Move to Hanford

YUFFEE: How long were you in Chicago with—

GAMERTSFELDER: Just short of a year.

YUFFEE: Just short—so that would bring you to 1943?

GAMERTSFELDER: Yes.

---

[24] Film badges are dosimeters worn routinely to measure accumulated personal exposure to radiation on photographic film.

[25] an accelerator in which particles move in spiral paths in a constant magnetic field

YUFFEE: And where did you go from there?

GAMERTSFELDER: To Oak Ridge.

YUFFEE: And did you all travel as a group to Oak Ridge?

GAMERTSFELDER: No. I was—Jim Hart and I went down ahead of other people.

YUFFEE: What was your purpose?

GAMERTSFELDER: Oh, we were the original nucleus for a larger health physics organization. That's what all. And then [Karl] Morgan came down, and he was to run a school to train people. We got five people from Du Pont to train, and I'm glad I don't remember their names—

FISHER: Oh, why is that?

GAMERTSFELDER: —but they were totally unacceptable.

FISHER: Really?

GAMERTSFELDER: I think they all thought they were going to be plant managers inside of two, three months. And we sent them packing and talked to Du Pont, and they sent us—this time we got 12 people, and we got 12 good ones.

For at least our purposes. Jack Healy was one.[26] C.M. Patterson[27] is another. They were all useful people we got. I may have their names if you really want to know what they are.

YUFFEE: That's okay.

GAMERTSFELDER: But I've forgotten some of them.

YUFFEE: How long were you at Oak Ridge at this point?

GAMERTSFELDER: About 11 months, or maybe 10. And on the day I got on the train to go to Hanford, Washington,[28] I was on the Du Pont payroll. I had been on the University of Chicago payroll at Chicago and at Oak Ridge.

YUFFEE: Why did you go to Hanford?

GAMERTSFELDER: Well, because they were having, going to have, a health physics group there, and Herb Parker was going.

YUFFEE: So did you decide to go because Dr. Parker was going, or—

GAMERTSFELDER: It's not Dr. Parker, it's Mr. Parker.

YUFFEE: Oh, Mr. Parker.

GAMERTSFELDER: He was very firm in insisting that he was not [to be called] "Doctor."

---

[26] For the transcript of the interview with Mr. Healy, see DOE/EH-0455, *Human Radiation Studies: Remembering the Early Years; Oral History of John W. Healy* (May 1995).

[27] C.M. Patterson was born December 24, 1913 in Fairfield, Nebraska. He received a B.S. in Pharmacy from the University of Nebraska. From 1944 to 1951, he served as Supervisor of Radiation Protection at Hanford Works. From 1951 to 1978 he was the Health Physics Superintendent at the Savannah River plant. Patterson served as president of the Health Physics Society from 1962 to 1963.

[28] the DOE's 570-square-mile former site for plutonium production, located near Richland, Washington

FISHER: I'm still a little bit curious about some of the work that you were doing at Oak Ridge with the [X-10] graphite reactor there.[29]

GAMERTSFELDER: Yes.

FISHER: You were there in the room when that—

GAMERTSFELDER: I was there when it went first time.

FISHER: And that was a vast improvement, of course, on what was going on in Chicago.

GAMERTSFELDER: Oh, yes. It was—well, it produced some [useful amounts of] power. And it produced—instead of micrograms of plutonium, it produced grams. So they had their reactor, and they had a separations plant.[30] They had quite a chemistry lab. We had our physics kinds of things, and the physicists had some other things to do.

YUFFEE: Did you have a choice about whether you could stay at Oak Ridge with that health physics group?

GAMERTSFELDER: Yes, I could have stayed. Dr. Wollan, who was at Oak Ridge, had—well, let's see—yeah, he was the guy who actually hired me at Chicago [and was the leader of my group there].[31] He had gone down to Oak Ridge, and he made a—he wasn't a forceful man. He invited me to stay there. But to me, the reactors were more enticing.

YUFFEE: At Hanford?

GAMERTSFELDER: But I find out later that his assistants got the—this is just this last year—got the awards for that Swedish—

FISHER: The Nobel Prize?

GAMERTSFELDER: Nobel Prizes. And that Dr. Wollan wasn't considered because he was dead. But, essentially, he would have—if they had done it earlier, he would have been one of those. And if I had worked for him, I might have been one of them.

YUFFEE: I think, when I spoke to Dr. Morgan, he mentioned that the work that Dr. Wollan had done had led to a Nobel Prize and that the people who had worked with him recognized that fact, that Dr. Wollan was one of the people that really deserved it.[32]

---

[29] The X-10 pile was a graphite cube, 24 feet square. It had been drilled with 1,248 channels that could be loaded with uranium slugs. Large fans blew cooling air through these channels. (Source: Richard Rhodes; *The Making of the Atomic Bomb;* New York: Simon and Schuster; 1986, p. 547)

[30] a facility where plutonium is extracted from uranium and fission products in irradiated fuel elements

[31] According to Karl Morgan in his oral history, Dr. Wollan spent most of his time developing fiber dosimeters—small electrometers with a fiber that moves across the scale proportional to the dose administered to the instrument.

[32] Karl Morgan recalls, in "Creating a Health Physics Division (1943–44)": "The [1994] Nobel prize in Physics was given to one of [Wollan's] students there who he educated and trained in neutron diffraction techniques. Had he lived and were he alive today, he would be the principal recipient of that Nobel prize in Physics. Of (continued...)

Why don't you tell us about your early days at Hanford?

GAMERTSFELDER: Well, I'm trying to figure out just how to get started.

FISHER: Well, I have a pet interest of mine. I'm very curious, with all of the people that we speak with that were there at the time, about what were the attitudes and the nature of the work; how it changed in this six-month period from the fall of 1942 to the spring of 1943, when everything that you had been reading about or all the academic research you had been doing suddenly was a reality, you were able to create a sustained reaction—

GAMERTSFELDER: Well—

FISHER: —that might have had a special effect on the work you were doing.

GAMERTSFELDER: Well, yes, it was the source of my livelihood from then on, essentially. Hanford was being constructed when we got there. We did some background checking around the whole area, just to see where we were. We knew we were going to need more people than we brought with us. Well, besides the twelve I said were good ones, Du Pont brought in another batch of five who then specialized in the problems with the plutonium purification (after you get rid of most of the other stuff) and in the ways in which you did things to make the pieces that went into the bombs. And they had five people who were specialized in that.

And, let's see—it wasn't very much longer after we got there, a month or so, that they took the first reactor critical.

FISHER: Do you remember the month, what month that was?

GAMERTSFELDER: I don't remember the time. It was in the fall.

FISHER: And you arrived about September or October?

GAMERTSFELDER: No. We got there at the tail end of August.

FISHER: August. Okay.

GAMERTSFELDER: And the first two days we spent in TQ, the transient quarters. It later became a hotel. After that, my wife went out to—was put in a dormitory, a women's dormitory. And I and four other guys ended up sleeping in a house that had just been finished, into which they stuck some beds.

YUFFEE: So it seemed like a lot of sacrifices were being made, on—you know, personal sacrifices—on the part of the scientists.

GAMERTSFELDER: Yes. Well, it wasn't all that bad. That was a period of about a month we lived that way, then we got a house of our own. We got some GI [(Government Issue)] furniture—pretty nice stuff, actually.

The startup of the reactor was—well, let me tell you a little story about the design of the reactors.

---

[32] (...continued)
course, that has been acknowledged." (Morgan transcript, DOE/EH-0475)

FISHER: Sure.

GAMERTSFELDER: They were designed with shielding and graphite blocks and with tubes running through from the front face. And they had intended to have a cylinder going through the graphite.

And one of the Du Pont people, probably associated with Charlie Wende, said, "We don't know any of those numbers very well. Let's fill in the corners." And they did, except for, maybe, the last one or two. And so they ran a dry critical, and it went a little bit quicker than they had expected. They ran a wet critical, and it took a little bit more than they expected.

FISHER: Can you explain the difference between those two? I'm not familiar with that.

GAMERTSFELDER: It's just a—well, the reactor was water-cooled.

FISHER: Mm-hmm.

GAMERTSFELDER: And so they loaded uranium in it, and they ran a critical on it when it's dry.

FISHER: I see.

GAMERTSFELDER: And the wet critical. They had water in it, but it wasn't flowing. It wasn't necessary for it to flow. It took a little bit more than what they had calculated. And they finally filled it out to the big cylinder and ran some tests. And they were checking coils and this and running it up megawatts and made more tests, on this thing and that.

Then they finally took it up to 10 megawatts, and were going to run a test to see how things went along. And slowly, they had to keep pulling the rods out. And they finally got the rods all the way out and the power [still continued to decrease]. They kept watching it, and then they started to get a little bit of power out of it. And, pretty soon, we knew what it was that was going on. That was the xenon.[33]

FISHER: Right.

GAMERTSFELDER: And so they overloaded, went into the corners, and got up so they were running in the hundreds of megawatts.

FISHER: But that xenon poisoning really changed the way the reactors were designed thereafter.

GAMERTSFELDER: Oh, yes. Well, they didn't change the design, but just knew how to run them.

FISHER: Oh, okay.

GAMERTSFELDER: Because the making of the manufacture of the parts, I guess was essentially: you had the parts, you had to put them together. I don't remember

---

[33] a noble gas; symbol Xe. The isotope ^{135}Xe is created as a fission product in some reactors. Xenon-135 nuclei absorb neutrons. The presence of ^{135}Xe in a reactor will slow down the chain reaction, until the isotope decays. This effect is known as "xenon poisoning."

the time schedule, now, of the other two reactors that they got going fairly quickly. And then they started getting some fuel going through the processing plants. And we got the fuel, got some plutonium, shipped it off.

YUFFEE: Down to Los Alamos?[34]

GAMERTSFELDER: Down to Los Alamos. And Healy and I had a bet on when they were going to test it.

(laughter)

FISHER: Really? Who won?

GAMERTSFELDER: I did.

FISHER: You did?

GAMERTSFELDER: "Listen," I told him—I saw him, oh, a few years ago, and he said, "It was a five-dollar bet." I think it was a quarter.

(laughter)

GAMERTSFELDER: The main thing—it was an "I told you so" bet. And I don't really remember which way I bet. The date was the 15th of July, and I won.

Well, the thing is—the security was arranged so that the people in the pile areas ("100" areas, we called them) didn't know what was going on in the 200 areas, which was the separations plants. But Health Physics was a small group, and we needed flexibility. We needed people to be able to fill-in here and fill-in there, and we had clearances for everything. So we had access to a little bit more information than most people around the place did.

YUFFEE: Sure.

FISHER: How many folks were in the initial group? It was you and Healy?

GAMERTSFELDER: Well, it was—there was Herb Parker and me and the 12 people from Du Pont. And I guess the other five got there fairly quickly.

One of the early things we did was start training people for some of the other jobs we were going to have to have. The people who already knew the instruments had to have more people around. We called it the—what the heck did we call those guys? [Inspectors.]

FISHER: Well, they would be the technicians?

GAMERTSFELDER: They were essentially technicians. And they were people with high school educations, and not *just* out of high school. They had working experience of one kind or another, and were married and had responsibilities.

---

[34] the National Laboratory near Santa Fe, New Mexico, where nuclear bombs were assembled before and during the Cold War; operated by the University of California for the U.S. Department of Energy. Since World War II, Los Alamos has been a research and development center for nuclear weapon designs and other scientific studies.

FISHER: Was it effective in the early days? Do you think that you did a good job with those resources?

GAMERTSFELDER: I think so. See, we only had one reactor to start with.

FISHER: Right.

GAMERTSFELDER: And there wasn't all that much stuff [(plutonium)] around.

FISHER: What was the framework of authority? You had—Du Pont was running Hanford, and then you had Groves[35] here, certainly.

GAMERTSFELDER: They fought a battle about that. Herb Parker was very insistent that he didn't want to work for anybody whose responsibility it was to produce plutonium.

(laughter)

FISHER: Boy. How did he get around that?

GAMERTSFELDER: Well, they ended up by putting us in the Medical Division.

FISHER: Run by [Stafford] Warren[36] or [Hymer] Friedell?[37]

GAMERTSFELDER: No. No, Dr. Cantril at—out at Hanford. Cantril wasn't part of the operation; he was a consultant.

It was a Dr. [W. Dag] Norwood who was the head of the—and Dr. Norwood was a medical doctor, but he had had an engineering degree before he went into medicine. He sort of delighted at being introduced as "Doctor" and, in a meeting, showing some sense in terms of things that are [of a] scientific nature in other fields.

Health Physics Monitoring and Early Exposure Standards at Hanford

YUFFEE: But you were on the Du Pont payroll?

GAMERTSFELDER: We were all on the Du Pont payroll.

FISHER: But in the Medical Division? That was very important to Mr. Parker?

GAMERTSFELDER: Yes. He—and there was, I think, good reason for it—he wasn't compromised by the feelings of getting something out, quite to the same extent.

FISHER: But those difficulties weren't solved once and for all once you were in the Medical Division.

35 General Leslie R. Groves, U.S. Army, assumed command of the Manhattan Engineer District in 1942 and led it to completion of the Manhattan Project.

36 A professor of Radiology at the University of Rochester (Rochester, New York), site of research involving plutonium and human subjects, Dr. Warren left Rochester to work on the Manhattan Project in Oak Ridge as head of the medical section and headed an Intramedical Advisory Committee. After World War II, he became dean of the University of California, Los Angeles Medical School.

37 In 1943 Friedell became the Executive Officer of the Manhattan Engineer District Medical Division. For the transcript of the January 28, 1995 interview with Friedell, see DOE/EH-0466, Human Radiation Studies: Remembering the Early Years; Oral History of Radiologist Hymer L. Friedell, M.D., Ph.D. (July 1995).

GAMERTSFELDER: Oh, no. There was always give-and-take. The first fuel that was dissolved was cooled,[38] probably 35 days. And from then on, for a while, they were running fuel of about the same magnitude of cooling. And an awful lot of iodine [was going out of the] stack.

As soon as we found out how much iodine was going up the stack, Herb Parker started lobbying for getting some longer cooling times. And eventually, it went up to 45 days, 50. Finally, we got it worked up to—it finally ended up about 80 or 90 days, something like that. That cut down the iodine quite a bit.

FISHER: And who would be fighting Parker? Would it be the Du Pont people? Would it be Groves, looking for increased product?

GAMERTSFELDER: Well, that I don't know. I don't know where the arguments were. They were above my head. Parker was involved in the meetings that our general manager had, and he presumably reports to Groves. I don't know, it was just—what I saw was what, in the end, happened.

FISHER: Okay.

GAMERTSFELDER: I wasn't privy to all of the arguments that were made to stretch it out.

YUFFEE: Was there a concern at that point that the amount of iodine that had already been released was of a danger to the population?

GAMERTSFELDER: Well, no. It was—well, the general philosophy was trying to keep the doses as low as you could. Going back to [my days at the Met Lab in] Chicago, I remember Ernie Wollan and Herb Parker talking about the radiation levels they would have to have in the plants, when they got to running.

And the guidance that was available—there weren't any regulations, like would be put forth by the AEC[39] now. But the guidance, which was provided by the ICRP[40] and the NCRP,[41] was that you could take 100 millirem[42] a day, and with a provision that there was a vacation every year of at least a month and to be taken all at once.

YUFFEE: Oh, it was mandatory?

GAMERTSFELDER: Well, that was the recommendation. Nothing was mandatory about it.

YUFFEE: Sure.

---

38 allowed to sit while the short-lived fission products to decay away so that the fuel rods could be chemically processed and plutonium separated out

39 the U.S. Atomic Energy Commission, predecessor agency to the U.S. Department of Energy and Nuclear Regulatory Commission (NRC); established January 1, 1947

40 International Commission on Radiological Protection

41 National Council on Radiation Protection. Although the words "and Measurements" were later appended to the name, the council's initials remain NCRP.

42 A millirem is one-thousandth of a rem. A rem is a unit of radiation dose equivalent, or "rads times the quality factor, Q." The limits for occupational exposure of workers to radiation range from 2 to 5 rem per year for most countries.

GAMERTSFELDER: I'm sure things were handled in different ways in different places and, probably, better in [the] Medical Department than in the Irradiating Castings Department.

YUFFEE: Was it, in your mind, a fair estimate, the 100 milligrams a day?

GAMERTSFELDER: Millirem.

YUFFEE: Sure.

GAMERTSFELDER: They're nearly compatible, but not quite. Yeah. Well, at that time, we didn't know about the milk cycle.

FISHER: I'm sorry, can you say it again?

GAMERTSFELDER: And the problem was one of inhalation of iodine.

YUFFEE: Milk cycle.

FISHER: Oh, okay.

GAMERTSFELDER: Iodine tends to go through cows into the milk.[43] And the milk goes into babies. And [for] babies, the diet is all milk, and they've got small thyroid[44] glands. A baby can take quite a dose, [if one were to] give it a little bit of iodine.

FISHER: So did the Army, in their authority as, or in their position as the major authority at Hanford, did they respect the recommendations of the ICRP for worker standards?

GAMERTSFELDER: I don't know what they thought. These fights were someplace else. We didn't have contact with the military in that sense, at the time. There were military people around.

FISHER: So you dealt with Parker as the supervisor?

GAMERTSFELDER: Yes.

FISHER: And when did Parker arrive? Did he arrive with you in August of '43?

GAMERTSFELDER: No, but shortly thereafter.

FISHER: Okay.

GAMERTSFELDER: The timing is, sort of, slightly different.

YUFFEE: What would have comprised, basically, your day-to-day type of work at that time?

---

[43] Scientists at this point of time were not aware that radioiodine depositing on pasture land, ingested by dairy cows, transferred to milk, and ingested by man (and children) would constitute a major intake pathway, leading to excessive concentrations in human thyroids. For a discussion of attempts to monitor the milk-to-man iodine cycle at Hanford, see "Unknown Health Hazards From Fallout" and "Monitoring Livestock Exposure" in the John Healy transcript (DOE/EH-0455, May 1995).

[44] an endocrine gland located at the base of the neck and secreting two hormones that regulate the rates of metabolism, growth, and development

GAMERTSFELDER: Well, at that time, I was assistant to Herb Parker, and we were trying to man the operation with people who knew what was going on. We spent a lot of time driving around the plant, going to this area and that area.

YUFFEE: And, at the time, were you monitoring people, soil, animals—what type of monitoring were you doing?

GAMERTSFELDER: Well, we weren't doing so much of that at the time. We were—we did monitor vegetation (because it did pick up the iodine), primarily. We had a site-survey group. We had a lab that analyzed the samples, and we had our own counting room.

YUFFEE: And were they being analyzed for elements other than the iodine?

GAMERTSFELDER: Well, some of it was just total—whatever it was we picked up. We would take vegetation samples and things. And we had filters running. Around each of the operating areas we had "614" buildings, which were essentially large telephone booths, and they had Victorine [detectors][45] in them. There was an ionization chamber, which was—either of you instrumentation people?

FISHER: No, I'm afraid not.

GAMERTSFELDER: They had a rotating part in them which, essentially, instead of measuring the dc current from the ionization chamber, gave you an ac signal. And those bearings in those systems weren't accustomed to the dust of the Hanford area. The bearings would wear out. They were out of business, maybe better than half the time. What we had—there was power available at the 614 buildings, and we also had some [of the] 614 buildings offsite, over near Kennewick and Pasco and Benton City. They were scattered around.

FISHER: Were you picking up significant readings, even in the early days?

GAMERTSFELDER: Not particularly, at that time. It was a routine we had to go through. We would get some stuff on the vegetation, but not much at the large distances.

FISHER: At that time, were you collecting people's readers [(film badges)] to see what type of levels—

GAMERTSFELDER: Oh, yes. People coming into the gatehouse showed a badge and picked up a—that is, a card that said they were cleared, and they got a badge which had a film badge in it. It had a filter over the major part of the badge so that the radiation recorded by the badge was—the response was essentially linear with respect to different energies of radiation.

And then they had some holes punched in the badge to make the number (employment number) so they could record things against his name when they read the films. Then we had—everybody got two pencil chambers.

[45] Victorine detectors for measuring cumulative exposures to radiation

FISHER: Why two of them?

GAMERTSFELDER: Redundancy. They weren't always perfect.

FISHER: There was a concern about them?

GAMERTSFELDER: They failed.

FISHER: They took [(used)] the lower of the two readings, didn't they?

GAMERTSFELDER: Well, I don't know they did that, or whether they averaged them. Most of the time we got two readings.

FISHER: And who was interested in these readings? When your office was with Parker, you compiled these results?

GAMERTSFELDER: Well—well yes, everything. We had weekly reports, proof we were working, essentially.

(laughter)

FISHER: Mm-hmm, just earning your paycheck.

GAMERTSFELDER: [Proof that we had run] so many surveys. The people running the badge said—they had numbers of all of that. And along with that were statements of how many—what the results were, in very simple terms.

And that goes into Herb Parker's office. And Herb Parker has a weekly report that goes to the manager. And the manager has an assistant who goes through all of that stuff and condenses it down for the manager and writes the letter for the manager to send in to the Army, which says, "Everything's fine this week, and next week it will be better."

(laughter)

Thor—I just thought of his name. I tried to think of it the other—Thor Hauf. He was a—I think he was a chemist, but he got assigned to be a technical helper to the plant manager, and he was writing those reports.

FISHER: How often were badges read for a worker?

GAMERTSFELDER: Badges were [read], I think, weekly.

FISHER: And pencils, too?

GAMERTSFELDER: And pencils daily.

FISHER: Daily. I see.

GAMERTSFELDER: Daily. It was—you had to turn the pencils in. The badge was put in a rack in the gatehouse.

FISHER: And were any of the veterans that were stationed at Hanford, were they ever badged, to your knowledge?

GAMERTSFELDER: Veterans?

YUFFEE: Or the soldiers, at the time, that were stationed?

FISHER: Well, yeah, the guards.

GAMERTSFELDER: I don't know where the soldiers were, if any.

FISHER: Well, there were actually quite a few, it turns out, from the very early days all the way through the '60s. They were manning antiaircraft guns all throughout the reservation.

GAMERTSFELDER: Never saw them. *(laughs)*

FISHER: Really? Never saw any soldiers there?[46]

GAMERTSFELDER: No. I never saw them.

GAMERTSFELDER: I don't—they could have been checked at barracks. But I thought all of that stuff was—as soon as they finished building the reactors, that stuff kind of just shut down. I don't know where they were.

Well, there were some that were just outside the 200 area, and then they were interspersed all around the periphery of the camp, the perimeter of the camp. And there were a couple of large gun emplacements throughout. But of course, the place is so large that, during the course of your job, you might not ever bump into them.

Well, there was a time when we had a station on top of Rattlesnake Mountain we visited regularly. I never saw any [soldiers]. I was up there a couple of times myself. I rode up with my hand on the side of [the] jeep, running through dust, it was that deep.

FISHER & YUFFEE: Really?

(laughter)

FISHER: Not too much vegetation up there.

YUFFEE: During this time, was there was any biomedical research going on?

GAMERTSFELDER: There was—well, from the very start, there was a fish lab. There were people [who] were concerned about the salmon in the Columbia River. That eventually was part of the health physics—well, we were [the] "Health Instruments" [group] at Hanford. [Dr.] Dick Foster was running that, and there were consultants from the University of Washington coming over every once in a while.

YUFFEE: And you were monitoring the level of exposure?

GAMERTSFELDER: Yes. And we monitored the readings of the water that was dumped into the river. Most of it was relatively short-lived, so—

FISHER: With radioiodine?

GAMERTSFELDER: Iodine would be one of the things, but most of the stuff we were measuring were things like sodium and other relatively short-lived things. And some of the gas was a little bit radioactive.

---

[46] The military headquarters were located at the south end of the Hanford site, but the defenses were established *outside* the Hanford area, to protect the site from possible Japanese raids.

And we had monitors that monitored the water going into the ponds, and that took some devising. One of the things we finally ended up with was a Geiger counter over which clean water was running, surrounded by a veil of single streams of water that was contaminated. That kept the counter from getting contaminated, in itself.

FISHER: A lot of ingenuity went into these instruments in the early days.

GAMERTSFELDER: Yes. I—the organization changed—I ended up being the head of the scientific studies kinds of things. We had lots of different names for things. It changed with time. But I had people in the Physics Group, I had an Instrumentation Group. Under me was a Calibrations Group, which serviced the people in the plant, in terms of calibrating the instruments regularly and running test films through the operation to be sure that the badge systems were working right.

And I had a soil chemist, and ended up with a geologist. And then, eventually, they put the Meteorology Group under our side of things. We ran the routine meteorology. We had a group that gave advice to the people running the plants, as to whether it was a good time to dissolve the fuel or not. And we also did some research kinds of things, trying to figure out what the deposition velocities were, what particles were falling here and there. *(laughs)*

Biomedical Research at Hanford

YUFFEE: Was there any biomedical research done on people earlier?

GAMERTSFELDER: Well, there was some. There was a batch of goats on the plant, and one of our guys, Carl Herde, got interested in it. But they were monitored. We weren't into sacrificing animals at that time. [We] did end up, eventually, with a biology system, and they were doing research on, oh, yeasts and microorganisms and mice.

FISHER: Well, and the fish you mentioned, the salmon.

GAMERTSFELDER: And rats, and the salmon—that was always part of it. But that got to be part of the biology lab.

FISHER: Then later on, there were dogs and things that you were using?

GAMERTSFELDER: And they had dogs, pigs, goats. There was a—I don't know whether I'll tell you this story. You can delete a few things. They had some sheep, and they were feeding some iodine to them. And in order to keep things usable in the lab, they had some pens and living quarters that were covered with neoprene (artificial rubber, which was pretty tough), and hoofs wouldn't bother it, and it could be cleaned relatively easily. And they were fed radioactive materials. And they ended up having trouble with the rams mounting the ewes, because the floor was slippery.

(laughter)

GAMERTSFELDER: And so somebody got hold of some research on the general subject of experimental work with sheep. One of the stories in there was a batch of

1261867

100 ewes that were separated for a genetics experiment. They were going to breed them with very specialized sperm from several different places. One ram got into the pen one night. He impregnated 50 of them.

(laughter)

YUFFEE: A rather potent ram, huh?

FISHER: Despite the slippery floors.

GAMERTSFELDER: I don't know how many more he tried.

YUFFEE: Did he drop dead at the end of the evening?

GAMERTSFELDER: No. No, apparently he was inexhaustible.

FISHER: When you were doing this research in the Biology Division, and the work that you were doing compiling exposures and things, was all of this work done towards establishing a standard of maximum permissible dose, or do you think that it was done in an effort—

GAMERTSFELDER: It wasn't so much establishing a standard, as establishing the means, maybe, to establish standards.

FISHER: Mm-hmm.

GAMERTSFELDER: I don't remember what—we didn't have standards that way, around—really, until they got the NCRP going, with, essentially, Government sanction and understanding.

We had, at the starting point, that 100-millirem-per-day [standard for maximum exposure]. In our operating rules for people who were working in the plant, we investigated anytime somebody got 50 in any one day. And we tried to find out what was going on. It isn't that we punished anybody for getting over 100. Those were unusual circumstances if they did that.

FISHER: And what happened if somebody received a greater-than-permissible dose?

GAMERTSFELDER: Well, they would just try to find out what it was. We would record it. Everybody had something that recorded what total dosage he was getting. So at the end of the year, we would sum things up. I don't know if we even told them at the beginning. But eventually, we were telling them every year.

FISHER: But a worker's duty might not be altered or changed if, one day, he got over the dose?

GAMERTSFELDER: Normally, not.

FISHER: So there were, in fact, people who were getting—

GAMERTSFELDER: Well, they wouldn't—nobody was getting 5 rems a year, or anything like that.

FISHER: So the doses were reasonable ones?

GAMERTSFELDER: Yes.

FISHER: Even by today's standards?

GAMERTSFELDER: Well, they've lowered the limits a couple of times since.

FISHER: Yes.

GAMERTSFELDER: But I think the philosophy, what they were doing at Hanford, kept up with whatever changes were made.

YUFFEE: And there was obviously follow-up to make sure that the—

GAMERTSFELDER: Yes. Well, those people that we hired with the high school educations, they were very responsible people. May I skip around a little bit?

FISHER: Sure, absolutely.

Nuclear-Powered Aircraft; the Aircraft Nuclear Propulsion Program

GAMERTSFELDER: I left Hanford, went to the Aircraft Nuclear Propulsion Division of General Electric. We were going to fly an airplane on nuclear power.[47]

They had several different kinds of missions that they were working on, and we stopped with this direction. We finally ended up where we were testing the device with the cycle that we would expect maybe, would end up in the airplane. [These tests were run at the GE Aircraft Engine Group facility in Evendale, just north of Cincinnati, Ohio.]

They had run multiple engines off of one chemical heat source, and we were testing [a] reactor [at the Idaho National Engineering Laboratory].

(Material deleted. Dr. Gamertsfelder inserts the following for clarity and accuracy:)

The initial criticality steps had been completed. And when they started to operate at higher powers, the monitor they had installed in the reactor did not respond properly.

The reactor had a zirconium hydride material as the moderator.[48] It held about as much hydrogen as the same volume of water would, and it could run at higher temperatures.

---

47 In the late 1950s and early '60s, several contractors worked on the development of nuclear-reactor–powered jet engines for long-range military aircraft. The projects were funded by the AEC and the Department of Defense, and the contractors included General Electric, Pratt & Whitney, and others. Engines were built in Connecticut (Pratt & Whitney) and Ohio (GE), and some were tested at the National Reactor Testing Station in Idaho. Also known as the NEPA (Nuclear Engine for the Propulsion of Aircraft) program, the nuclear aircraft program was cancelled by President Kennedy because problems with engine weight and crew shielding, as well as design philosophy disagreements, were halting progress.

48 a substance that slows (moderates) or thermalizes neutrons coming from the fission reaction, increasing the probability of their causing additional fissions in sustaining the chain reaction. In modern reactors, water is used as the neutron moderator.

(Material deleted. Dr. Gamertsfelder inserts the following for clarity and accuracy:)

It was replaced by an ionization chamber which, normally, was located outside of the reactor, and was meant to work like a cruise-control throttle in an automobile. In order for this chamber to work in this new location, the power supply for it was modified by adding some filtering circuits. This system worked very well for several incremental increases in power level. When they started the next increment, there was a nuclear excursion.[49]

The excursion had taken place after the normal workday at Evendale had ended. The next day in Evendale, a meeting in our conference room was convened to discuss the problem [by phone] with Idaho people in *their* conference room. They did not yet know the cause of the excursion. Our management decided to send a group to Idaho to assist in the investigation and subsequent recovery. We were told to go home and pack a suitcase, and return. When we returned, we were taken to an airport, where our airplane (a C-54[50] on bailment from the Air Force, and known officially as the "Site Flight" and unofficially as the "Slite Fright") then took us to Idaho.

The next morning, after getting to the test site, we were told what had been learned while we were out of communication. They had not yet discovered the cause of the excursion. About a half-hour later, the two-man team that was examining all the instrumentation came into the conference room with a graph of the response of the modified power supply, which was not large enough to provide a shutdown signal.

FISHER: When was this? When did this occur, more or less?

GAMERTSFELDER: Oh, in the late '50s. I can't get an exact year.

FISHER: It was just a brief little interlude you had, because you did go back to Hanford, didn't you?

GAMERTSFELDER: I did. I went back to Hanford for a short period of time[, three years]. It was, overall I guess, a mistake, but—

FISHER: Why do you think it was a mistake?

GAMERTSFELDER: Hanford was changing. They [were going to break it up].

YUFFEE: So this was diversification?

Health Physics Response to Accidents at Hanford

GAMERTSFELDER: Diversification. The job I had to do was not what I thought it was and was disturbed by an excursion in a system, which required my services full-time for months.

(Material deleted. Dr. Gamertsfelder inserts the following for clarity and accuracy:)

---

49 an unexpected rapid increase in fission rate, resulting in a nuclear chain reaction

50 a four-engine cargo plane built by Douglas Aircraft for the military as the C-54 Loadmaster and for civilian airlines as the DC-4 passenger plane

I was put on an investigation committee, along with four other senior GE employees, to determine the cause of the accident and evaluate the way in which it was handled, and to make recommendations to prevent a recurrence. The chairman of the committee was Carl N. Zanger, of the AEC.

There were two other groups: a "Working Group" to investigate the ways to safely correct the situation, and an "Advisory Council" to review and approve the plans of the Working Group. Our committee members were forbidden to take an active role in the work of the other two groups.

There was a plutonium processing plant in the 234-5 Building in the 200 West area which produced plutonium-contaminated liquid waste streams. These waste streams were being treated in the Recuplex[51] operation, which had been designed as a semiworks to develop the best way to recover the plutonium in the waste stream.

The recovery equipment was in an enclosure made of transparent half-inch-thick plastic sheets. The enclosure was about 40 feet long, 20 feet high, and 10 feet thick. There were glove ports for some operations, and a control panel for pumps, remote valves, heaters, and other equipment. All of the tanks and piping in the enclosure which contained plutonium were geometrically safe. Some of the vessels which were used to prepare solutions to treat the plutonium were not geometrically safe.

FISHER: Would the delay in reading the badges have affected the readings?

GAMERTSFELDER: No. No, it just delayed our getting the information on them.

FISHER: I see.

FISHER: And there were no problems, no health problems?

(Material deleted. Dr. Gamertsfelder inserts the following for clarity and accuracy:)

GAMERTSFELDER: Well, no, there apparently weren't any health problems. The whole-body doses, including gamma and neutron immediate effects, plus the doses due to self-irradiation from activation products in their bodies, were 110 rem, 40 rem, and 20 rem. The RBE [(relative biological effectiveness)][52] for the fast neutron doses was two.

The employees who were taken to the hospital were retained there a little longer than necessary, to see if there were any delayed effects. No damage of any kind was found. However, plans were made to check each of them on a regular basis.

FISHER: Doctor, it's interesting that you said [that] the three individuals involved—they were in the accident (the excursion) were taken off the plant site into town.

GAMERTSFELDER: Into town, yes.

FISHER: Into the local tri-cities hospital?

GAMERTSFELDER: No, there was a hospital in Richland.

---

[51] a plutonium waste recovery facility at Hanford, in the 234-5 building

[52] the ratio of the damage caused by that radiation compared to the damage caused by the same absorbed dose of reference radiation, usually cobalt-60 gamma rays

FISHER: Kadlec Hospital, right? But it—are you talking about the hospital? Was this a medical facility that was administered by the Medical Division?

GAMERTSFELDER: There were GE doctors there.

FISHER: Oh, okay. It wasn't a public hospital.

GAMERTSFELDER: Well, it *was* public. Richland, unlike Oak Ridge, has always been an open city. The restricted area began a few miles north of the city.

Kadlec Hospital was always a public hospital. In the early days, however, you probably could not get a house to live in unless you were working in Richland or the plant. Some time in the late '50s, the people living in the houses were able to buy their homes at very attractive prices. When we came back in 1961, we bought a house.

FISHER: Was it Kadlec Hospital? Is that where?

GAMERTSFELDER: Yes, they were—well, at this time, Richland was a completely open city.

FISHER: This would have been in the early '60s when this occurred?

GAMERTSFELDER: Yes.

FISHER: Okay.

YUFFEE: Maybe we can take you back to the late '40s.

GAMERTSFELDER: All right.

The Green Run

YUFFEE: To what is well-known, the Green Run.[53]

GAMERTSFELDER: Yes.

YUFFEE: And we could get your observations on the Green Run?

GAMERTSFELDER: Well, the Green Run was requested by the military[, the Air Force].

YUFFEE: And did they—

(Material deleted. Dr. Gamertsfelder inserts the following for clarity and accuracy:)

GAMERTSFELDER: Herb Parker called me to request that I, and the groups that I supervised, cooperate with the Air Force in the conduct of an experiment which became known as the Green Run[, which involved the intentional atmospheric release of radioiodine].

FISHER: And so the military ran the show?

GAMERTSFELDER: I am sure that our GE management had some concerns that the running of such an experiment might not be covered by our contract with the AEC. I assume that the AEC was able to provide some assurance that

[53] Operation Green Run is discussed in *Human Radiation Experiments: The Department of Energy Roadmap to the Story and the Records* (310+ pages), (DOE/EH-0445, February 1995). For more on the Green Run, with an emphasis on its military purpose and the involvement of the U.S. Air Force, see the John Healy interview transcript (DOE/EH-0455, May 1995).

they would be covered. And, as a result, GE agreed to cooperate with the Air Force. Obviously, some pressure was applied by the Air Force to get the agreement, but after agreeing, we did cooperate without abdicating any of our managerial responsibilities.

YUFFEE: Sure. Who were some of the other people involved, besides Jack [(John)] Healy?

GAMERTSFELDER: Well, essentially our whole site-survey group, we treated it as a special run. And we found out where the [radioiodine] cloud went, for our purposes.

YUFFEE: So meteorology was already under your purview at that time?

GAMERTSFELDER: Yes. And we didn't recommend, we wouldn't have recommended, that they operate it. We told them that. They wanted to run anyway, and they did run—

YUFFEE: And were you told the purpose?

GAMERTSFELDER: No, we guessed.

FISHER: What did you guess?

GAMERTSFELDER: We guessed they were interested in finding things out so it would help them look into [what the Soviets were doing in their nuclear program].

FISHER: You mean, monitoring of plant activities?

GAMERTSFELDER: See, what was—that's what we thought. And nobody told us one way or the other. Earlier than that, we had had a visit from somebody who we knew was somehow associated with espionage, and had been a worker with radiation. He talked about getting radiation headaches, apparently getting radiation levels higher than we [would] ever allow.

FISHER: Sure.

GAMERTSFELDER: And shortly after that, one of the guys that worked with Healy, Walt Singlevich, went and joined them—or joined some [other secret] group, anyway. I ran into Walt several times and never got the hint of anything that they were possibly doing.

FISHER: Really? Do you think it was necessary to use iodine that was as "green" as it was for the detection purposes you supposed they were trying to accomplish?

GAMERTSFELDER: Well, the amount of material being dissolved was, I think, smaller than normal. This was just a batch that had been fixed up particularly for them. When the reactors had run originally—when the military was very, very interested on getting their hands on plutonium—they put out a lot more than was put out in the Green Run.

FISHER: A lot more what?

GAMERTSFELDER: Iodine.

FISHER: In the early production days?

GAMERTSFELDER: Yes, very early production days. There was a lot of iodine put out.

FISHER: Well, the Green Run iodine was cooled about 16 days, I think?

GAMERTSFELDER: Something like that.

FISHER: But yet, earlier you expressed alarm that iodine, or Parker expressed alarm that iodine was cooled for only 35 days originally.

GAMERTSFELDER: Yes. But that was a rather continuous operation[, with much more uranium and fission products].[54]

FISHER: I see.

GAMERTSFELDER: No, they were completely different subjects. The cloud wandered off and went down to the Columbia River Valley, turned around and came back and wandered off towards the east. And you could find traces of it in vegetation. Most of that territory doesn't have very many people in it.

YUFFEE: Was that your role? Your specific role was to monitor the cloud?

GAMERTSFELDER: Well, it was something special. We were prepared. We knew what was going on—prepared to go and do it. We just didn't agree with them on the time we were doing it.

[My only instructions about the Green Run was a verbal request to cooperate in the running of the experiment. Our role was to do what we normally did when the separations plants were going to dissolve irradiated fuel. We advised them about the weather and expanded our environmental sampling schedule because of the magnitude of the purposed release.

While we did not know what kind of measurements were going to be made with the airplane, we thought that a smaller release would have been adequate].

YUFFEE: Who had the final say as to the exact time of the—

GAMERTSFELDER: [I am sure the colonel who decided to run the experiment was given the weather forecast, and the time chosen was consistent with the forecast of suitable weather. They had an airplane. I never saw the airplane. I don't know whether it operated out of the airport or out of an airport that was at Richland.

FISHER: It may have operated out of Othello, Washington. There was a radar station in Othello, across the river, just north of the reservation.[55]

GAMERTSFELDER: I don't know where the airplane took off from. I never even saw it.

YUFFEE: Did it tag the cloud, or was it—

GAMERTSFELDER: I don't know what it did[, and I don't know what results they obtained].

FISHER: How vocal were you with your team?

---

[54] products such as the elements strontium and cesium that are formed during the splitting of uranium atoms in a nuclear reactor

[55] a colloquial term commonly used to refer to the Hanford site

GAMERTSFELDER: Well, we were loud enough to let them know what we recommended. But we were told to cooperate, and we cooperated.

YUFFEE: Were there any AEC officials who were present for the Green Run?

GAMERTSFELDER: I don't know of any. There was—there were AEC people as part of—they had an office.

FISHER: They had an operations office out there?

GAMERTSFELDER: Yes. Whether they had any people in the field or not, I don't know.

FISHER: Are you familiar with the name Walt Williams, Walter Williams?

GAMERTSFELDER: No.

FISHER: He would have been the Deputy General Manager of the AEC at the time. He was one of the only AEC high officials who was around at Manhattan Project time. He was also an instrumentation person, a technical guy.

GAMERTSFELDER: Yes. Well, they had some technical people, but at that time—I don't know of any contacts that we had with the AEC at that time.

YUFFEE: One of the reasons why we're interested in these questions is: there's a basic lack of documentation that we can find on the specifics of the Green Run. In fact, we're curious as to whether or not this was done on purpose.

Was there a message sent by the [Air Force] that documents—things should be said and not written, with regard to the Green Run, or was there—do you remember there being pretty good documentation about what happened?

GAMERTSFELDER: [I don't know of any message or document from the Air Force concerning anything about the Green Run. I am sure that our routine activity reports included data about the Green Run.] I don't remember the detail of our reports. We would have had to have gone through Parker.

YUFFEE: But they were written reports?

GAMERTSFELDER: There's other reports, internal reports. And I don't know whether they've found them now or not. The good copies of all of that stuff went to Du Pont. Du Pont lost those. And some of the things—I went up and talked to Battelle[56] about some of these things—and some of those documents are very hard to read.

YUFFEE: I'm sure. They probably were done on onionskin.

GAMERTSFELDER: Well, either that or copies made by that kind of blurry purplish ink process [(mimeograph)]. But I don't know of communications with the AEC at that time. I don't know what-all was written down by Herb Parker.

FISHER: Sure. Okay.

---

[56] Since 1965, Battelle Memorial Institute, headquartered in Columbus, Ohio, has operated the Pacific Northwest Laboratory in Richland, Washington, for the U.S. Department of Energy.

GAMERTSFELDER: But we did make surveys. We knew where the stuff went[, and I don't know of any restrictions on our normal internal reporting].

FISHER: How far away did you monitor? Did you get to Walla Walla [(Washington)]?

GAMERTSFELDER: I'm sure we got to Walla Walla. The furthest that I know of would probably have been down the Columbia River Gorge, probably as far as [the Dalles].

FISHER: That would have been [south]west?

GAMERTSFELDER: Yes.

FISHER: I see.

GAMERTSFELDER: And for the other, we might have even gotten [northeast] to Spokane [(Washington)].

YUFFEE: How many years were you at Hanford that first time?

GAMERTSFELDER: The first time? About—well, I got there in '44.

FISHER: Or '43?

GAMERTSFELDER: Forty-three, '42— down to Oak Ridge.

YUFFEE: In '43? So it would have been '44.

GAMERTSFELDER: And this would be—

YUFFEE: Because you were out in Chicago for the [pile startup] in December.

GAMERTSFELDER: Yes.

YUFFEE: And then you stayed until '43 for a little bit less than a year, then you went down to Oak Ridge.

GAMERTSFELDER: Yes.

YUFFEE: For about a year?

GAMERTSFELDER: Yes. It was '44.

FISHER: So that would have brought you into '44.

FISHER: Okay. August of '44.

GAMERTSFELDER: Yes.

General Electric Takes Over the Hanford Contract (1946)

YUFFEE: Okay. And when did you leave to join GE?

GAMERTSFELDER: Well, GE joined me.[57]

FISHER: Oh, GE joined *you*?

(laughter)

GAMERTSFELDER: That's right, when Du Pont left [as prime contractor for running Hanford], after the war.

FISHER: That's a good point.

GAMERTSFELDER: Oh, we had fought—in moving from the technical division, which is where we would have been ordinarily, because of Herb Parker's insistence, we ended up without all of the job titles available to the other people. We ended up with senior supervisors reporting to senior supervisors reporting to senior supervisors.

YUFFEE: Sure.

GAMERTSFELDER: And we had just gotten that settled. So we got to use some other titles, like Area Supervisor and things of that kind.

YUFFEE: "Supervising Supervisor."

GAMERTSFELDER: And GE came in, and *everybody* was a manager. *(laughs)*

FISHER: Oh, too many chiefs and no Indians.

GAMERTSFELDER: Philosophies of operation were different, and—

FISHER: How so?

GAMERTSFELDER: Du Pont was, "Grandpa knows best." *(laughs)* GE listened a little bit more, or it was a little further down the line, or something.

FISHER: That's surprising, because Du Pont really only agreed to build the Hanford plant "kicking and screaming." They weren't wild about it from the outset.

GAMERTSFELDER: Oh, I know. And they stuck by their guns. They got out when they said they were going to get out. Then they got back in.

FISHER: Yes, down at Savannah River.[58]

YUFFEE: And so, when GE joined, where were you?

GAMERTSFELDER: GE—

FISHER: I think it was '46, '47, right after the war ended, I think.

GAMERTSFELDER: Yes, it was about—it was—

---

[57] General Electric took over from Du Pont as prime contractor of the Hanford site after World War II.

[58] a Department of Energy weapons site in Aiken, South Carolina, that, during the Cold War, was the major source of tritium and plutonium for atomic bombs

FISHER: Because, by '45, Du Pont was saying that they were going to stick to the contract [allowing the company to back out after the war, if it chose], and they wanted out.

GAMERTSFELDER: Yes.

YUFFEE: So when did you begin work on the aircraft, the nuclear-powered aircraft?

GAMERTSFELDER: I went in '52, in the fall.

YUFFEE: And you moved out to Cincinnati?

GAMERTSFELDER: To Cincinnati.

YUFFEE: And that's where they were doing the work?

GAMERTSFELDER: Yes.

YUFFEE: Up there, were they using the facilities at Fernald[59] for the—

GAMERTSFELDER: Fernald? I don't know that we had anything that we did there. I went through Fernald once.

YUFFEE: And how many years did you live in Cincinnati during this?

GAMERTSFELDER: [Till] '61, about [nine] years.

YUFFEE: And then you went back to Hanford in '61?

GAMERTSFELDER: Hanford for three [years]. And then I went to Philadelphia.

YUFFEE: When you went to Hanford the second time, we know [that] again, there were some more field releases, not [of] the magnitude of the Green Run. Maybe you could tell us a little bit about those?

GAMERTSFELDER: I don't know much about them.

FISHER: Well, there were some of the milk studies in '63 that you participated in.

GAMERTSFELDER: Well, the milk study I participated in, I drank some milk.[60]

---

[59] Feed Materials Production Center, a uranium processing facility near Cincinnati, Ohio, that was part of the defense nuclear fuel cycle. Former workers have filed a class-action suit, claiming they had not been informed of the dangers of working with uranium; for a detailed discussion of the Fernald suit, see DOE/EH-0456, *Human Radiation Studies: Remembering the Early Years; Oral History of Merril Eisenbud* (May 1995).

[60] In 1963, milk from dairy cows fed iodine-131 was consumed by eight General Electric/Hanford workers either as a single dose or as several daily doses. During the study, the amount of iodine in the cows' diet was increased from 5 milligrams per day to 2 grams per day. The resulting uptake by the human thyroid was determined in Hanford's whole-body counter facility. Participants were Hanford scientists who had volunteered to drink the milk and be counted over a period of approximately 1 month. This work was supported by the U.S. Atomic Energy Commission. Source: "HS-1: Ingestion of Iodine-131 in Milk by Hanford Employees," in *Human Radiation Experiments Associated with the U.S. Department of Energy and Its Predecessors* (213 pages), DOE/EH-0491, July 1995.

Human Experimentation at Hanford

YUFFEE: Was it the first time that you were ever sort of a subject in a research?

GAMERTSFELDER: No. The first human experiment I know about was Dr. Cantril. He wore a piece of uranium metal taped on his arm for quite a long time, and it probably showed [slightly] red sometimes from chemical irritation.

(Material deleted. Dr. Gamertsfelder inserts the following for clarity and accuracy:)

FISHER: Some sort of irritation?

GAMERTSFELDER: I think it was slight, but I never saw any report about the experiment. And I doubt there was any formal report written.

I was involved in three separate experiments. The first of these experiments involved four people who had a plutonium solution painted in a one-inch-diameter circle on their upper arms. A protective plastic cup was taped over the test area so the plutonium would not be removed while bathing. Measurements of alpha radiation[61] from the contaminated areas were made with a cylindrical ionization chamber with thin plastic film.

Initial readings on all subjects were similar. Subsequent readings, taken at various intervals over the next week, showed reduced detection of the alpha radiation. The last reduction was about 20 percent, and the largest (mine) was about 50 percent. The plutonium was removed after one week, by washing. Analysis of urine samples from participants showed no positive results.

FISHER: That's right. You were talking about some of the experiments.

GAMERTSFELDER: We had a lab that routinely took samples of urine from people in the plant, delivered bottles to the front door.

YUFFEE: Sort of like the milkman?

(Material deleted. Dr. Gamertsfelder inserts the following for clarity and accuracy:)

GAMERTSFELDER: The process of measuring the plutonium content of urine samples is quite complicated because the materials of which the counters are made are also contaminated with natural radioactive elements which emit alpha particles. The analytical procedure included tests of known standard samples. The best people doing the analyses seemed to possess a combination of neatness and precision that some otherwise-competent chemists could not supply.

YUFFEE: That's funny.

GAMERTSFELDER: It was peculiar.

FISHER: Were these sort of tests done under the biology section that you mentioned?

---

[61] emitting helium nuclei during decay, possibly causing tissue damage if ingested or inhaled

GAMERTSFELDER: No, this was done under our regular—well, the work started in our regular laboratory. When we got to where we thought we were doing [well], we [made a separate] operation out of it. It was located in downtown [Richland].

YUFFEE: Were you and your colleagues the only subjects in this particular experiment?

GAMERTSFELDER: Oh, no. [What I just described was the laboratory which routinely tested people who worked with plutonium. The experiment with plutonium on the arms was only done once.]

FISHER: You said that [these were] the [only] experiments that you knew of. Were there any other ones that you knew of?

GAMERTSFELDER: [These were the only ones during the first time at Hanford.]

FISHER: Well, there was the milk, the ingestion of milk.

GAMERTSFELDER: There was the milk. Yes, I drank milk and had my thyroid measured. That was when I was there the second time.

The day after—well, my first measurement was very shortly after I drank it, and the amount in the thyroid was low. I had a count the next day, and the amount in the thyroid was high[er—about where it was expected to be]. That day, I got on a train—no, I guess I flew—to Chicago. I had my thyroid counted out at the Argonne Labs,[62] and I was going to go down to Oak Ridge, but I stopped. I had to see somebody down in Indiana, the University of Indiana. I had to see somebody who Parker was on a committee with.

YUFFEE: In Bloomington?

GAMERTSFELDER: Yes. Then I went down to Oak Ridge, and got my thyroid counted down there. And then I went to—I saw somebody that had nothing to do with [the experiment]. Then I went to New York and went up to the place that the state was running (where they sampled milk and things) and had my thyroid counted there. [The lady in charge] wanted to know where I had been, so I had to tell her a little bit about what was going on.

Then I got back and had my thyroid counted some more at Hanford. And all of the points fell [into a nice smooth line, where thyroid iodine uptake[63] was plotted against time on logarithmic paper]. The instruments at Argonne Labs— they had a system which used four different counters, and one wasn't working. But apparently, they had calibrated each counter separately so that they were arranged in different places. Oak Ridge had two. What we had at Hanford was one big one, right under the chin.

YUFFEE: Were there any other subjects who drank milk, or was it just yourself?

---

[62] Argonne National Laboratory outside Chicago, Illinois; operated by the University of Chicago

[63] an excess assimilation of radioiodine in the thyroid, indicating abnormality

GAMERTSFELDER: Oh, there were others. I don't remember what all of the—

YUFFEE: Were they all volunteers?

GAMERTSFELDER: Oh, yes.

YUFFEE: And all were people who worked at Battelle?

GAMERTSFELDER: Yes.

YUFFEE: Well, I guess, at that point it probably wasn't Battelle yet.

GAMERTSFELDER: No, it wasn't. That was before Battelle. [It was General Electric Company.]

FISHER: Were they all lab—they were all scientists? They weren't atomic workers or anything?

GAMERTSFELDER: No. Well yes, they were. I don't guess there were any weekly[-paid] [(semiskilled or trade)] personnel involved. They were all monthly-paid people [(professionals with the requisite advanced degrees)], and they knew something about what was going on.

YUFFEE: Sure. And were there any other experiments or research with human subjects that you know of?

FISHER: There is a great story that I read about in Newell Stannard's[64] book[65] about a little joke you played on [Dr.] Harry Kornberg.

GAMERTSFELDER: Oh, he put that in there?

FISHER: He did. He certainly did. It takes up almost the whole page.

(laughter)

GAMERTSFELDER: Yes, that was—oh yes, that was the tritium one.

FISHER: That's right. He was running the Biology Division.

GAMERTSFELDER: That was the tritium one.

YUFFEE: He could not understand?

GAMERTSFELDER: No. I—well, when I was in grade school, I made a beautiful scar on my arm with ink and a red pencil. I tried that here, and I couldn't get anything that looked reasonable. Then, somebody suggested to me that you could dissolve some red lead in Duco cement and put it on. That

---

[64] J. Newell Stannard, a professor emeritus of Radiation Biology and Biophysics at the University of Rochester (Rochester, New York)

[65] *Radioactivity and Health: A History*, Office of Scientific and Technical Information, October 1988. Currently published by Battelle Press, Columbus, Ohio; 2,010 pages in three volumes; ISBN 0-87079-590-2. Stannard wrote the book in response to the need for a definitive review of the biomedical research directed toward understanding the behavior and effects of radioactive materials in the biosphere. Sponsored by the DOE's Office of Health and Environmental Research, *Radioactivity and Health* documents the development of professional knowledge in this area from before the eighteenth century into the early 1980s. Presented in a narrative style and generously illustrated, the book includes anecdotal material and explains the role played by the principal men, women, and institutions. Extensive indexing by the author and editor make it easy to find specific subjects, people, places, and events.

looked—that could have been acceptable, except that when it got completely dry, it turned the most horrible shade of pink.

(laughter)

GAMERTSFELDER: In the process of getting that Duco cement off my arm, I had a beautiful [appearance of] erythema.[66]

FISHER: Oh, boy.

YUFFEE: I'm sure.

GAMERTSFELDER: And I told Herb Parker about it. We were having a staff meeting, and Harry Kornberg was there. We were waiting in his outer office while Herb was finishing up with his visitor.

[The visitor left, and Herb came out, and without saying anything, gave Harry a look that said, "How could you make such a mistake [as to let Carl suffer a radiation burn]!" I relented the next day. Harry was leaving town[, and I thought I should tell him].

(laughter)

FISHER: He was apparently very frantic.

GAMERTSFELDER: I called up to tell him, and he wasn't—he was deliberately not available, I think.

FISHER: That's very funny. Dr. Kornberg was quite concerned, apparently, that he had made a mistake somewhere.

GAMERTSFELDER: Well, he hadn't made it.

YUFFEE: Oh, that's funny.

GAMERTSFELDER: Well, I had to liven things up a little bit.

Environmental Monitoring at Hanford

FISHER: It's a great story. It's a great story.

Dr. Gamertsfelder, you mentioned once that the dust that was swirling all throughout the southwest central Washington state on the Hanford reservation did a number on some of your monitoring stations, on the bearings and instrumentation like that.

GAMERTSFELDER: Well, it did that. And we had some other—these chambers, essentially large pencil chambers, large like this. *(demonstrates with his fingers)* They [measured gamma radiation]. They worked fine.

We had some of them where we had punctured lots of holes and put some aluminum foil in there. They didn't work at all. The birds[, attracted to shiny objects,] just loved to punch holes in the aluminum foil.

---

66 an abnormal reddening of the skin due to local congestion, such as inflammation, or excessive radiation exposure

FISHER: I bet.

YUFFEE: Oh, that's funny.

FISHER: Well, was the dust a major consideration; the resuspension of materials into the air?

GAMERTSFELDER: No, the dust—the bearings, no. We could collect the dust on the samples. It didn't interfere that way. Nothing indicated that radioactivity was associated with the dust that we collected.

FISHER: But the fact that the materials (not just the radioiodine but maybe the plutonium) that would be released could blow around and would be difficult to measure accurately, because it would blow from one spot to the next, to the next, to the next.

GAMERTSFELDER: Well, no. I've looked at that kind of stuff, and the heavy stuff doesn't resuspend quite as easily as sand does.

FISHER: Really? So you think the plutonium is more—

GAMERTSFELDER: Well, I don't. And besides, *plutonium* you can work on chemically to see if it's there. You don't have to test the whole bulk of the sample. You can run it through a chemical process. I just don't think plutonium travels much. There were—well, the major part of these were in tanks in the 200 areas.

FISHER: Sure.

GAMERTSFELDER: Some dilute wastes were dumped into the ground out there; enough to disturb the water table in the 200 areas. They ended up being mounds of water. And being mounds, and left alone, they tend to distribute. Some radioactivity got through and showed up in wells at the 300 area.

FISHER: Sampling wells?

GAMERTSFELDER: Yes. Well, they were [water] wells that were used. They weren't drilled for samples. We drilled lots of wells for sampling, but I don't think we drilled many in the 300 area. Some of those just existed, because people had used that land beforehand.

FISHER: Were you ever involved, or did you do any work, with a special-hazards group? Did the Health Instruments Division ever participate in any, or do any work that was done specially on command for a special hazards group that may have existed?

GAMERTSFELDER: That doesn't ring any bells.

FISHER: —providing technical assistance to groups that were responsible for emergency evacuation and things like that, making preparations?

GAMERTSFELDER: You mean, at Hanford?

FISHER: Yes.

GAMERTSFELDER: I don't know. We had emergency practices. I remember one practice, where the air in the valley seemed to be doing this *(swirls his finger)*. *(laughs)*

FISHER: Swirling?

GAMERTSFELDER: I wasn't sure that everybody who was taking data knew the proper way to take meteorological data. Some of the people would call a north wind [(a wind blowing from the north)] a south wind.

FISHER: That's not good.

GAMERTSFELDER: We had, at least during the early days, a 24-hour coverage with somebody who knew health physics. He had a car, signed on at the guard station. Sometimes you would find yourself talking to somebody in Texas. *(laughs)* No, we had somebody who had a badge of some kind, had a car. The guards always knew where somebody [who understood health physics] was.

Emergency Preparedness

FISHER: You were on call in case something happened?

(Material deleted. Dr. Gamertsfelder inserts the following for clarity and accuracy:)

GAMERTSFELDER: Yes, I got called once. That was the second time I was at Hanford. There had been a nuclear excursion in a plutonium recovery operation, from waste materials no longer suitable for the production line.

I had never been in the building where the excursion happened. Here I was, one of the first people called down to emergency headquarters, and some of the other people who knew about the facility were off—Saturday morning, doing other things.

FISHER: Sure.

GAMERTSFELDER: They dragged-in at various times. The manager of all the on-plant health physics groups showed up, and took charge of all the health physics data that was coming in.

Then, Herb Parker finally got around. He was one of the last ones to hear of it.

FISHER: Did that particular incident that you've described to us end up having a name? Or, how did people refer to that? Did the committee you sit on have some sort of name?

GAMERTSFELDER: I don't know what the thing was called. If I take a minute, I might be able to find a report on it—see if it has a name on it.

FISHER: Well, okay. All right.

GAMERTSFELDER: [Here are the titles of the official reports on the nuclear excursion: An "Official Use Only" report titled *Final Report of Accidental Nuclear Excursion Recuplex Operation 234-5 Facility*. Date of incident: April 7, 1962. Prepared by: Investigating Committee, August 1962. The report has no document number. It was accompanied by an unclassified document HW 61010 titled *Accidental Nuclear Excursion Recuplex Operation 234-5 Facility, April 7, 1962 Final Medical Report.* There is also an article in *Health Physics* 1963 Vol. 9, pages 757 to 768, titled "Dosimetry[67] Investigation of the Recuplex Criticality Accident."

An appropriate name could be "The Recuplex Criticality Accident Investigating Committee]."

The thing happened, and GE immediately formed a committee, with Miles Leverett in charge of the committee. The next day, the AEC said they had to run the committee. *(laughs)*

(Material deleted. Dr. Gamertsfelder inserts the following for clarity and accuracy:)

In compliance with *AEC Manual* Chapter 0703, an AEC–HAPO committee composed of two AEC employees (one of whom was the chairman) and five General Electric employees was appointed by the manager, HOO (Hanford Operations Office). The GE people were the ones originally picked by GE. The AEC chairman then ran the meetings.

When we got to the technical [material], Miles Leverett ran the meetings. Everything just worked just as smooth as anything.

YUFFEE: Sure.

(Material deleted. Dr. Gamertsfelder inserts the following for clarity and accuracy:)

GAMERTSFELDER: There were three things necessary for the accident to occur: (1) There had to be a plutonium solution on the floor with a depth sufficient to cover the end of the hose; (2) the valve in the pipe connecting to the hose line had to be open; and (3) there had to be at least a partial vacuum in the tank in which the excursion happened. It was known that the tank that collected the concentrated plutonium nitrate had overflowed. The problem with this list is the fact that none of the operators remembers opening the valve.

The nuclear excursion did happen, and the three men nearest to the facility saw the "blue glow," and all of them immediately left the building. One of the men reacted rather poorly—he thought he was going to die.

FISHER: The nervous guy?

GAMERTSFELDER: Yes.

FISHER: Doctor, was there any other AEC "interference"—I'll use that term in quotation marks—like on this committee, on other committees; you know, where they would demand to run, say, a human use committee? Was there a human use committee established at Hanford while you were there?

GAMERTSFELDER: Not that I know of.

---

67 the process or method of measuring or calculating the dose of ionizing radiation, or energy absorbed per unit mass, using data from bioassay and other radiation measurements

FISHER: Not that early?

GAMERTSFELDER: Well, this was—

FISHER: In either the '40s or the '60s?

GAMERTSFELDER: The '60s? No, I—no.

YUFFEE: But you would have been aware had there been a human use subcommittee in regard to using people?

GAMERTSFELDER: I think so. [I do not know what you mean by "using people."] I think so. Herb was—when I was at University of Chicago, Herb was just like any other researcher, and everything. He was cooperative. When he ended up being in charge, he was a difficult personality [some of the time].

There was a time fairly early, when Herb was out of town, and I ran this staff meeting for him. The guys unloaded on me. They had been trained [by] Du Pont [and] had ideas on [how] things [operated], and Herb didn't behave that way. *(laughs)*

When Herb came back, I told him what had happened, and he called a meeting, and none of the guys would [say anything]. But Herb then tried to change. I think he learned how to get along a little bit better.

YUFFEE: Was that one of the reasons why you decided to go to Cincinnati?

GAMERTSFELDER: It was part of it. But I think my wife was another part of it. I think if I could have taught her to wear green goggles, she might have liked it better, but— *(laughs)*

FISHER: What do you mean by that?

GAMERTSFELDER: Things out there are brown, not green.

(laughter)

FISHER: Oh, I got you.

GAMERTSFELDER: She grew up in this country [(meaning Tennessee)].

FISHER: I understand. I went there for a week, and I was longing to see green and trees myself.

Certainly your observations on Herb Parker are to be taken at face value, because nobody worked more closely with him than you did.

Work on the Apollo Project

(Material deleted. Dr. Gamertsfelder inserts the following for clarity and accuracy:)

GAMERTSFELDER: Well, that's right. I guess some other people were close to him—C.M. Patterson and Jack Healy. C.M. Patterson (one of the Du Pont trainees) went with Du Pont when they built the Savannah [River] plant.

FISHER: When you left the second time, that was the last time you worked out of Hanford?

GAMERTSFELDER: Yes. That's when I went with the—well, into essentially, the rocket business. I went with the group that was making a power supply for the Apollo missions, using plutonium-238 as the source of heat to generate electricity, using thermocouples.[68] The fuel was carried separately in a pyrolytic[69] graphite container on the outside of the Lunar Excursion Module (LEM) [(the moon landing vehicle)], and had to be put into the generator after the astronauts landed on the moon.

After the Apollo missions, our source of funds was considerably reduced. And for a while, I was involved in writing proposals for developing instrumentation for earth resources satellites. And while that was interesting, I thought I was better qualified to remain in the health physics field.

After some preliminary contact with friends in the AEC, I accepted an offer to be interviewed by Dr. Forest Western, who was the Director of Radiation Standards. During the interview, which included Lester Rogers who was Dr. Western's deputy, I was told that Dr. Western was going to retire and Lester Rogers would become the Director.

After the interview, I received an offer, which I accepted.

From then on I was mostly involved in defining "As Low As Possible" (ALAP) standards by comparing the costs for the design, manufacture, and use of waste treatment systems against costs to individuals and populations in the vicinity of a reactor.

What had been known a ALAP became ALARA (As Low As Reasonably Achievable). Lester Rogers left, and while there were things to do, there were other people who could do them. So I decided to retire. And with my wife's blessing, we bought a home in Knoxville, Tennessee.

. . . One guy wanted to hold the thing at pole-vaulter's pole length; the most awkward way to handle the thing you could possibly think of.

Just a moment. *(walks to the next room)*

FISHER: Sure.

GAMERTSFELDER: *(returns with a model of the Apollo spacecraft)* Well, we built it. We had to write a safety report about the thing. We talked to GE management about it. We talked to the AEC about it. I don't know whether what I have to say next ought to be recorded or not. I think you better turn it off.

(tape recorder turned off)

[68] devices that measure temperature as a function of the electromotive force induced when heat is applied to two dissimilar metal wires joined at both ends

[69] involving the subjection of organic compounds to very high temperatures

Accidents at Hanford and Idaho

FISHER: Okay. We're talking about the redox facility, or the "Parker problem."

GAMERTSFELDER: I was talking about a separate facility which was put at the base of each stack [in the separations areas which was meant for gas analyses. The B plant was never operated, and we used it for a laboratory.]

YUFFEE: And this was to—

GAMERTSFELDER: [We put a soil scientist in to test fission product retention in soils. Everything in this] building was stainless steel, if it was metal. In the plant, everything was stainless steel except, somewhere in the ductwork, something was not stainless steel that should have been [but rather, a corrodible grade of steel], and they got rust particles that had contamination on them. So that was one of our—

YUFFEE: And these were getting through the [tall venting] stacks or through the scrubbers [designed to cleanse the exhaust of radioactive particles]?

GAMERTSFELDER: They were getting through the stack, and they didn't have scrubbers [at] that point.

YUFFEE: Sure.

GAMERTSFELDER: And they ended up putting in the sand filters, all of that stuff, afterwards. But it was peculiar, because [the] safety showers in our labs were stainless steel. *(laughs)*

FISHER: That's funny.

GAMERTSFELDER: We got some rust through. I guess I don't know any more things. If you've got questions, I'll sure try to answer them.

FISHER: I think we've got a couple. I'm still a little bit concerned about what you thought, or how your ideas were received, on the feasibility of trying to do—of trying to chart internal doses to people. That was an idea that Herb Parker thought about a lot, I understand, about internal doses.

GAMERTSFELDER: Well, I guess the most important one would be thyroid. That was—we had methods of measuring what was actually in people's thyroids. We had ways of measuring plutonium in people.

FISHER: In the lungs?

GAMERTSFELDER: That's the urinalysis.

FISHER: How about in the lungs?

GAMERTSFELDER: You would have to depend on knowing what they were breathing. You don't go putting neutrons in people, trying to find a plutonium particle. I guess that it could get into the bloodstream eventually—small ones, right [(you understand)]?

FISHER: But you did manage to persuade people in authority that measurements of the thyroid were accurate and that it was feasible to measure product [(plutonium)]?

GAMERTSFELDER: Oh, sure. The thyroid measurements, after you got these big sodium iodide crystals, it got to be an easy job and an accurate one.

FISHER: And you feel that they were accurate, that you could stand by those measurements? In fact, all of the procedures that you were involved with, with the pencils and badges and the rings and film (film badges on people) you thought that those, and still think I suppose, that they were reasonable and acceptable and they did the job that was necessary?

GAMERTSFELDER: Well, I would guess I—beta[70] radiation to the hands, in uranium processing—I don't think we did a very good job. I'm not sure a good job is possible.

FISHER: Why is that?

GAMERTSFELDER: Just, it's a hard problem.

FISHER: Because of the hand, and—

GAMERTSFELDER: The hands. We had rings on the fingers. We had little pads put on fingertips, film. The film was a little sensitive to pressure, too. I think we did the things we could do.

I only know of one guy who got in trouble and got some redness [(erythema)] on his hands. That was down at Oak Ridge, and he was the optician who was making gadgets for them to look through; to look at the back side of the pile, and stuff of this kind. They were running a test of some kind on one of his instruments. It hadn't behaved properly, and he couldn't wait to get his hands on it. *(laughs)*

YUFFEE: And it was hot [(radioactive)]?

GAMERTSFELDER: And it turned out to be hot, and nobody caught him. He got some redness on his hands.

YUFFEE: Just erythema, nothing else?

GAMERTSFELDER: I don't think there was any other damage. I don't know how long he was around, either. It was known; we reported it. *(laughter)* [(So the incident may have cost him his job.)]

YUFFEE: Sure.

FISHER: When we were talking earlier about the Green Run— I'm wondering if you're aware of any other similar releases like that, either before '49 or after '49, while you were there or while you were away.

GAMERTSFELDER: Well, at the Idaho facility[, in the '50s] where we were testing the jet engine running on our reactor, there were some releases. There was the nuclear excursion [we discussed earlier].

As far as I know, everything that came out headed off down towards the south end of the site—we were at the north end—or at the southwest side of the site. And they ran out of being able to track the [radioactive]

---

70 a radioactive substance that emits electrons or positrons during radioactive decay

1261889

plume before it had got to the edge of the Idaho test station. That was because it ran into the mountains.

FISHER: What was released?

GAMERTSFELDER: All kinds of fission products.

FISHER: And this was an excursion, not an intentional release?

GAMERTSFELDER: This was an excursion. The rules were violated, and the instrumentation was incapable of stopping itself. Mechanically, it could work, but it couldn't get a signal. There was a second one, which was deliberate. We had them fix up a special fuel element. Fuel elements were something about *that* big *(indicating)* in layers.

YUFFEE: Were they round, about two inches around?

GAMERTSFELDER: Round, round.

FISHER: About like a golf ball?

GAMERTSFELDER: No, not—they were cylinders.

YUFFEE: Oh, okay.

GAMERTSFELDER: One cylinder inside another cylinder in segments about this long *(indicating)*. The fuel element was—

FISHER: Oh, I see, like slugs. A couple of inches, almost like a big slug?

GAMERTSFELDER: It was this long. Well, a long slug, but with air spaces in it.

YUFFEE: Okay.

GAMERTSFELDER: And we fixed this up with a device to chop off the airflow to it. We had the slugs irradiated for a while, and then we let them cool for a while so that we were only having iodine-131, really, to worry about.

We had a report on what kinds of things we expected to happen and whether we wanted to run it in, and had a disagreement with the health physics group. The health physics group there was run by the AEC, John Horan. He was more conservative [about dose] than I think was necessary, and we argued for quite a while.

In fact, I was in town arguing, when eventually our manager says, "Go ahead and run it the way they want to run it." So I was on my way out to the site [(50 miles away)] when it was run. It was run under weather conditions which were rather more dispersive than what we had wanted to do. [During the experiment, the wind direction did not change much, but the velocity increased considerably.]

There was—the surveying offsite was done by the AEC. There were people living about seven miles away, and I don't think they [(the health physics group)] found anything of any significance there. If they had, they were on good relations with the people there and would have given them milk and confiscated any milk that—they had other people who had some cows there.

We found some iodine, something like 50, 60 miles away, in a slightly different direction. And that turned out to be something that had been released down in Nevada, gone west over the Pacific Ocean, up along the coastline, and came back in, up the Columbia River Gorge. We could tell it was the bomb debris, because we analyzed it, measured the half-lives, and [found] iodine around that we hadn't put out there.

FISHER: What year was this?

GAMERTSFELDER: This would have been in the late ['50s]. I don't remember exactly.

FISHER: Sure. This was when you were working out of [Cincinnati].

GAMERTSFELDER: Yes.

Cancellation of the Aircraft Nuclear Propulsion Program

YUFFEE: But you had gone out to Idaho?

GAMERTSFELDER: Yes. [Our test station was there.] There was one other little incident. Convair had people working on these kinds of problems. They were going to build the airplane that we put this device in. They had figured out a nice sampling scheme, using little model airplane engines to pump air through filters, and they had it hung up to get a vertical profile of whatever was released.

They had been checking with Percy Griffiths, who was one of the health physics people for the AEC. And he [told] them there wasn't a chance of running. And [the Convair people] went off on a sightseeing trip, and our [General Manager, D.R. Shoul,] gave in, and we ran the test. [The Convair equipment was not used.]

FISHER: Sure.

GAMERTSFELDER: I'm not sure how they explained things to their boss. They had been spending weeks trying to get him to—I would take his numbers and show him what—I don't know whether he believed me or what.

FISHER: Was that the primary focus of your work while you were in Philadelphia—concern with that sort of stuff elsewhere in the country?

GAMERTSFELDER: Well, no. We were also concerned about *flying* the danged airplane.

Somewhere along the line, [a fellow was driving] some tank truck with liquid oxygen, I think, and it had come into Bend, Oregon. He parked his truck and went away to find lodging or something. During the night—he apparently had some bad brakes—the fire started. The danged thing blew up.

FISHER: I bet it did.

GAMERTSFELDER: It took out a couple of city blocks' worth of a fair-sized town.

(laughter)

YUFFEE: Wow!

GAMERTSFELDER: I assigned a guy to look at the population densities in possible routes for the airplane to fly over. We had an airplane hangar (to take a nuclear-powered airplane) built—

FISHER: Where was that?

GAMERTSFELDER: Out at the Idaho site. We didn't have a runway yet, but they were going to build one if we had continued. [That building was eventually used as a warehouse.]

YUFFEE: Did you ever get a fuselage and get a plane put together?

GAMERTSFELDER: Oh, no. It didn't ever get that far. They flew a little water-cooled university-type reactor in an airplane and made their scattering measurements from beams, and things of that kind. It was just an ordinary airplane. That was done by [Convair]. I think that program died because [of increased capabilities of the rocket program].

They were—the thing we were working on finally, the mission was going to be to fly on chemical power out over the ocean, turn on the reactor, fly [reconnaissance] missions around Russia; monitoring what was going on and paying attention to radio traffic and all kinds of things of that kind.

If necessary, they would come in, dive down low, deliver a few bombs in strategic spots, and leave. And then come back, turn off the reactors, let them cool off some, and fly through a corridor back to our site.

We looked at population densities along the [possible routes]. The airplane would have been escorted in [and] escorted out. [If it crashed,] we would have been able to dump tons and tons of foam, things of that kind. There were mechanisms we could use. This was during the Cold War. People were serious.

YUFFEE: Sounds like it.

GAMERTSFELDER: I'm glad it got canceled. That's why I went back to Hanford: they shut us down.

Current Environmental Concerns at Hanford

FISHER: It's interesting at this point, where your work sort of has evolved into some of the more environmental concerns. Maybe it was just a general mindset that was developing. But there were concerns about milk, and there were concerns about local vegetation and concerns about population densities; where, earlier on, your work was much more occupational—doses for workers near reactors and things like that.

GAMERTSFELDER: Yes.

FISHER: I'm wondering if you think—

GAMERTSFELDER: Well, things changed when the AEC got in. The people with the most knowledge were the medical people, in terms of things happening to people, and they weren't really knowledgeable, in terms of things happening at lower doses.

We've always had a look at what background radiation was doing, and you can't find that. In fact, you can go to people living in Denver, and I don't think you can find any difference there. And that background is twice what it is here.[71]

FISHER: Sure.

GAMERTSFELDER: Other places on the coast, it might be as much as a factor of two less. They aren't that much more healthy. *(laughs)*

FISHER: But at places like Hanford, for example, do you think there has been any measurable effect on the environment from releases of radioiodine?

GAMERTSFELDER: I don't think so. I think Battelle thinks so. They're about to get to the point where they're going to try to predict—not predict, define—

FISHER: Does a dose—

GAMERTSFELDER: — what doses might have been obtained in a certain few individuals. My kids were all born out there in Richland.

FISHER: How about increases of thyroid out there, or thyroid nodules,[72] for example?

GAMERTSFELDER: There was a big batch of data taken back, I don't know, 20 years ago or something. I've been retired for 19 *(laughs)*.

FISHER: Good for you.

GAMERTSFELDER: It was—some good people took a lot of data, and they found the overall cancer rate in the area to be normal. They found a very rare kind of cancer in which there was something that would seem to be significant, maybe one or two cases, because it's a very rare kind of thing.

Alice Stewart was one of them, and as health physicist, has been riding that for a long time. She seems to think people got damaged out there.[73]

FISHER: Is her work credible?

GAMERTSFELDER: Not to me.

FISHER: Really?

GAMERTSFELDER: No.

---

[71] In the United States, an individual's exposure to background radiation averages about 350 millirem per year; the amount will vary with elevation and other factors. Daily fluctuations in the background occur proportionately with the amount of cosmic radiation striking the earth.

[72] small, rounded masses or lumps

[73] In 1956 and 1958, British epidemiologist Alice Stewart had written articles claiming that a dose as small as half a rad to a rad received by children in utero would raise by more than 50 percent the risk of cancer in the first 10 years of life. She and John Gofman later became professional friends. For a discussion of their friendship, see "The Low-Dosage Harm Controversy" in the Gofman transcript (DOE/EH-0457), June 1995.

FISHER: Do you think that environmental concerns about the tank farms,[74] since that's what being raised now—

GAMERTSFELDER: Well, the tank farms are something to worry about.

YUFFEE: Do you think so?

FISHER: Because of the leaking?

GAMERTSFELDER: Well, anything of that kind, I don't know. Most of them are sitting out in the desert and boiling. I don't know why they didn't double-hull those things.[75]

FISHER: In the beginning?

GAMERTSFELDER: I think the only people I know of that got killed were some of the workers, when they dropped a tank on them.

FISHER: The construction accident?

GAMERTSFELDER: Yes.

FISHER: Well, what's your concern about the tanks now?

GAMERTSFELDER: But the—I don't have to worry about that. *Any* construction job is going to be killing people.

YUFFEE: Right. Sure.

FISHER: But do you have a concern about the contents of the tanks or the lack of knowledge about them?

GAMERTSFELDER: Well, this was—the dropped tank was when they were building it. It actually killed somebody.

There were some low-level wastes that were dumped into the ground. They got as far as the 300 area. That included tritium[76] and—it was one of the rare earths; I don't remember the name of it. It's one where you do something to it chemically, and half of it comes out and half stays in the solution to do something else. And they don't—the regular processing didn't catch it all, by any manner or means. It can travel underground. And it did, to the 300 area.

YUFFEE: Was there a thought that the fact that the land out there, the subterranean land, a lot of it was clay,[77] that it would soak up—

FISHER: Would it retard the movement of some of this?

GAMERTSFELDER: Oh, that land out there is [sand and] gravel.

---

[74] Westinghouse Hanford Company currently manages the transfer, storage, and treatment of radioactive liquid waste from process facilities. The liquid wastes are stored in underground tanks.

[75] The problem is that the liquid wastes contained corrosives that ate through some of the tanks, allowing some liquid leakage into the ground.The single-shell tanks have been replaced with double-wall tanks.

[76] a radioactive isotope of hydrogen having an atomic weight of three. The heaviest isotope of the element hydrogen, tritium gas is used in modern nuclear weapons.

[77] In actuality, there is *no* clay in Hanford soils.

YUFFEE: Oh.

GAMERTSFELDER: [But underneath] it's gravel, [rocks, boulders—and very large basalt] boulders.

FISHER: Really?

GAMERTSFELDER: Real hunks.

FISHER: Right.

GAMERTSFELDER: And in the space in between, filled with smaller hunks. And there are apparently some things like old lava or something in there, some places. So the water will flow generally this way and some will flow generally off that way.

YUFFEE: That must make it difficult to track, then?

GAMERTSFELDER: Well, there are lots of wells. We put lots of wells in out at the 200 areas. We brought in what we thought was going to be a job for a geologist of a few years. I think he's still there [after twenty-some years]. *(laughter)* I think it's a bigger group, but it's still there.

FISHER: Do you think that the soil composition causes some of the spills from the tanks to migrate?

GAMERTSFELDER: Well, I had a soil chemist, and most of the things that get thrown into the ground apparently like to link up with the kind of soil that we had out there.

YUFFEE: So it certainly wasn't a retardant. Instead, it was quite the opposite?

GAMERTSFELDER: Yes, for most things. But that doesn't count the whole—it doesn't count everything.

YUFFEE: No, it doesn't cover the whole periodic table [of elements].

GAMERTSFELDER: But the major hunk apparently stopped. I thought we did a pretty good job.

FISHER: How about some of the lawsuits that are going on out there now? Do you think there's any basis for these people looking for medical monitoring funds to be established?

GAMERTSFELDER: I think you've got some people who've learned some of the lingo [of nuclear physics, health physics, and litigation] and are extrapolating. I can't see any very large number of people actually being involved in anything of this kind. It may be difficult to really prove it, but I remember reading something very recently. It sounds like he had read an awful lot of stuff.

FISHER: Really? Was this in the newspaper or something?

GAMERTSFELDER: Probably more—there are a few technical people who are—Gottfred?

YUFFEE: Gofman?[78]

GAMERTSFELDER: Yeah, Gofman.

FISHER: Yeah, John Gofman.

GAMERTSFELDER: He did some questionable stuff. He had collected data in Illinois around the GE reactor plant down near Morris, Illinois. One of the counties we've talked about was being affected. The cancer [incidence] had gone up [by] a factor of two or three. And he didn't find out, or neglected to find out, that the county population had gone up by a factor of three, or something like that.

FISHER: Oh, I see, skewed results.

GAMERTSFELDER: And then, one of the doctors in the [AEC] Division of Biology and Medicine, whose name has now slipped me, did the whole state of Illinois. And he did it properly (a medical man ought to) and it showed absolutely nothing.

More Memories of December 2, 1942

FISHER: Well, I think I've run out of questions. But I do have one final little aside. I'm just wondering. You mentioned that when the first sustained reaction appeared in December (December second, 1942) that you celebrated, and that there was the knowledge that something really wonderful had occurred. I'm wondering if anybody said anything that you recall at that time, just by words—

GAMERTSFELDER: I don't remember.

FISHER: Well, I'm looking for your own recollections.

GAMERTSFELDER: No, they were just patting backs. *(laughs)* And the people didn't hang around very long. They later ran that reactor up at some higher power. They did it from a control room further down in the building. I remember, after that, picking up the copper wire and checking it out. It was [radiologically] hot. It had just been on the floor.

YUFFEE: And you picked it up?

GAMERTSFELDER: Yeah, I picked it up. I think I dropped it in an envelope or something.

FISHER: Well, it's quite a contribution to history. You've certainly been able to see a number of interesting events.

GAMERTSFELDER: Oh, it has been interesting.

YUFFEE: We took an excursion yesterday to the [X-10] graphite reactor.

---

[78] John Gofman, a physician and biophysicist, held that there is no safe level of radiation exposure. Gofman's public views and outspoken style brought him into frequent conflict with the AEC. For Gofman's account of these conflicts, see "The Controversy Over Nuclear-Armed Antiballistic Missiles (1969)," "Testifying Before Congress on Radiation Effects," and other sections in DOE/EH-0457, *Human Radiation Studies: Remembering the Early Years; Oral History of Dr. John W. Gofman, M.D.* (June 1995).

GAMERTSFELDER: It doesn't look like what I saw when I was there.

FISHER: I wondered about that. It seemed awfully souped up.

GAMERTSFELDER: It has been filled up with [offices]. There used to be a lot of open space in there.

YUFFEE: Really?

YUFFEE: We were curious, but we didn't know that—saw that your name—you had signed the 50th Anniversary plaque, as well as Waldo Cohn, who we were with yesterday.[79]

GAMERTSFELDER: Yes.

YUFFEE: We want to thank you for talking to us.

FISHER: We just want to give you the opportunity to say anything else, if there's anything.

GAMERTSFELDER: Are we on the record?

FISHER: Well, but we can turn that off if you would like.

GAMERTSFELDER: Well, okay, turn it off.

FISHER: Okay. It will just give you the opportunity to say anything else, wrap up anything, ask any questions we should have asked, but didn't.

GAMERTSFELDER: No, I don't have anything.

FISHER: Okay.

GAMERTSFELDER: There's a plutonium-238 fuel element in the Pacific Ocean somewhere.

YUFFEE: Oh, really.

FISHER: Where's that? What was the source of it?

GAMERTSFELDER: You know the Apollo mission that didn't make it?

FISHER: Mm-hmm, Apollo 13.[80]

GAMERTSFELDER: It did go to the moon['s orbit], and they used the [LEM] that was to take them down to the moon as part of the mechanism for bringing them back.

FISHER: As the rescue operation, right?

GAMERTSFELDER: Yes. And that had that fuel element. It was in a protective casing. The casing had been tested in the facilities as to how it would stand up to the reentry into the [earth's] atmosphere. That casing would have taken anything that could happen to it, but that casing was held onto the LEM

---

[79] At Oak Ridge National Laboratory, Cohn was a senior biochemist in the Biology Division, where he investigated the radiotoxicity of fission products. For the transcript of the interview with Cohn, see DOE/EH-0464, *Human Radiation Studies: Remembering the Early Years; Oral History of Biochemist Waldo E. Cohn, Ph.D.* (June 1995).

[80] The aborted mission and the successful rescue became the subject of a major motion picture, *Apollo 13,* in 1995.

with some metal fittings. We weren't sure what those would do to the reentry process. Nothing happened. Nothing was found in the atmosphere. Nothing has been found in the ocean, so far as I know.

YUFFEE: In the ocean?

FISHER: But the casing did break off?

YUFFEE: But it's there?

GAMERTSFELDER: I don't know. But the fuel element hasn't produced any [noticeable effects]. Now, there was an earlier version which used plutonium metal in the fuel element, and it burned up in the atmosphere. And there was some of it spread somewhere from Capetown[, South Africa], on up the east coast of Africa somewhere. Nobody ever found any of it.

YUFFEE: Oh, wow. That's interesting. Well, we appreciate your talking to us and giving us some of the insights you were able to.

GAMERTSFELDER: Well, it has been interesting.

FISHER: Good. I hope you've enjoyed it as well.

The Genesis of Health Physics and Occupational Radiation Standards

YUFFEE: And I also want to note that we were made aware of by a health physicist that we work with that, I guess, the Health Physics Society has named you as one of the true founders of the field of health physics.[81]

GAMERTSFELDER: Oh, that's K.Z. [Morgan]. There were health physicists before us. Essentially, Herb Parker was trained as a health physicist a long time ago.

YUFFEE: Well, I guess, apparently a person who worked with Darrell Fisher, who is a health physicist who works out at Battelle, said that recently the group named a few people as the founders, and you were one of them. So we wanted to at least note that for the record, and also, to say that it means a lot to be able to talk to people like yourself who have a lot to say and interesting insights.

FISHER: True.

GAMERTSFELDER: I remember when they were starting the Health Physics Society. There were a lot of health physicists around, and one of them didn't seem to

[81] [Herbert M.] Parker was thus to become the principal architect of the Health Physics program at Clinton Laboratories [Oak Ridge, Tennessee], providing for development of suitable instruments and standards for the measurement and control of radiation. He served as head of the fledgling Clinton Laboratories Health Physics Organization in 1943, and, along with Ernest O. Wollan, a cosmic-ray physicist, and Carl C. Gamertsfelder, he was one of the original three to bear the title of 'health physicist' . . . His group later included several who would make their mark in the new profession of health physics, in no small measure due to his influence . . . [including] Karl Z. Morgan, longtime head of the Health Physics Division at Oak Ridge National Laboratory [as Clinton Laboratories came to be known] . . ." Source: *Herbert M. Parker: Publications and Other Contributions to Radiological and Health Physics;* edited by R.L. Kathren, R.W. Baalman, and W.J. Bair; Columbus, Ohio: Battelle Press, 1986.

know that it was older than the project. They thought it started with the project [(Manhattan Project)].

FISHER: With the project?

GAMERTSFELDER: Actually, they were going to call it the Biophysics Society, and there are other kinds of biophysics[82] that had been going on for a long time, too.

YUFFEE: Sure. Well, I guess we know you're being humble.

FISHER: Well, in all fairness, Doctor, it's true that the idea of coming up with standards really didn't—I mean, even standards for x rays weren't created until 1936 or so—'35 or '36.[83]

GAMERTSFELDER: Oh, yes. Well, yes.

FISHER: So the idea of creating standards and maximum levels was a relatively new one?

GAMERTSFELDER: When I was working with radiation in the '30s, one of the suggestions in one of the textbooks was that if you were going to run a laboratory properly, as far as your own exposure was concerned, you would store your film without extra protection in the lab in which you were working. *(laughs)*

FISHER: True.

GAMERTSFELDER: We didn't do that then. We kept x-ray stuff around. I mean, I was working with x-ray machines right in the same—in the lab. One thing: we had an x-ray—this has nothing to do with that. I was working with x rays and, in the circuit which ran the transformer that provided the voltage for the x-ray machine, was a length of fuse wire bathed by water (which was the cooling water that went through the cathode of the x-ray machine) so that, if the water shut off, the fuse would blow and the thing would shut off.

YUFFEE: Mm-hmm.

GAMERTSFELDER: I came in one morning, and the thing had shut off. I checked the fuse, and it had blown. I opened up the box in which the x-ray tube was sitting, and the x-ray tube, which had been supported at either end, and the target was in the middle—you had an x-ray beam that came out through a hole in the lead box—the tube had busted. Before the tube had busted, I had seen it and it was black. What happens is, some of the x rays react inside the glass.

YUFFEE: Sure.

GAMERTSFELDER: The glass had deteriorated to the point where it just couldn't hold a vacuum anymore. *(laughs)*

YUFFEE: It just broke?

---

[82] the branch of biology that applies the methods of physics to the study of biological structures and processes

[83] Actually, the first standards for x rays were created in 1928.

GAMERTSFELDER: And it gave way, and it dropped. And those pieces of glass, you would pick them up, they were slippery. It was sodium hydroxide and other oxides, a little bit of moisture—slippery. So the x-ray machine would have been turned off, in any case.

YUFFEE: Well, that's good to know.

FISHER: Certainly some interesting experiences, and you've met some interesting people.

YUFFEE: And we thank you again for talking to us.

GAMERTSFELDER: Well, you're welcome. I've talked to a lot of people during the last year.

YUFFEE: This issue seems to be getting a lot of attention.

Reflections on Herb Parker and Karl Morgan

GAMERTSFELDER: It's too bad Herb [Parker] didn't get to this point.

YUFFEE: We feel the same way. It would have been nice to talk to him.

GAMERTSFELDER: He was a very smart, quick mentally, man. He got [riled up] once at a meeting in Chicago, and there was a—this was at the University of Chicago, after we had left there. It was a health-physics–type meeting. He was probably mad at K.Z.

(laughter)

YUFFEE: Mm-hmm.

GAMERTSFELDER: There was a mural on the wall in there, with shepherds and sheep and crooks and things, and he turned that into health physics. That crook had a lamp on it that was a survey meter. I can't remember all the things he did.

(laughter)

YUFFEE: Oh, that's funny.

FISHER: Well, that's good. Did they—was it a very closed community—Herb Parker and K.Z. Morgan and Carl Gamertsfelder and Simeon Cantril? Were you close personally? There weren't a lot of people, men, in the world that knew what you knew then.

GAMERTSFELDER: Well, there were a lot of people [who] thought there was a lot of bad blood between [Englishman] Herb Parker and [North Carolinian] K.Z. Morgan. K.Z. was a southern gentleman from the word "go." They were good personal friends. They visited each other at their houses. You get them in a meeting, and—*(laughs)*

YUFFEE: Sure.

GAMERTSFELDER: But the guy I was talking to was surprised they even talked to each other.

YUFFEE: Well, I got the impression from when I met Dr. Morgan, that he doesn't seem as if—I mean, everyone who's familiar with the issue knows that he has taken some views now that a lot of people don't necessarily agree with. [84]

It seems to me that the transformation—I would have a hard time believing that it's a huge transformation. It would seem to me that he hasn't really changed a heck of a lot over the years. I could be wrong. Am I wrong in that respect?

GAMERTSFELDER: Well, I couldn't say he changed from—any different now than when I knew him in Oak Ridge. I haven't been around him during his [times when there were arguments about his views]. I really haven't been in the same places.

YUFFEE: Sure.

GAMERTSFELDER: We weren't there. There's a part of my life you haven't—you don't know about. It's still health physics.

FISHER: Which is?

GAMERTSFELDER: My stint with the Atomic Energy Commission.

YUFFEE: Oh. Please tell us about it.

GAMERTSFELDER: My part of which later became the Nuclear Regulatory Commission.

FISHER: Oh, wow. Why don't we—since we don't know about it, let's—yeah—no, I'm very interested in that.

GAMERTSFELDER: You can turn the machine off. ❑

---

[84] Some scientists have expressed concerns that Dr. K.Z. Morgan exaggerates the radiological risks associated with trivial levels of radiation exposure.