Nevada Test Site Oral History Project
University of Nevada, Las Vegas

Interview with Stuart Black

January 18, 2005
Las Vegas, Nevada

Interview Conducted By
Suzanne Becker

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Suzanne Becker: *OK, so if you could start with your name and some background, where you're from, background leading up to how you ended up in Las Vegas?*

Stuart Black: How far back in the background?

As far back as you want to go.

My name is Stuart C. Black. I was born in Charleston, South Carolina. My father was in the Navy, so we moved a lot. I started grade school in the Philippines, Manila, the Philippine Islands, and graduated from high school in Corbin, Kentucky. Went through World War II in the Army Air Forces. Went to the University of Florida under the GI Bill. Got a bachelor of electrical engineering in 1949. In the spring of that year, I applied for an AEC [Atomic Energy Commission] Radiological Physics Fellowship. And since GE [General Electric] wasn't hiring engineers at that time, I took the fellowship and went to the University of Rochester in New York, to the Atomic Energy Project. And when I finished the Radiological Physics Fellowship, they urged me to try a pre-doctoral fellowship, so I did that and got a Ph.D. from the University of Rochester in 1957 in radiation biology.

One of the projects I was working on was low level analysis of lead-210 and polonium-210 [Po210], because one of the foundations of the nuclear age was the mining of uranium ore to produce both the fissionable uranium and as a feed stock for producing plutonium. And there were a lot of lung cancers occurring in the uranium miners and due to their exposure to atmospheric radon [Rn], and the daughter products of radon wind up as lead-210, which changes to Po210. They thought if they could use low level analysis of these isotopes, that we may be

able to measure past history, radiation history of the uranium miners because the monitoring that went on in the mines at times was one time a year, and miners were maybe working year-round. So the level of exposure was almost unknown for the early days and then was very poor for many of the years that they worked, and we thought we could develop a bioassay method for that. As it turned out, even using experimental animals, it seemed to work OK except when they were actually coming out of the mine, the present exposure to radon daughter products overrode the emission of the lead-210 and Po210 from their skeletons. So that method of bioassay didn't work out very well.

And then I got into the Public Health Service and they moved me to Farmington, New Mexico because studies by the Water Pollution Branch of the Public Health Service indicated that radium-226 [Ra226] levels in the Animas River which feeds Farmington, New Mexico for both irrigating crop and for drinking water for the city had higher levels above the recommended levels of Ra226 in the water. This came from the mill in Durango [Colorado] where the tailings that were dumped on the side of the river, and rain was washing this stuff into the river. And so we needed to measure radium body burdens in the people there. Again, the problem was no data for past history. We didn't know what the adults might've gotten in previous years. And so we decided to **[00:05:00]** go with deciduous teeth, that is, teeth that the children develop. Since radium is taken up in the bone and the teeth are growing when the children are growing and drinking their water. And the incisors are developing first, almost at birth, and then the side and pre-molars, and some people get their wisdom teeth in their teens, late teens, and almost up to twenty, we could get teeth. And we had developed a little badge system for the schools [that said], "I donated a tooth for research." And if they donated two, we would give them one that said "two teeth" and "four teeth." We got six teeth from some of the children. And we would get

the ones, depending on the child's age, so that we'd get enough sample to analyze. The advantage of that was with a twelve-year molar we could go back at least eleven years in measuring what their intake was, basically measuring the river water. Although most of the people in Farmington were shopping at the supermarkets rather than raising their own, but there were a lot of farms around there and of course some of the fresh produce came from irrigated farms there. Another interesting thing we found is that in going to the farms themselves, we asked if they had canned any fruits and vegetables in the earlier days. We got fruits and vegetables that were canned in the 1940s, and this was a project that was started in 1960. So when we got back twenty years, then we could measure radium in levels like that.

To translate that into body burdens in the people in the area, we developed a method of measuring their radon exhalation, which of course was done because of the radium dial painting studies done by Dr. Robley Evans at the Massachusetts Institute of Technology, MIT, in Boston. He developed methods of measuring radium body burdens, and we were using his methods. Now that we have an exposure, perhaps, level, we could do that. And we found that we could measure some levels that were above background levels in people. If we used Pueblo, Colorado, for example, bone samples from people there, or having breath samples, we could measure higher levels in Farmington than in Pueblo, Colorado. However, we got some people from Houston [Texas] that had higher levels than the ones in [Farmington]—so it turns out that because of the conservativeness of the standards that are set by the Public Health Service and now EPA [Environmental Protection Agency], that the body burdens never reached what those standards indicated they should

While I was winding up that project and we were getting ready to shut down the laboratory, Dr. Delbert Barth came by as one of the reviewers of the project. He had been

assigned here in Las Vegas to develop a research program on the Nevada Test Site based on the radioiodine problem. He asked if I would be willing to come over here when we wound that up. So after the final report on that, I moved here in July of 1964. And we started the Bioenvironmental Research Project, which included developing a dairy farm on the Nevada Test Site.

Can you talk about that a little bit?

Surely. The dairy farm had in the neighborhood of about twenty dairy cows, Holsteins generally. The farm had enough acreage to grow alfalfa crops to feed these animals.

How big was it?

[00:10:00] About two acres of alfalfa. And we had a five-thousand-foot-deep well that was feeding the water there, so it was fairly clear water, as far as we could tell. And we had to develop methods of spraying radioiodine aerosols over this crop, and then reaping the crop and feeding it to the dairy cows. And so we would reap the crop and we would get a bag of, let's say, twenty pounds for feeding of alfalfa, and we'd take samples of that and measure it and feed the rest of it to the cows. We would feed as many as twelve cows at a time. Maybe four of them would be uncontaminated hay, or uncontaminated alfalfa, in this case. Then there would be three other groups of four with low level, medium level, and high levels of iodine. Then we'd milk the cows and we'd measure the amount of radioiodine excreted in their milk over a period of a week or so until it got down to unmeasurable levels. And the cows were very good producers of like twenty to thirty gallons of milk a day, so they were a good herd.

And we tried different kinds of aerosols. We tried different kinds of feed; Sudan grass instead of alfalfa. And different forms of the iodine, whether it was I-128 or a -131 or the gaseous iodine, and things like that. When we had enough of that material on hand for a good

analysis, then we switched to other isotopes. Those in general we didn't spray over the alfalfa crop. We gave it by injection or by oral bullets. We'd put them in a plastic container and shove it down their throat and they would just swallow it from thereon. And so we measured the excretion in milk of a bunch of radioisotopes, some of the actinides and more of the other things like cesium-137 [Ce137] and strontium-90 [Sr90] and the normal isotopes you hear about as being in fallout and perhaps [are] a concern of the populations downwind from the test site.

In addition to milk, when the cows got old enough to be, well, to have reduced milk output, we would then sacrifice the cows and measure liver and bone samples and other organ samples for their radioiodine count. And of course the radioiodine was mainly gone by that time, but for the other isotopes with the longer half-lives, like cesium and strontium and beryllium and—I don't know, there's a whole list of isotopes we tried.

In addition to the dairy farm, we had a beef herd that roamed in Area 18 of the Nevada Test Site. It was a hundred-cow herd and it was started in 1957. And we maintained it until 1981. Each year they were rounded up twice a year and we'd get two adult cows and two calves, or yearlings, in the spring and in the fall and sacrifice them and measure their tissues and bones for whatever might show up, because they were grazing in this area that had had a few tests, not very many, but a few tests. And of course it was downwind for a lot of the tests in Area 5 and Yucca Flats**.**

So we closed both the dairy farm and the beef herd in about 1981 I think. And there are annual reports, EPA reports, on the history of those and their findings and a kind of a summary of their findings.

After that, most of my time was spent in doing annual reports, both the National Emission Standards for Hazardous Air Pollutants report, which we abbreviated as NESHAPs,

[00:15:00] and the Annual Environmental Reports, beginning with just for the EPA itself and the work we were doing. We had a group that was monitoring around the test site all the time, particularly concentrating on times of tests for the cases where there might be leaks of things, ventings they called them, for the underground tests.

There were three of them that I remember particularly that we were involved in with offsite populations. One was a test in 1964 that vented and led to a cloud of low level radiation over the Las Vegas area [Pike]. So we went to a couple of dairy farms that existed here at that time, and of course we were interested in radioiodine because it's the first to show up and it's produced at about 5 percent of all fission products in normal fission, so we expect to find that. And we did find low levels in those cows. And the second one was an event called Pin Stripe in, I believe, 1965 [1966] that vented and led to relative high levels of fallout in the area of Alamo and Hiko Nevada, and so we went—

OK. Where are those?

They are northeast. If you go up, what is it, [Interstate] 93 that goes up that way? Well, they're along 93. And so we collected milk samples and pasture samples. We brought people in and did thyroid measurements of the children and things like that. We actually had a mobile laboratory for the Pin Stripe event that we could go up on a trailer and measure those.

And then the last one of any significance was one called Baneberry in December of 1970. It vented and the cloud went to the northwest, so we went up towards the Beatty area. There was a farm up there where a cow was grazing on the pasture and so had the most exposure. It turned out something in the range of like 800 millirem [mrem] thyroid dose to a child if they had been on that milk a long time, but of course we took them off the milk as soon as we found the levels of iodine there.

And then after that, I guess my main function was making accurate reports for the annual reports and things. So that's about most of my history; the short version.

That's a pretty substantial history. You mentioned that some of those reports from the farm are written up, but I'm wondering if you could briefly summarize the general findings, or did it tend to vary year to year? Because that was a pretty substantial time that the farm was running, and I'm just curious what the overall trend of the findings were.

Well, because they were experimental procedures, the levels fed to the cows were fairly high so that the results were fairly high. But the principal thing we were interested in was how long did it last in milk, and then what rate did it decrease. And we found that iodine-131 [I131] which we were interested in, the longer half-life isotope in fallout, in the cow it was close to four-and-a-half days instead of eight days. So there was a biological half-life as well as a physical half-life that combined to give you in fact a four-and-a-half or five-day half-life for the cows. And this applied to nearly all of them, nearly all of the isotopes. The excretion in the milk was less than the physical half-life. And in the forage, this was also the same because one, forage is growing and so it dilutes the stuff. The other is rain and other processes wash the stuff off, so that in the field a three-and-a-half or four-day half-life on forage was about right. So these were **[00:20:00]** important findings for when you have an accident: how long you had to take care of things, how long you had to keep the cows off the feed or how long you had to supply new milk for the dairy farmer or whatever. Most of the time it wasn't for a dairy farmer but for the individual farmer who had his ranch, his own cows for milking and drinking.

And the beef herd, we had control cows from around the Reno area. There was a herd up there and we got control cows from there, and we always compared the results we found in our

beef here in Area 18 with the cows for these other things, from these other areas. They didn't vary that much. Most of the time, you could not tell that the cow was from near the test site.

And a similar thing occurred near Denver at the plant there, the Rocky Flats plant. There was a dairy farm or a beef farm, I'm not sure which, I think it was beef. It was adjacent to the fence line of Rocky Flats and they had cows there. So we went to them, bought some cows from them. They were north and east of that plant. And so we analyzed those, made a report on those, and their bone levels of plutonium were very low. In fact much less than we expected from reading the reports of the population who were sure that everybody was going to die of plutonium poisoning.

We also started a project with Denver Medical School. They were to collect bone samples from people that came to autopsy that lived in the area for any length of time. And we divided them into three groups: one that were within two or five miles of Rocky Flats; others that were up to twenty miles from Rocky Flats; and then people from Pueblo, Colorado as controls, since Pueblo was south about a hundred and some odd miles. And fortunately we didn't find anything. We had, I would say, at least fifty or sixty within five miles of Rocky Flats. We had in the range of thirty or forty from within twenty miles, and we had about twenty-five controls from Pueblo, Colorado. We measured liver and bone, which are the two storage areas for plutonium, and we also measured the ratio of 239 to 240. It tells you whether it was fallout plutonium or whether it was weapons-grade plutonium because the ratio of the 240 to 239. And as I say, we didn't find much. They did a statistical analysis and you could see it scattered all over the place, but there was no consistent level and above for the people living around Rocky Flats plant.

So fairly random?

Yeah, fairly random. And so then we shipped the rest of the samples off to Los Alamos [National Laboratory] because there was a group down there that was measuring plutonium in the bones of offsite people as well as workers in plutonium at the plant.

But I think that those two were the main offsite things. We had a program in our monitoring that took water samples from wells in the areas of the—part of the Plowshare program. One of them [Gnome, 12/10/1961] was in Carlsbad, New Mexico which was actually a multipurpose experiment. It was not only for measuring seismic effects but also for containment of the materials in the area of the explosion in the thing.

OK. I didn't realize that.

Yeah, and in Mississippi they also had one of these. They called them Vela Uniform. They exploded a—

What are they called?

[00:25:00] Vela Uniform Tests. They had a salt cavity down near Hattiesburg [MS], a salt formation. They emplaced a nuclear explosive down there, formed a cavity in that, then put another nuclear explosive in there, and then it blew off. But there was an air space there so that it would tend to minimize the shock to the ground, a way of telling the difference between a nuclear test and an earthquake, for example. If you had geophones in the ground and you were picking up these sounds—

If you're monitoring these things—

You wanted to make sure that if you were monitoring Russia, you wanted to be sure it was a nuclear test—

And not an earthquake.

And not an earthquake. And then the other ones were actual Plowshare events; Gasbuggy in New Mexico, trying to stimulate natural gas, and Rio Blanco and Rulison in Colorado. Once those tests were wound up, we instituted a series of sampling wells around there. Some of them were normal wells, some of them were drilled by the communities and municipalities, and some were exploratory wells done by gas companies or whatever. And so we'd get samples from those to see if there was any leakage from these—

And what—?

Gasbuggy, after about fifteen years we did find tritium and those things, but not in any of the others. In the one near Hattiesburg in Mississippi, there was a lot of tritium contamination of some surface wells caused by inadequate cleanup methods, but not by leakage from the cavity.

So the cleanup was more detrimental than the actual test itself.

Yes. Right. So that's about what we did for the offsite, and things that weren't part of our original charge when we started.

So I guess given just scientifically or factually what your work has uncovered and what you have learned, what do you make of claims from folks that have been in downwind areas?

Well, it seems to me that, based on my experience and what I've read in the literature, that the downwind doses have been too small to have led to any long-term effects. And there are many people that say, `Well, you weren't down there measuring that stuff [during] the atmospheric tests, there weren't people out monitoring in St. George [Utah] or Cedar City [Utah] or those places.` That's true. But they could project from measurements of the cloud made from planes through the clouds, and got measurements of the activity in the clouds. And they knew how it was going to spread and how it was going to decay with time, so there were estimates of that fallout. And in the later, in the '55, '57, '58 tests, they actually did have film badges out in places like St. George. They had people that were wearing

them. And [in] Cedar City, and some other cities in Utah. We estimated that something like 4 Rem [Roentgen Equivalent Man], for example, occurred in St. George over all the atmospheric testing things, and that's not enough to cause anything for anybody. The standard for occupational exposure is 5 REM per year, and in a twenty-year exposure you're going to get a lot more than 5 REM. And they were getting 4 REM from 1950 to 1958, so an eight-year exposure. It didn't make sense, and I think that when Senator [Orrin] Hatch put it in his bill to compensate victims and Downwinders in Utah, it was because they couldn't really prove that stuff. It was a squeaking wheel and he put some oil in it by giving them fifty or a hundred thousand dollars depending on the type of—

So if you can't not prove [it], it's safer to go with the bill.

Yes.

[00:30:00] *I just may not know enough about it, so I'm curious about longer-term effects, because it sounds like things have been monitored over a significant amount of time, fifteen years or so. [But] I've heard people talk about,* `Well, that's not enough time.`

Well, we're still monitoring offsite, and it is being done now by DRI [Desert Research Institute]. It was done by EPA up until, I don't know, four or five years ago? And as far as I know, they're continuing to do that, and I don't think there's any suggestion that it be shut down yet. And onsite, the annual reports, the Site Environmental Reports, based on measurements onsite, those are in those reports, as well as the NESHAPs report which measures offsite exposures from air concentrations. So I'm sure they're going to continue those.

And these are all reports that if the general public wanted to access, they're able to?

They're here, in our library, yes [at the Atomic Testing Museum/DRI building].

Do you think that, in your opinion and your experience working within the program, that there has been information made available to the public and that there is enough public awareness that folks actually understand what's—?

I think that's the problem—is the understanding is not there. And the health physics profession's been a little bit lax in that, in not informing the public accurately and teaching them the difference between this and that and the other in radiation effects. The fact, for example, that the people in Denver get twice as much radiation exposure from background radiation as people in the seashore, New Orleans or in Charleston, South Carolina, but they don't have any higher cancer rates. And radiation from background is no different from the radiation in fallout products. So I mean, X-rays are X-rays, gamma rays are gamma rays, wherever they come from.

Right. Yes, I think that's definitely been a point of contention throughout the years, is the flow of communication or lack thereof.

Yes. We kind of let the radicals, I think—and of course newspapers like to publish things that are startling or hazardous or whatever. When it's safe, it's not a story. Here we've exploded these hundred atmospheric tests on the test site and as far as we know, nobody downwind has been harmed by them, but that's not news.

Right. Just backing up briefly—

Well, I should say maybe not that nobody's been harmed because there are ranchers almost at the boundaries up there along Highway 25 and I used to know the names of those people but I don't anymore. Perhaps some of them had higher exposures, and it's possible that they are more likely than people in St. George, for example, to get a long-term effect from that. But again, the population is small and their lifestyles are a lot different and things, so I guess I should hesitate

and say, I can't say that nobody got any effects from those hundred atmospheric tests, but as far as we know—

Sure. And I guess that's another question, is what about those folks who have been working directly out at the test site for fifteen, twenty, twenty-five, thirty years?

Yeah. Well, I'm not sure because I don't know what their exposures have been. I know that for **[00:35:00]** all of us that worked at the farm, we had our film badges in the early days and thermoluminescent dosimeters in the later days, and we've all had our records. As far as I know, our highest exposure was to a guy who was downwind of Cabriolet watching a haystack when it was fired. It was like 300 millirem, and if he added his total exposure for the five years he was with us, it was something in the range of 400 millirem. So as far as I know, he was the most exposed person that I knew about in our group. Now we had a group at the laboratory who flew planes through the clouds. Those I don't know about. And they all, of course, wore dosimeters and film badges. I'm sure that Martha DeMarre [of the Nuclear Testing Archive] upstairs has their film badges and maybe their records, so if anybody was interested, I guess they could go up there and check.

Were you out there when Baneberry happened?

No. We went out afterwards and, of course, it was going northwest and our farm's on the east side, so it was going away from the farm. Pin Stripe in '65 was just before we got the farm started, so I missed that one.

What [were] your initial impressions of the Nevada Test Site? I'm just wondering what you thought when you started with that project and what your initial impressions were?

Of the test site itself? By the time I started working there in '64, I thought they were a very professional group, that they were concerned about safety, and that they worried because of the

publicity of doing something that would expose the offsite population. For example, Baneberry, they had a set of standards that they were to follow in drilling the holes and backfilling them for these underground tests, and Baneberry surprised them with something. So immediately they stopped the underground for about four or five months and tried to figure out how to prevent that from happening. They established what was called a Containment Evaluation Panel [CEP] which then had the laboratories and the people from NOAA [National Oceanographic and Atmospheric Administration] and people from USGS [United States Geological Survey] and all of those come in and talk about the geology, the well-drilling, what they found in the wells, how they were going to backfill it and what the nominal and maximum yield of the device was going to be. All this stuff went into this Containment Evaluation Panel which then said, `This is going to be a good test. Go ahead.` Or, `You need to do this or that and the other before you can go ahead.`

So it was pretty thorough.

I thought they were very thorough, yes.

And were you involved at all with other sorts of safety procedures that went on, or monitoring?

Oh yes. Such things as wearing C-suits, contamination suits, we did those and we practiced with them. They're only good for external stuff that [will] fall down on you or get on you because you're in the water and the sun. They don't protect you from gamma rays, and so you might have to wear a breathing apparatus if you're in a cloud. Or if you're just cleaning up an **[00:40:00]** area, you may not need a mask but you do need something to keep the stuff from getting on your skin. And then there are the normal industrial safety—they also had industrial safety experts out there that went around and made sure that people used ladders properly and that they used

headgear, helmets. And so I thought it was, you know, it was a very—safety was an important part of their operation.

And they were conscious of it and—

Conscious of it, absolutely.

Yes. I guess, depending on who you talk to, there's two sides to the coin. The government, or the test site, knew of no dangers resulting from testing or, depending on who you talk to, the government knew, they just weren't divulging all the information.

Well, let's do a little bit about standards. In 1949 when I went to the University of Rochester, the standard at that time was 300 millirem per week permissible for occupational exposure. Well That's 15 Rem per year. It stayed at that level until about '79, and it went down to 5 Rem per year occupational exposure. The offsite general population exposure was not considered a problem in the early days, and so there were no standards until about 1955 or so for offsite people. And that was in the range of 500 millirem per year, instead of 5 Rem per year, a factor of 100 down. No, a factor of 10. Actually it was a little more than that but that's close enough. And then in 1980, they made the occupational exposure no more than 5 Rem per year for several years, but a lifetime average of about 2 Rem per year. So even though they have not found any detrimental effect from the earlier levels, they keep dropping them down because they can operate at those levels and so why have any additional exposure? And then the 500 millirem offsite population exposure went down to 100 millirem at the same time, with 500 millirem OK for one or two or three years, as long as the lifetime exposure didn't average more than 100 millirem per year. So those are the safety standards we operate with. Now when we had the atmospheric tests in the fifties, the standard they set for offsite populations was 3 Rem, and it was based on the fact that the occupational exposure was 15 Rem per year at the start, or no more

than 3 Rem per quarter. And since the tests in those days lasted for three months and then ended for the year or they went to the Pacific, they figured, `Well, if we just keep the tests for three months, then we can let the offsite exposure be no more than 3 Rem.` So that was the standards that they used. Now the long-term studies of the population from Hiroshima and Nagasaki, they have just recently redone the exposures of those people based on experiments with the nuclear tests at the test site and they are now in—well, they started them in 1950 with a **[00:45:00]** group of about 76,000, I think, survivors of those two. And they have found of all the cancers that have occurred, solid cancers as well as leukemias, not more than 5 percent have been due to radiation exposure. They have not found any detrimental effect from exposures less than 10 Rem. So this shows you that—and you would expect that 10 Rem all at once would be more hazardous than 10 Rem over a year.

Sure. That makes sense.

And so that's an important milestone in our safety studies, I would think.

Yeah, that's very significant. Now I don't know if they're really publicized these studies or findings—

Yes, it's available on the Web but who goes to the Web, because they don't know what to look for.

Well, that's the thing, you have to know it's there and to look for it. Did you ever think about any type of exposure while you were out there? I don't know how much time you actually spent physically on the test site. It seems like you spent some time on the farm.

Yes, it didn't worry me. We had a fellow that worked for us that wouldn't go on the test site because he was so frightened of the plutonium in the ground soil, so we had to keep him on the offsite program. But it didn't worry me. I know that any of the inhalable stuff, plutonium or

whatever, is probably long gone; what's left is attached to larger dirt particles that hardly ever get up into the breathing zones, so that's why it didn't seem to make much sense to worry about it. There are areas there that did have high levels of gamma coming out of them, so you want to stay clear of those. But they're few and far between. It just takes a little bit of common sense.

When you guys were out there, did you stay out there?

Yes, we spent the night because normally the winds were most favorable about four or five o'clock in the morning.

Right, so the tests went early.

We would hope they would happen about midnight or something like that. But they never did, so we would stay in the dorm and wake up and go out there and wait for the weather reports and see if they were correct. Then we would contaminate our alfalfa field and go on.

Right. Were you out there for any of the tests when they happened?

No, all of us were generally in the offsite area when these tests went on.

OK. Now you weren't in the Las Vegas area yet when they were doing the atmospheric tests, I don't think.

No. See, they ended in—actually the last atmospheric test was in '63, I believe, '62 or '63.

Right, '62, I believe.

And they weren't very much. It was like Small Boy [7/14/1962] and Little Feller I 7/17/1962**].** It was the same in Area 18 and over in Area 5.

Miscellaneous, I just remember looking at your information here that you spent a little time in Austria?[1977-1980]

Oh yes.

What was that for?

Well, the International Atomic Energy Agency is a United Nations agency, and the U.S. supports it and DOE [Department of Energy] supports that particular agency by sending personnel over. Since our program was funded by DOE, I applied to go whenever they needed somebody. So I got chosen to go, which I enjoyed. And the problems I worked on over there were—the things that they were interested in was what are the relative hazards of a coal-fired power plant, electric power plant, a nuclear power plant, a thermal electric power plant, a gas-fired power plant, and an oil-fired [plant]. So you go through and you consider the hazards to the miners for the ore in the nuclear power plant, the processing of that to make the fuel; the building of the plant **[00:50:00]** and the hazards you get from them, and then measure the standards for emissions from the plants. Then you go to the coal plant and you got the coal miners and you got the shipment of the coal. Then you've got the building of the plant, and then you've got the emissions of sulfur dioxide and all of the things that come out of that. It turns out that the nuclear power plant was the safest in terms of industrial accidents. And we think it's the safest in terms of radiation, too. But of course if you build them like the Russians did, maybe not. But our plants and most of the European country plants are very safe. I enjoyed that because that was a long-term study and we published three or four papers on the relative safety of those plants. And I did a lot of traveling on the weekends in all the countries, you know, within an overnight train trip almost so—

Yes, I bet it's beautiful.

Yes. My wife enjoyed it.

Oh, she got to go with you.

Oh, sure. Yes.

That's good. Now did you spend a lot of time away from your family while you were involved with this?

No, the family would go along with me. I mean, you know, [except] for the nights we spent out or going to meetings and things.

Right. How about in terms of at the test site, did that take you away a lot?

No. I mean we were out there maybe two or three days at most sometime, and maybe that's only a couple of times a year. Most of the time, it was overnight, you know, and so no, no big problem.

Anything else that [we] haven't covered yet that you feel is important in terms of getting an idea of what you did at the test site and important to the work?

No, I don't think so. I think I've about exhausted my resources on that.

I'm just curious, very early on in the interview you mentioned that you worked for the Atomic Energy Project when you were in grad school.

Yes.

And could you briefly talk about that a little bit, what that was?

Well, it was my fellowship, and the project there was basically dealing with alpha emitting things, with uranium and plutonium and alpha radiation and things like that. And so I didn't get involved very much in that. They used a human glove box, I guess you'd call it. It was an enclosed area under negative pressure where they did all the experiments in plutonium and alpha radiation, and mine being all low level stuff, Po210 and lead 210, didn't involve any huge hazards. That could be done in the normal laboratory atmosphere, and so—they published a book and there was a whole series of books published by the Manhattan Engineering District. The University of Rochester Atomic Energy Project had their own book on alpha emitters and stuff

like that. And so they did a lot of very interesting things there in terms of the metabolism of plutonium and alpha radiation and uranium, and they did a lot of measurement of uranium and radium in water supplies. And they were interested in radon studies, which led to the things I was doing, radon exposures and things. So that's about all I can say about that project.

OK. I was just curious. You mentioned it earlier and I read it on your bio and so I was just

[00:55:00] *I guess I do also have another question that maybe you can shed some more light into. You guys used cows. Is there going to be any significant differences between cows and humans? In other words, looking at cows, seeing how exposed they were, I don't know if "contaminated" is the right word, obviously for people eating the meat or drinking the milk, that's important, but also just looking at how they absorb the exposure—*

The cattle themselves and the effects on them? We never found any. Of course, none of them were very long-term. I mean we didn't go for the lifetime of a cow, which I'm not sure what they are, ten, twelve years, maybe. The ones in the beef herd, since they were only exposed to low level stuff, I don't expect that anything would ever happen to them. In fact, the only cancers they ever found from them was called cancer-eye from the ultraviolet exposure of sunlight exposure. So that's about all I can say about that, I guess. We wouldn't expect cows to live long enough to get these long-term cancers. They take twenty years to develop in humans.

Right. I'm just wondering if it manifested differently in a cow than say in a human.

No, it shouldn't.

Or I guess a different time rate.

No, their metabolism isn't faster than ours. Only in rats and things, and dogs, they have a faster metabolism, but not cows.

I can't imagine. The other thing you mentioned, the Plowshare program, and that you really didn't find, that that had—

No leakage from the—

Right. I was reading through an interview, I guess, with Bruce Church, and his thoughts were that it was actually more dangerous to the folks who were working on the cleanup aspects of it than—

Yes.

—to those who were—

Offsite.

May [have] been, yes, randomly exposed to it.

Yes.

Is that your take on it?

Sure. Sure. It's just like I was saying about the drilling in Hattiesburg. All the contamination occurred during the cleanup and so those people that were involved in the cleanup had the most exposure.

I guess thus far you've actually really given a good description of an aspect of the test site that we haven't talked about too much yet, so—

Well, good. I'm glad I could do it.

If I have further questions, I may give you a call if that's OK.

Absolutely. No problem.

But I certainly appreciate you taking the time to talk to us, and it's good to finally sit down and do the interview.

Well, it's my pleasure.

Yes, thank you so much.

You're welcome.

[00:59:14] End of Track 2, Disc 1.

[End of interview]