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AN EXCEPTIONAL MAN FOR EXCEPTIONAL CHALLENGES

Stafford L. Warren

Interviewed by Adelaide Tusler

VOLUME II

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VOLUME II

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JUNE 23, 1966

TUSLER: Last time, you were talking some about Mr. Eastman at Rochester and some of the social life that centered around him there, but I don't believe you got into any remarks about the circumstances of his suicide.

WARREN: Well, as I indicated, Mr. Eastman was a very meticulous man who figured everything out as precisely as possible. I think I mentioned that he'd outlined the location and size of all the tools that were in his factory and around his house. He, of course, was very meticulous about his own hygiene and was always dressed very nicely and properly, shaved and barbered, and so on. But then he began to get feeble and developed some incontinence and had to hire a nurse to take care of him. After a while he began to wear the equivalent of diapers so that he wouldn't have a mess on his hands.

He decided he wasn't going to tolerate this, particularly since he'd seen what happened to his old friend, Mr. Colter. He had invented the mail drop shoots in buildings and became very wealthy, and lived across the street. Mr. Eastman could see Mr. Colter sitting in his window during the last ten years of his life, becoming more and more of a vegetable. He just sat there. Mr. Eastman used to comment about how futile that was. So we should all have been prepared for what he finally decided to do, and did; but we weren't. And yet we thought that it was so typical of the man that we weren't shocked too much. We said it probably was an appropriate thing.

All of a sudden he had a series of very nice parties during which he shook the hand of everybody who was there as they left and said some nice things about their life together over the years. Then he had a few of his very intimate friends in for luncheon or supper in groups of one or two or three. There was some comment about this--"The old man must be getting a little soft" or something.

Then he went to the Rochester medical school and had Dr. William McCann, who was his personal physician and who was a professor and chairman of the Department of Medicine, do a physical examination. While Dr. McCann was percussing out his heart and listening to his heart, Mr. Eastman remarked to Dr. McCann about the fact that he was always puzzled about the anatomy of the heart. Since he knew Dr. McCann used a pencil to draw it out on the skin for students, he asked him if he would mind penciling it on his chest so he could kind of recall the anatomy better. So Dr. McCann did, thinking nothing of it. They had quite a discussion about heart sounds and the difficulty of making the measurements of size and how Dr. McCann could identify different diseases of the heart by the size and shape demonstration.

He went home and a little later, apparently, went upstairs to a bathroom. First he wrote out a letter to the chief of police and then called him up and said, "I don't want you to be particularly disturbed by something I'm going to do. I have a letter for you which you are going to get."

And he hung up on him and then went upstairs to the bathroom and made some excuse to get rid of the nurse. He sent her to the other part of the building. Then he took a big bathtowel and put it on his chest and shot himself with a revolver, very cleanly, no mess, nothing.

TUSLER: Was it instantaneous death?

WARREN: It was instantaneous death because he had the heart all marked out. And, of course, the nurse was horrified to find him. She had heard the noise and found him. She called Dr. George Whipple.

Dr. Whipple said, "Well, you better call the chief of police"--which she did. Then the chief of police arrived and called Dr. McCann and Dr. [Albert D.] Kaiser, a very close friend, who went hunting with Mr. Eastman in Africa. But before any good story could have been made, about his having a heart attack and died, a reporter began to suspect something, and so he called the chief of police. And the chief was so distressed that he lost control of the situation and said, "Well, Mr. Eastman just shot himself."

Now the Presbyterian church, of course, didn't approve of suicide. But he had made all the arrangements for a funeral, with the proper number of flowers and a chosen casket. This was all done and paid for a year or so earlier. It was all set, so the minister turned his head the other way and went ahead and had the service. [laughter] And about half the town turned out, because he was such a prominent and important person.

Did I describe the music charity drives for Rochester?

TUSLER: No.

WARREN: Well, Rochester at that time had a population in the county of Monroe of about 250,000 people, or a little less. Mr. Eastman, of course, didn't like these multiple charity drives. It was all focused around a music drive because they had the Eastman School of Music and Howard Hanson's orchestra, and the [Eugene] Goossens group and so on. This needed some support, but added to this was the support of other welfare charities in the town.

So Mr. Eastman would hold a luncheon at which there'd be Mr. [James E.] Gleason and the Bausch family, who owned Bausch and Lomb optics, and other tycoons in town. They would lay out the amount that each company would contribute, how much its employees would give, and then they would figure out how much the public might give. This would go on for a about a week. Almost all of the money was subscribed at the luncheon, but there was a drive in the town just to be sure there was some public participation. When it was over the money was parcelled about. That's the way it was done [laughter] all the time he was alive. After his death, some of the company officials continued this for a while. It may even be done that way now, but it was interesting to see how much of a company town Rochester was, with these several big industries.

TUSLER: Everything was centered around them?

WARREN: Everything was centered around them. Well, just about the time we were getting into the war I had an idea that we could parley some of the war needs into getting ourselves some X-ray equipment for cancer treatment, because about that time million-volt X-ray machines were being used to x-ray castings for defects in cannons, steamship crankshafts, big engine crankshafts, and all kinds of things. The Symington Company was making tanks and, unfortunately, every once in a while there would be a big bubble of air right in the middle of a tank door, or in some other part. Of course, this is just like cheese. A machine-gun bullet would go right through it and kill the occupants.

I was well acquainted with Dr. Kenneth Mees, who was the research director for Kodak, and I went and asked him what he thought of the possibilities of raising maybe a half-million dollars to build a building and to buy an X-ray machine and do this service during the war. When the war was over, we would have a cancer treatment clinic and an experimental unit. Well, he thought it was a good idea, and so I talked to Dr. Whipple. He said, "Well, sure. It's good to get in and to support the war effort and this is something that's worthwhile. And if you can get an X-ray machine of high calibre out of it for experimental work later, well, that's good. We'll get a lab, too."

Then I went to the president of the university [Alan Valentine], but he wasn't much interested. Neither was Mr. [Raymond L.] Thompson, the treasurer, interested. Ray Ball, who'd formerly been the treasurer of the university and now was the president of the Lincoln Alliance Bank, thought this was a good idea, but that I would have to do it on my own. So then I went around to see all the people and Symington. Dr. Mees said he and Kodak would help because they wanted to test out the films that were most suitable for this kind of work. They had no way of doing it. As a matter of fact, he thought he could give the X-ray machine if we would use all Kodak experimental films and give them duplicates. So right there I had $100,000, you see. [laughter]

TUSLER: That wasn't bad for a beginning.

WARREN: Not bad. So using that as the wedge, the Symington people and Gleason [Works] put up the rest of the money.

We had a lovely time trying to design the building with concrete walls thick enough to protect against million-volt X rays. Finally, after talking with Lawrence M. Taylor, who was then in the Bureau of Standards and was becoming an authority in this area, and after talking to many others, including Bob Stone in San Francisco, who also had done some studies on protection, we decided to build three-foot-thick concrete walls. Then there was a problem of a roof. We decided if we made the walls twenty feet high we could have two stories up around it on the outside and we'd leave the top open, except for an ordinary roof. We were advised that there would be no backscatter, because we would point the radiation down, or to the side, and not up. All the rays that would scatter would probably not be sufficient to bother anybody.

TUSLER: I don't understand backscatter. What do you mean by that?

WARREN: When the radiation hits a wall, it's reflected; it's scattered back, you see.

TUSLER: And injures the people who are in the way.

WARREN: Those who are in the way, you see.

TUSLER: I see.

WARREN: And at this time nothing much was known about high intensity, very highly penetrating radiation. So we were completely on our own. With the investment in concrete, this was quite a problem. Then how were we going to see inside the chamber and get in and out of the room? It was quite clear that we couldn't get enough lead glass for windows, so we designed a window port like a fish tank. This was made of lead plate glass and filled with a solution of lead and bromide salts which were opaque to X rays because of their weight but were transparent. This was also three feet thick, and about three feet square on the face. The door was also a problem. We had all kinds of ideas about it. We were going to have a hydraulic hoist and hoist a great big concrete slab up and down. But this didn't work. We finally ended by having a maze with two turns in it so that the operator could go around two corners and then through a lead sliding door which weighed about a thousand pounds and was equivalent to a half-inch of lead.

Well, then we provided for a small animal quarters. And we had space for an outpatient clinic which we used at first to set up the material we were going to x-ray. So we finally got the building built. The laboratories on the second floor were filled up with spectrographic equipment, which we received on loan from Bausch and Lomb, and with Geiger counters.

Then we started to turn the machine on. Well, the first thing that happened was that the Geiger counters went off scale. This was due to the entirely unexpected scatter from the air above the roof. The X rays would hit the floor, bounce back, and go through the roof. They they would scatter from the air above--what was called "skyshine"--and scatter back into the building a distance of one hundred feet. So we began to learn about the problems of high intensity.

We had a little money left, which we were going to put into laboratory equipment; instead, we built a one-foot-thick shelf of concrete on the laboratory side of the big three-foot-thick vault. The walls were three feet thick surrounding this vault in which we had the machine. We extended this out about halfway across the roof of the room and this solved our problem. It didn't entirely cut the scatter out; but it reduced it so that it was only twice the background radiation, and this could be tolerated. We tried not to do Geiger counter work when the machine was running so that we would eliminate that problem.

Symington began sending up a lot of tank doors, and we found a lot of defects. Kodak sent up a lot of casting, too. They all paid for this. And out of this income we operated the program, plus some of the research. By now we also were beginning to get money from the Public Health Service to do little jobs of one sort and another.

About this time, I got interested in crushing shock. Then Dr. [Andrew] Dowdy got interested in gas gangrene on the theory that it might be possible to kill the bacteria with X rays in gas gangrene infections. I think I described the shock work last time--the crushing shock and the work with Kathryn and Bob Fink.

Did I describe the setting up of the laboratory in the unoccupied part of the new hospital wing? Well, we got the hospital contractor to donate the rough floor and we got doors from an old school building and hauled them in. Actually, we were shut down by the labor steward for a while, but then we talked him into having the labor union contribute weekends of wiring work,]laughter] as well as the wire. They hadn't wanted our graduate students to do the wiring; this was the whole business, you see. The students and I had been doing the wiring. We were all right; we just strung "BX" around and connected up a bunch of outlets and strung some lights that we got out of the old school building and put big bulbs in them. The plumbing was the hardest thing. We found a couple of sinks from second-hand shops where we could scrounge them. The contractor closed his eyes and connected them. [laughter]

Well, that laboratory was used for about two years before the war. Then at the beginning of the war the hospital got some money to finish that floor and it became a hospital floor. By this time, however, we had finished most of the shop work, anyway. The Finks were getting their degrees, and we unwound that program. We had a lot of things that we would have liked to have done which still haven't been done.

The cause of shock from this kind of crushing damage is not well understood today. The problem of having somebody under a beam or under a car or under some weight for four or five hours and then taking the mass off and watching them just fade and die when they had been in good shape up to that moment is still kind of a mystery.

Well, about this time, too, in November 1942, I was visited by two army men. They came at the request of Dr. [Albert K.] Chapman, one of the vice-presidents of Kodak with whom I'd hunted pheasants a lot, and who was a very nice friend. He said, "These men want to talk to you and you'd better do what they want you to do."

In the meantime, we had discovered that Dr. Chapman was involved in a big war program in the South. He was constructing the Holstrom Works which was a big plastic factory that used brush from the hills in Tennessee to produce solvents for the early kinds of plastics. So I thought all of his interests in the South were there. It turned out he had a new interest, which was at Oak Ridge, Tennessee. We didn't know about that, of course, for months.

Dr. Chapman invited me to lunch at the Genesee Valley Country Club in the center of Rochester. I met these two army gentlemen there. One was Mr. Groves, slightly heavy set, who later confessed he was General Leslie Groves. He was in civilian clothes. And the other one was Colonel James C. Marshall. They offered me a drink and I declined. I didn't drink, particularly in the middle of the day. So I had orange juice, and I think both of them had orange juice. Mr. Chapman had a martini, [laughter] just to show his independence.

We talked about what I was doing with shock and the work I was doing with X rays and tanks and with other things. They wanted to know what I was doing in radiation. So I discussed the cancer work and some of the other things, including fever therapy. I said I was pretty well occupied with war work and with more than I could do very easily because some of my graduate students would be drafted immediately. I told them I had a hard time keeping the programs manned with good researchers. Well, then we finished and I wanted to know what it was all about. And they said, "Well, if you don't mind, we'll excuse Dr. Chapman. We'd like to talk to you in private. We have a room engaged upstairs." So we went upstairs. But first, Dr. Chapman shook me by the hand and said, "I want you to listen carefully and do what they say." This was very mysterious.

We got upstairs and they looked in the closet and they closed the transom and they looked out the window which was on the second floor. There was a big lawn out there, you see. Then they closed and locked the door and said, "Sit down." So I sat down.

They said, "We would like to have you work on a secret program in which we need a doctor who is familiar with things that you've been working with and we'd like to have you come right away." I said, "Well, gee, I just would like to know more about it. In the first place, I would be glad to help you because Dr. Chapman says what you are doing is very important, but I don't see where I've got anything that you would need." And they said, "Well, you have to let us be the judge of that It's a very secret and difficult and confidential program."

We stalled for a while and I said, "Well, you'd have to ask the president and ask the dean." I said that I couldn't because I had already worn out my [laughter] welcome with them, because I was doing so much war work and so little diagnostic work there now, and that if I were to take on something else it would cause them to object. So they said, "Well, we can get their permission. We don't have any doubt about that because we have a very high priority." (Priorities by this time were a common thing. You practically had to have an order through a government agency in order to buy anything. It was the beginning of the control of production. There was a big organization that had control of all our production about then. It was controlled by a man that smoked his pipe upside down. I later got to know him fairly well. I can't think of his name.)

I said, "Well, if you're going to start something you're going to have to have some pretty good priorities because everything is pretty well tacked down." They said, "Well, you leave that to us. We've got all the authority we need to do anything we need to do. And if you come to work for us you would have everything that you need for our program." I thought this was hogwash. So they said, "Well, if we make our arrangements, we would like to see you in New York a week from today." I said, "Fine, if that's all right with my administrators and superiors, I'll be there." And they said, "We will let you know the address. And the University of Rochester will be reimbursed for your travel." So we all shook hands and they said, "How about a drink now?" And I said, "No." [laughter]

Then I went back to the university medical school. Of course, I had had to get my car out of parking, and the president's office on the university campus was right across the street from the Genesee Valley Club. The two army men went directly to the president's office. As soon as I got in the medical school, Dean Whipple called me and said, "Come down." So I went down to his office. And he says, "Well, what's all this you're getting mixed up in?" I said, "I haven't the foggiest idea." Then I described what had happened. So he called Dr. Chapman. Dr. Chapman said, "Well, it's a very high level thing and it's very important to the school and everybody that this be done, and you'd better agree. I'd advise you to agree."

They had known each other for a long time, and Dr. Whipple protested because he didn't want to loose anyone else. By this time, you see, the faculty was stripped down to almost the minimum. We could hardly teach. We were on an accelerated program and we couldn't buy any new equipment. Everything was kind of going to pot and everybody had to improvise. So Dr. Whipple was against it.

Then Dr. [Alan] Valentine, the university president, called up Dr. Whipple and said, "Well, I've just been visited by two army men who say they're going to procure Dr. Warren, and if we don't let him go they're going to draft him." I told Dr. Whipple I heard this. You see, I was sitting right there. And I said, "Well, I was in World War I. I was a gob and a hospital apprentice, second class" But I don't think they can draft me." He said, "Oh yes they can." [laughter] Then President Valentine said, "We went over that and they can put you in any special category and in uniform the next day." So they both said, "Well, we'd better do it." I was just a pawn you see.

TUSLER: Yes, you had a big choice.

WARREN: Yes, a big choice. So I said, "All right." And I told them I was to go to New York. That afternoon I got a telegram authorizing my travel to New York and giving me the address.

TUSLER: From whom did that come?

WARREN: That came from a Lieutenant Colonel [Kenneth D.] Nichols. And it was the Manhattan [District] Company, or something like that. So I went down, knocked on the door, and the secretary brought me in. And there was Colonel Marshall! So he said, "Well, it was nice of you to come. I'll introduce you to Major Hymer Friedell, a doctor who's trained in your field. He'll be your guide and fill you in." He said, "I'm very glad you could come. We'd like your advice on a lot of things."

Dr. Friedell had just finished his residency in radiology with Bob Stone in San Francisco and had been in Bob Stone's office when Lieutenant Colonel Nichols had come in to talk about some things that Bob Stone might do with his accelerator. He was also looking for people, doctors particularly. He was talking to Bob Stone, at the time, to see if he wouldn't take the directorship of the radiation biology program at the University of Chicago, which had just finished the successful reactor under the Stagg Stadium. (Fermi's experiment with the reactor had been successful so now they were going great guns; they were going to build reactors.) They hadn't chosen Hanford, Washington, yet, you see, or hadn't known anything about what they were going to do. But this was the decision, based on the committee recommendations, which I'll tell you more about later.

Dr. Friedell walked in and Dr. Stone said, "Here's a young man that's just right for what you want. He's fully trained. He's now finished his work to be a specialist in this field. He's a good biologist and he's draftable." (He hadn't been drafted yet, you see. He was just at the end of his training period.) He said, "He's been in here to ask me whether he should go into the navy or the army or the air corps."

Lieutenant Colonel Nichols said, "Fine, would you like to work on radiation biology and so on in the armed forces?" Dr. Friedell said, "Yes." So Colonel Nichols said, "All right, you'll receive notice of your commissioning day after tomorrow." [laughter] Stone knew a little bit more, so he believed it; but Dr. Friedell had his tongue in his cheek and he said, "Well, I'll be very glad." [laughter] So this is how he happened to be there in New York. He had moved to Chicago, and then travelled back and forth from Chicago to the New York office.

The New York office was the planning office for the operation. General [Lester R.] Groves had the responsibility for staff planning and about this time he had made the arrangements. First of all, he had been appointed by General [Brehon] Somervell, head of the Army Corps of Engineers, and had been assigned with President Roosevelt's blessing and his advisory committee's blessing to develop the program to build the bomb and do whatever was necessary to make it. President Roosevelt used the Office of Emergency Management's funds, which was his personal budget for all kinds of hidden things. Congress didn't know anything about it, you see. This policy was kind of contrary to that of the day.

TUSLER: Was it so top secret, you mean?

WARREN: Well, President Roosevelt manipulated things that way. He ran the war program without Congress having any say. Congress just rubber-stamped the money, and that was it. That has its good and bad points. There are a lot of good things about that, and some bad ones. Anyway, the New York office was the first operating office of the atomic bomb program. They had a lot of names for it, but settled on "Manhattan," and that's how they got the name Manhattan Engineer District. It was under the Corps of Engineers, but it was a detached program so that General Groves answered only to General Somervell, or to the president directly, depending upon the circumstances. The president insisted on dealing with him directly, and Somervell was agreeable to this, particularly in the later stages when things got complicated.

Well, during the first visit, I was sworn in and made a consultant. Dr. Friedell said, "Well, you'll probably have to come into the army." And I said, "Well, let's see what we can do as a civilian so I can wind up the things at home." So he said, "Well, could you do some toxicity programs. We have a problem with some chemicals, which I'll tell you about later. Would you go back home and see if you can set up a laboratory in your building to do some toxicity experiements." I said, "Well, I've got Harold Hodge, who's a good man in this field and is a pharmacologist, interested in this. He's been doing some war work on a small scale. I'm sure he's a good organizer and could do better." He said, "Well, do you have any physicists?" And I said, "Well, I've got Bill [William F.] Bale. He's just graduated and he's built Geiger counters and things." He said, "Yes, I know and we may need some." And I said, "Is this in radiation?" And he said, "I won't answer that yet, until we've tried you out a bit. These are my instructions. If you come in the service, I would advise you to insist on the rank of colonel. I'll try and get you a lieutenant colonelship. But being a colonel is like being vice-president; you have authority and you don't answer to anyone but the general." He ended by saying that he'd been in just long enough to find this out.

Then I met Lieutenant Colonel Nichols. He had just returned from taking a course in advanced chemistry--as a career officer, of course, in the military. I was told by Dr. Friedell that this was a scientific group, and that there would be lots of engineers, physicists, and chemists around. He and I had to worry about hospitals and people. He said, "I can't tell you yet, but I will later."

TUSLER: So you really didn't know what the full import of the program was at that time?

WARREN: No, I didn't know for two months. But I'd be called up and Dr. Friedell would say, "How many beds would you need for 2,000 people? Don't ask me where." [laughter] I said, "Well, give me a little chance to ask around." You see, I hadn't done any thinking on this.

Then the security people came. They asked all of our neighbors about my wife and me. They asked Mrs. Whitley, "Does Mrs. Warren play bridge? Is she a gossip? Do they fight? How many children do they have? Who are their neighbors?" Then they asked our other neighbor. [laughter] Mrs. Whitley, of course, spilled the whole beans to us. The other neighbor never peeped until afterwards.

In March of 1943, I was asked to take a trip with Dr. Friedell. I was told I would be gone three days but was given no information of where. We would start from the

New York office. So I went down overnight to New York. We got on the train again and went to Knoxville, Tennessee. Then we got in a car and sent over a muddy road to Oak Ridge. Nothing was said, nothing, no comments. We tried to talk, but we couldn't talk about anything except other things. [laughter]

Well, I learned that Dr. Friedell had a wife and two young children. He knew I had three by this time. He discussed his training with Dr. Stone and we had a lot of mutual acquaintances in Berkeley and San Francisco, of course. Well, we arrived at this farm area way out in the sticks. There were three valleys side by side or parallel. We drove into the part that Dr. Friedell said was going to be a big camp.

TUSLER: There wasn't actually too much there at the time?

WARREN: There wasn't anything. There were just a lot of bulldozers and beginning piles of lumber. The architects had a shack; the planning engineers had a shack; Mr. Jones, the big contractor, and Stone and Webster, another big contractor, all had shacks. Gangs of men were beginning to arrive. They were bringing in trailers to live in. They had a caterer, at first, to bring in food, and they finally set up a canteen.

Dr. Friedell said, "We're going to have a couple of thousand people here, civilians, who will work in these plants and we've got to build a hospital. From the maps, I thought it might be a good place to put it up here on this hill." So we got in the car and went up there and looked. It was a nice place, with a view all around and trees and things.

So I said, "Fine, why not build it out of concrete block. I just built a lab out of that and it's pretty quick. We were able to keep the animal quarters quite clean by painting the concrete block on the inside. And if they're going to save money, this is one way to do it. It's also fireproof." (This is a big hazard, you see, in a hospital. It was not a good thing and wouldn't do to have wooden barracks shacks, particularly if we were going to be there more than one year.) So I said, "How long?" He said, "Well, it'll depend." [laughter] That was a big help.

So he said, "We'll also have to worry about the cafeterias and recreation halls and things like that because this is going to be a classified city and we'll have to have all of the essential elements here." I said, "Well, are you going to be in charge of this?" (You see, he was the official and I was the consultant.) He said, "Yes, the medical will be the one thing, but then there's the food, the meat, the water, and other things that engineers will design, but we'll have to set the standards." Well, this was new to me, and I said, "Gee, I don't know anything about this." He said, "That's all right. When we get down to some of these things that you and I can't settle, we'll get an officer to do this, or a consultant, if it's just an interim thing." Boy, by this time I began to be puzzled as all get out, as you can imagine.

TUSLER: You must have been so curious.

WARREN: About two weeks later, they called me in and said, "We've got to visit the plant in Buffalo. Do you have a Geiger counter to look with there?" I said, "Why do you need a Geiger counter? Do you have machines?" They said, "No, we've got uranium." (This was the first I'd heard about it.) "But you never mention the name; you call it tuballoy. Depending on the plant, you'll have all kinds of different names." Then they explained the code to me. You see, by this time the security had investigated me. It took about three months because they were so pressed. They couldn't put very many operators on it at a time. And they were just learning how to do it, too, I think.

Then I went back to Rochester. We could have done this on the phone, you see, but they couldn't disclose the tuballoy over the phone. So I talked to William Bale. He said we could probably make one up by parasitizing parts. So he gave me a Geiger counter and I met Dr. Friedell in Buffalo. We got in the car and went to what was called Electromet. This was a code name, too, because there was a different name on the building. They had a contract under which they were refining ore. The ore of course was uranium.

Uranium has two daughters, uranium X^1 and uranium X^2, which give off very penetrating gamma rays. These are contaminents when they refine the uranium ore. Uranium X^1 and X^2 are in the discards. You have for each ton of uranium about forty curies produced every ninety days of Ux^1 and Ux^2; so that even if the stuff sits around, you have this as a problem. In every step of the processing over a period of months, there is more and more and more of these produced. Everywhere that it's handled, you have to provide protection against it. This became obvious.

Dr. Friedell said, "I'd like to have you come to Chicago and spend three days for some indoctrination. We're going to have a report of their work." So I went to Chicago and I met a breed of person that I was to know well later--the area engineer. [A. V.] Peterson was the one I met there. He was in civilian clothes at the time. It turned out later that he was a captain, then became a major and a lieutenant colonel. He furnished me a car and took me to the meeting, picked me up afterwards and took me to the Faculty Club where I stayed at the University of Chicago.

The meeting was in the University of Chicago and was held in an old brewery which they'd rented near by. They were beginning to refine uranium ore and to attempt to make a metal, the uranium metal, which was the start of everything. You had to have the pure metal or a pure salt in order to do the work. It was easy to make the metal. For reactors, they had to have it, of course, because the uranium metal was bombarded with neutrons in order to make it "fish" and produce the plutonium, which is what they were making. This process built up the extra parts of the atom.

Well, I got a little look at part of the production. It was dusty as the devil. Dr. Bob Stone was there and went around with us, and I began to understand a little more. I had known him for years. As the seminar progressed, I began to see the various steps, and where the hazards began to develop. It was mainly dust, which was an inhalation problem as well as a hair and body contamination problem. Then there were all of the problems of ventilation and washing down and all kinds of things. They had done quite a bit of toxicity work, but obviously there was a great deal more work needed. So they said, "Well, could Rochester take on part of this?" I said, "Yes, I think so." I thought I could speak for Dr. Hodge. He and I had talked over a probability, not knowing what was involved, but Hodge had said sure, he'd like to do some war work particularly some classified, secret work. He knew it was important or it wouldn't be classified.

When I came back to Rochester I got in Dr. Hodge and Dr. Bale, and we decided that this could be done. We talked over the design of the programs, but we needed more space. For four or five months we batted this around with Bob Stone and Dr. Friedell to gather any information we could get. We found out that people were working in Columbia on this, and we began to have people all over. I would visit as a civilian, partly to get indoctrinated and partly to look for hazards.

TUSLER: Was this all under the auspices of the Manhattan Project?

WARREN: Manhattan District--I'll have to get out some of the notes to get this name. The district engineer in the New York office was a man who had the responsibility for contracting all these programs. This was Colonel Marshall. He would contract with a company, and the company would have to have a security program and all the employees would have to be cleared. You can see this was a tremendous undertaking. Colonel Marshall was not convinced that Oak Ridge would ever amount to anything large, but General Groves was insistent that it would probably be very large.

I got into this discussion because I began to hear 5,000, 7,000, 10,000 people. So I said we'd better build a 100-bed hospital and fix it so we could expand it if we had to. The same plan should hold for the cafeterias, and so on. But they got into such a hassle that Colonel Marshall was transferred and Colonel Nichols was advanced. Colonel Nichols was a very good administrator. He came under the district engineer and was moved to Oak Ridge.

From then on, things really boomed at Oak Ridge. Housing went on much faster. Marshall was going to build maybe only 100 houses. As soon as Marshall stepped out, Colonel Nichols got his way and went on to build about 1,500 houses, and later about 3,000. Then he got into all kinds of barracks buildings and built big dormitories, three-story jobs. Some 5,000 people would be housed around a court. And there were markets and meat stores and drugstores.

TUSLER: It was a tremendous job--building all those things.

WARREN: Yes, it eventually had 71,000 people.

TUSLER: That many?

WARREN: In a year.

TUSLER: Fantastic.

WARREN: Well, it got to the point where I could no longer operate as a civilian. It was necessary to order things. The best they could do for Dr. Friedell was to consider making him a major in another year. As a captain he couldn't do too much. So we had a long argument over what my rank would be. I insisted on being a colonel, which was lucky because we had no promotions during the war.

TUSLER: Really?

WARREN: Well, we had one. I think Dr. Friedell was moved up to major. This, then, gave me quite a leg up in the military hierarchy, because wherever I went I was an operating officer, a manager, and a vice-president.

TUSLER: Had there been any objections to giving you the rank of colonel?

WARREN: You see, their table of organization was classified. They had a limited number of bodies, you might say, in all ranks. And, unfortunately, the concept at first was too small. So they didn't have enough top ranks. They could have an almost unlimited number of first and second lieutenants and quite a few captains. The morale was low going into the second year when no promotions came in and these fellows had worked like dogs, you know. Normally, they would have been promoted. Their confreres working on other projects, or in the field, were promoted two and three ranks.

TUSLER: That was very unfair.

WARREN: It was very unfair, because the pay was a problem too, you see.

Now, I'd like to go back to 1926 and talk about Rochester and a little bit about family situations and the faculty. As I said earlier, we arrived with thirty-five dollars and had pretty hard sledding the first month or two. We lived in a boardinghouse where the boardinghouse lady had a gas ironer. Did I describe that to you? Viola had always wanted an ironer, and the landlady said she would sell it for thirty dollars. We thought this was a permanent investment. With one child already and another baby on the way by this time, it was evident that she was going to have a lot of laundry. So I thought this would be a pretty good thing. So we bought the great big monstrosity. We had it for years and finally threw it out. It wasn't very efficient, really and it was a woman killer because it was so heavy. It had a big presser foot and was run by gas.

TUSLER: It sounds horrible.

WARREN: It was. [laughter] It was not like these neat electric ironers, but it would do a half a tablecloth, I think, at once, or a half a sheet. It was really a mass production affair. It was suitable for a boardinghouse, but the landlady had gotten a newer and lighter one. She was giving us a bargain, because I guess this one cost about $110, which was a lot of money in those days. It was a lot of money in itself.

Well, we rented a house for a couple of months and finally found 199 Barrington Street, which had been abandoned by a man who had made a lot of money. Finally, he said, "Well, I'll give it to you at a very reasonable price"--which he did. I think we paid $13,000, which was a heck of a lot of money for people with no prospects--well, I had prospects but no money.

I said, "I can't put anything down." But we arranged the transaction with the University of Rochester, which was the custom. The university paid the mortgage and from then on I paid the university on the mortgage. This has its good and its bad elements, you see, because if you wanted to leave you had a little, painful period of making arrangements with the university. They were always fair and did what was necessary and required, but they always resisted. Many of the faculty later bewailed the fact that this was the case. Anyway, it was very kind and important because it was the only way that the faculty could settle down and become permanent residents. The University of Rochester did this almost uniformly for the faculty. It was done through the Lincoln Alliance Bank. I think that Mr. Ball, who was the treasurer of the university when the Eastman and Rockefeller endowments were given for the Rochester medical school and for other parts of the university, frankly, played the market. This was during the 1920s inflationary period and they made money hand over fist. They fortunately got out before the crash of 1929. But this meant that they were much more flexible on things like loans because these meant millions of dollars with the total number of faculty involved and the development of the expanding university, as well as the medical school, dental school and music school. The dental school didn't involve very much. It was mainly included in the medical school.

Our house on Barrington was a three-story, cube house, thirty feet square, with a big front porch, of course. It was always a struggle whether it had roses or honeysuckle or bayberry bushes for a front fence. The school was just across the street, which was wonderful for us, but when it came to selling the house we realized that this was a depreciating factor.

Our second child, Dean, was born during the time when I was conducting my first seminar. I had brought a meeting of blood researchers to Rochester--a small society. Dr. George Minot had come as the speaker. As I said earlier, I had worked for him in Boston. He knew Viola very well and had visited her while she was in the hospital about to deliver. Darned if I didn't have to open the meeting when she went into the delivery room, and the baby was born while I was speaking. When I was through, I was poked and told by Dr. Minot, "You're a father." Of course, this pleased Dr. Minot no end. He sent Viola a big bunch of flowers and a nice note. And Viola said that she got more attention from Dr. Minot than she did from her husband. [laughter]

TUSLER: Did you know that the baby was being born while you were talking?

WARREN: No, I knew that it was due, but not that it was born.

TUSLER: You did not know that it was actually happening?

WARREN: Not that it was going to be that close. You see, I thought that I had an hour, anyway, for goodness sakes, but bang, she went into the delivery room and had the baby! Then we had the third child, later, without that kind of a problem.

The faculty, of course, had almost no spending money for a long time during the early years. So we had a lot of picnics and improvised entertainment. A lot of the faculty liked to hunt, so Dr. Whipple and Dr. Wallace, the chief of dentistry in the medical school, organized a hunting club. We would go every Thursday during the pheasant season. We'd get up at three o'clock and have breakfast at each other's houses. But the women were prohibited from cooking; this was a man's day, you see. Some of the breakfasts were a little weird.

Then we drove seventy miles to a place that raised pheasants and had about a thousand acres. This sounds funny. Of course, today it's the only way it can be done.

But pheasants that are released from the pens are just as wild--in fact, they are wilder than the wild pheasants and harder to hunt; so there's no decrease in the sport at all to have a released bird. We did a lot of dog training, of course. Some would buy dogs, but I took a couple of very promising pups that were born at the animal house and that we had specially bred.

We had all kinds of things. Vicious dogs would be turned in, or dogs came in from the pound. Some of the vicious dogs had papers and had been used for breeding but could no longer be handled. We took these because we had a good animal man who could calm these dogs. Then in about a month they would eat out of his hand and they would no longer bite. (If you learned how to do this training you could do it, too.)

We had several dogs during this time. We had one very beautiful setter that was all white except for a pair of black spots on each ear. And we called him Blanco. He weighed about seventy pounds and he could pull the toboggan with six kids on it. So we would go sledding with the dog. Six kids and a toboggan and a dog in the car is something to manage. I have a movie which shows these kids coming out of the car endlessly. It shows all the sleds being unloaded and the toboggan on top.

TUSLER: Like an old Laurel and Hardy movie.

WARREN: Exactly. This dog could run thirty miles an hour. He was a good retriever, but he had a mind of his own. For about five years, I tried to hunt with him. He would point beautifully at the the first bird. But after he had done the first one he was on his own, and he would not respond to a whistle or a command. Well, he would if he was far enough out. I could yell, "Sit!" and he would sit. But just about the time I got within reach of him, he'd be off again. And, of course, in the goldenrod and the weeds you couldn't see anything but the waving of the weeds and the birds going up. There'd be a lot of cussing. I'd try to keep him on a rope, but it's difficult to hold a hundred-foot rope in one hand and a shotgun in the other and walk through rough land. We would run him alongside the car before hunting, trying to get him tired out, but he was just indefagitable. So finally I stored him at a farm where he got some kind of infection--a big abscess--and died. He was just like a problem child in the family, adored by everybody--a big friendly dog the kids could roughhouse and have fun with. We were very sad when he left.

Well, after that, we got a little mixed-breed pup that was part springer and part cocker spaniel. I didn't cut the tail, so it was an odd-looking dog. You could see that it was part springer and part cocker and it should have a short tail. But I had that dog from a pup, a very small pup. This dog would learn to do almost anything that you wanted it to do. It was the most beautiful hunter you ever saw. I could shoot a bird and sit down and wait, and that dog would bring that bird back eventually if it were possible to run it down and catch it.

She also learned to go around the bird. The bird would be running, and I'd be tired so I'd just sit. Finally, after a couple of times, I learned to let her loose and she would go ahead and bring the bird running back towards me. A couple of times I got caught sitting when the bird flushed right in front of me. And it was the bird that we had been tracking for maybe a half an hour or so. This turned out to be the best dog I ever had.

Unfortunately she went with the boys one night while they were on their bikes, just at dark, and as they crossed the street a car ran over her. But this was a blessing in disguise. About this time bicycles had become very common, you see. Our kids wanted to ride indiscriminately. (One of the children in the block had been run over and killed. He had just come off the sidewalk, and he went straight into a car and bang.) So this was quite traumatic. They brought the dog home in Dean's arms. The other son brought the two bicycles. They came in crying. They had to walk about a mile. So we had a long session about bikes. After that they rode their bikes properly on the street. The whole block did, because the block was very much attached to this dog, too.

TUSLER: It was a good object lesson.

WARREN: Very good object lesson. This dog had an interesting habit. Down at the Canandaigua Lake place, she would chase water snakes. When they would dive she would dive. And she'd swim under water and get up and look all around and wait for them to come up and then she'd dive again. She never got tired of this, but she never caught any of them, or she got close enough to just nuzzle them but not to harm them.

TUSLER: Did you have a summer place there, or a cottage?

WARREN: Mrs. Walter Bloor and Vi found a piece of land down at Canandaigua Lake, about halfway down the lake, between Naples and the settlement at Canandaigua. It was fifteen acres on a hill and was about a half a mile from the road. Viola got a little bit of money from her mother's estate, so we were able to buy it. We would go down there on weekends. This was about 1930, I guess. From then on we spent almost no weekends in town. They were spent at the lake. We took the neighbors' kids, too.

We then practically led a boy scout life or a pioneer's life. We even built roads. I surveyed the hillside for a road, and then we got a neighbor to help. I went around with an ax and marked all the trees that were to be pulled down. The neighbor brought a team of horses and a big block and tackle and would climb up the tree, attach the rope to the tree and then attach the block and tackle to another tree. When the horses went downhill, I would stand at the base of the tree and cut the big roots as they came up. We had to do this in the winter right after the rains, after a thaw. The first winter after we bought the place we did a lot of this. By tremendous effort we plowed downhill on the uphill side of the road to make a furrow.

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WARREN: I was describing the method of making a primitive road in the bottom of our place on Canandaigua Lake near Rochester, New York. We pulled the trees out to clear a roadway. This had five switchbacks because we had a drop of 1,000 feet from the upper end of our property to the edge of the cliff on the lake side. The cliff was about sixty feet high above the water. After dragging the trees out, on the next weekend we got a team with a plow with an iron frame so that it was good and rugged. We started at the top and plowed a furrow as deeply as we could. In some places we had to make two or three passes at it, on the uphill side, because the hill slanted so much that we had to do some leveling.

Then I got an old Peerless car for about twenty dollars. We took the body off, which left the seat over the gasoline tank with the steering wheel. Later I put a wooden body on it to make a kind of truck out of it. Well, it had good-sized tires, but it was light and we could push it around. This was a very important element. We could get the car downhill all right, but getting it back up was tough because the road was slippery in places. With our own block and tackle we made one round trip in that whole weekend.

We brought sleeping bags and a tent and slept out in the woods. There were deer in the first years and quail and pheasants and bobwhites. It was isolated and very quiet and really in the woods, which were hickory and black oak for the most part. The hickory we found to be about 120 to 130 years old. They were about a foot in diameter at the base and almost a hundred feet high. They went right straight up and were beautiful trees. A lot of the oak grew the same way.

The farms around there were pretty poor. They raised grapes to some extent, because this was the wine district--Widmer's wine. The common opinion was that the soil was too poor to do anything with; you couldn't even raise a ruckus on it.

After we got the road started, each weekend, we got rocks out with pick and shovel. We gradually made it more usable. By the following summer, with some discomfort, we could get a car up and down the road.

At about this time, we figured that we ought to build a cabin. So we spent that first winter designing, picking the site, and talking with the lumberman down at Naples. He was called the "bull of the woods" and was the last lumberman in the area. He had a whole yard full of maple and oak that he couldn't sell, because about this time car bodies were being made of steel and the wood bracing in the doors and the body was no longer needed. So the whole market for rock hard maple just disappeared. There was a small market left for furniture and special paneling.

I made a deal with him: twenty-five dollars a thousand feet delivered at the top of the hill, of tongue and grooved, planed on one side, oak flooring of random boards from four inches to twelve inches--beautiful stuff--unplaned chestnut for siding, and maple two-by-fours, which were really three-by-fives (they were so hard that I had to drill to put a nail in them). We also got some big twelve-by-twelve oak timbers for the foundation. He hauled all that to the top of the hill where it remained until I could haul it downhill, which was quite a job.

I finally accomplished the hauling. In the process, I beat out a much better road. I got so I put a block and tackle on the end of each turn so I could pull the car back on the road, if required. We had to put a big sign up and Viola wrote this poetry on a piece of board: "Walk down and park your hack and then we'll drive you back."

By the third year, we bought an old Model A Ford for twenty dollars--the standard price for it. It was a sedan, and it lasted almost ten years. It was the favorite transport up and down, in low gear; it never wanted to go in anything else but low gear. I finally sold it to one of my buddies for five dollars. I understand that he used it around his place until 1950. It just kind of rusted up. It was the 1926 or 1927 model, one of the first Model A's.

Well, that first summer we took a month's vacation, which was standard. By this time we had a camp floor. We put a tent up. We had a rock fireplace, waist high, for cooking outdoors. We had a wire strung from the bank, from a tree to a big rock on the lakeshore, along which we ran a bucket to haul our water up with a rope. It had been quite a diving operation to get the rock and the wire far enough out in the water to fill the bucket.

We took the old top off of the car and hoisted it up between four hickory trees, suitably spaced, and then put three beds under it. We put logs across with big spikes and put chicken wire across. This made a very nice bed. Then there was a tree in such a place that, with all the branches off and the bark stripped, it could become a fireman's pole. The upper ones could slide down but had to climb a ladder to get back up.

The rule was that the children pick up their beds when they got up. This was not much of a chore because everything was made much like sleeping bags. But the three children slept in tiers. If there were a thunderstorm, the woods were so dense that the rain would go straight down. The old auto top protected them so they didn't get wet at all. They just loved sitting in the middle, with lightning storms all around. It was really better than our tent.

It took us two years to build the house. It was forty feet long and twenty feet wide, with an "A" roof. There was a series of windows facing the lake and a big porch, cantilevered over the cliff. You could look up and down the lake about fifteen miles in each direction. It was really a gorgeous place. Well, all our neighbors went down with us. Lots of the faculty would come down and spend the weekend with us. Viola said that it took a thousand chicken dinners to build the fireplace.

TUSLER: It was a very expensive fireplace, I should say.

WARREN: Well, we had interns and residents, and word got around that my residents had to be willing to throw concrete and build a fireplace over the weekend.

TUSLER: I bet they liked it.

WARREN: They did. Sure, they got a chicken dinner and a swim. It was a lot of fun because we hauled the rocks down the hill by filling the back of the truck-like car with rocks. Then I made a big sled, which we dragged and which was piled with rocks. You'd get a resident and you said, "Well, I don't think you can drive that down." And he'd say, "Oh, yes I can!" It was a Tom Sawyer trick!

TUSLER: It was Tom Sawyer all over again, yes.

WARREN: So they would go, and the kids would go with them and, you know, have a big party rolling these rocks out of the woods and onto the sled. When it was all loaded, they'd come downhill. We had to get gravel at the neighbor's. This car had some of the first hydraulic brakes. One time, I was halfway down the hill with a big load of gravel and with about eight kids sitting on the back of the gravel. One of the brake cylinders popped, and the car began to run away. Fortunately, I was near the bottom and had a turn which had an upgrade at the end. So I just made the turn into the upgrade and stopped. I couldn't get any parts, so I abandoned that car and threw it over the cliff where it became a pier. This was quite a trick to throw a car over a cliff, you know. [laughter]

TUSLER: With your very own cliff, you could do what you liked with it!

WARREN: Yes, and, of course, during the winter, the ice would push the shale around. By putting the old car body up there, we had no worry that the bank would move. The weight of the engine and frame out there added a big obstruction to the washing of the shale back and forth on the shore with the storms. The ice couldn't move it very well once it was really stuck. It was in about twenty feet of water finally. The shore bank was very precipitous. If you'd go out maybe thirty or forty feet it would be eighty feet deep. This was an old ice cap river canyon, you see, from the Ice Age. The water was cold after a storm, too. You needed a fur-lined bathing suit most all the time.

TUSLER: All summer long?

WARREN: Yes. Well, you could swim in it. You got used to it after a while; but the shale beach was kind of hard on the feet, so we all learned to swim in sneakers. We did a lot of rock collecting along the shore in a boat. We bought two boats, a clapboard-made boat (that's lapping sides), fourteen feet long, with molded shape. It was a special shape adapted for hunting. And we had a Sponson canoe. We acquired these very early. We had inherited an old boathouse, which the ice had wrecked, so we spent a couple of weekends shoring and jacking up and putting timbers underneath. We had plenty of timber in the woods which we could cut and haul down.

We had good luck on somebody else's bad luck. A big hardware store in Rochester had caught fire and burned. So they sold everything by the bushel. And I got a bushel basket full of nuts and bolts of odd sizes, a bushel of lag screws, and two or three kegs of spikes that were burned. If put in oil they didn't rust. I didn't care if the handles of some of the tools were burned off. I got wrenches and more axes. The temper wasn't so good on some of them, but it didn't matter. Most of it was rough chopping, anyway, and I had one good ax. I also got a big, six-foot timber saw. The whole equipment that went with about a dozen blocks and tackles I found there. Last, I had to buy a chain hoist, and then I was in business.

A crane with a log boom and wires and stuff was put up so I could take rocks, weighing half a ton, off of the sled. It was a job to roll them on; but once we got them there, we wired them down so they didn't slip off and come rolling down the hill. Then I found that I could lift them off with the boom, bring them around to the pile. Then with a sledgehammer--I got two nice sledgehammers out of this fire sale--I could crack them. These were boulders carried by the terminal moraine during one of the ice ages. They were composed of granite containing beautiful crystals. When they were split they could be installed symetrically in front of the fireplace. We figured there were about eighty tons of rock in the fireplace. It had an opening about seven feet square and took quite a bit of building. It took us about three years. We had to go three feet underground below the frost and into the shale. I sank twelve-by-twelve oak timbers about two feet deep into the shale, too--that was on the bank size--particularly the cross members so that the ones that went towards the lake were lag-screwed to it. If there had been a typhoon or other severe storm, the house couldn't slide over the cliff. It was buried in this trench. The fireplace was in the center and one of the twelve-by-twelves went right through the base of the fireplace. I didn't think they could move it. We had a cyclone go by there during the late 1940s after we sold it. It took the front porch and the big oak tree the porch was tied into, but it didn't bother the house at all. It didn't even crack it.

TUSLER: Where did you learn all your construction arts, as a child?

WARREN: Yes, as a child. Father was always building something. And I was always curious, too. When we built sheds or barns or the new house when we moved into town, I was a nuisance to the carpenters, I guess! But we had tools in the shop. I built my own racing wagon. (I told about that, I think, once.) Also, we were supposed to be self-sufficient on anything we needed to do. We could do it. So I tried to teach our kids this, too. I find that my son Roger is doing the same thing with his children.

TUSLER: Is he now? That's marvelous.

WARREN: They go camping and the kids can do anything. They make a fire and do other things.

TUSLER: How old were your children? They were still quite young, weren't they? They weren't old enough to really help with all of this building?

WARREN: Not during the building of the house, but later, when they got to be seven and eight. By that time we had electric power, and I brought down the refrigerator on a toboggan in the winter. It pretty near killed Mrs. Warren when we tried to get it on the porch. She was on the rear and I was on the front, pulling. I slipped on the ice and fell towards her and fell across her legs and I just waited for her femur to crack, you know; but it didn't, fortunately. She got up and sort of shook herself and said, "Gee, we mustn't do that again!" [laughter] Of all things!

TUSLER: She sounds like a real woodswoman!

WARREN: Yes, that's about the only really bad thing that happened down there. We were very fortunate. One day, the dog was following the kids across one of the little gullies. Of course, the moss on the shale and the wet stones made it just as slippery as ice. The dog was rushing ahead of the kids and got on a slick place and just bounced down one waterfall after another and shot down to the bottom. [laughter] He sort of shook himself and waited for a little bit and came up looking a little abused.

One of the things that Viola did early was to make double-reinforced overall seats. We taught the kids how to go up and down the cliffs, how to slide on the shale and keep out of the poison ivy. This was a problem for a while. The fishing wasn't very good. Somebody had let carp loose in the lake, and they ate all the trout eggs. It used to be a very famous fishing place.

There was a neighbor across the lake, Will Rozinski, who was a retired furniture manufacturer. He'd been a famous roller skating champion in his youth. He could jump six barrels, or some fantastic thing. He was quite an athlete. He had built his place and his rock retaining walls from scratch. He also collected roots for years. He'd had his place there for thirty years or so, but when he retired to live there, he would come over and help occasionally and then we would go fishing. Viola had a bell to call us, but we'd get out on the lake and she'd say we'd just ignored her. Actually, we couldn't always hear the bell.

TUSLER: Was he your only neighbor? Otherwise was it quite wild?

WARREN: Yes, there was almost nobody. When we got electric power, we built a boat from a diagram. The kids helped on that. I had a small milling machine, a saw, a drill, and a press. I could make any shape, so I cut all the ribs for the sides. You see we had oak and cedar and chestnut and maple. It's all beautiful stuff to work with. And it's just like iron when you get done. I made all the parts, and the kids would screw them in. Then we took a cedar tree and made a mast. Viola took an old piece of canvas and made a sail, and I bought a piece of boiler plate and made a centerboard, to stabilize it. You pull it up when you want to come ashore. We had a piece of concrete for an anchor. Everything was made right there--even the rudder.

Then we had the job getting it over the cliff. It took a whole Sunday to get it down the cliff without getting it scratched up, even though it was quite light. The kids were dying to sail it that weekend, but it was too late. By this time we had learned enough about the weather there. There was a chop of three-foot waves right close together. This was wicked because you could be swamped in a hurry. By this time, too, we had an outboard, and the kids had learned how to use an outboard and a boat and all of the business that went with it. We practiced rescuing. I would go out and tip the boat and canoe over.

TUSLER: So they really knew how to take care of themselves?

WARREN: So they really knew how to take care of themselves and how to get one another in and how to empty the canoe once you turn it over. You can't very well do it with a big boat; one person can't. You gain maybe four inches by lifting suddenly. Then the water comes out. And if you can get it flat before the water comes back in you gain three inches. Then with your hands, you can get a lot out before you try to get in. In fact, you ought to empty everything you can before you get in, and you get in over the stern. If you are a real athlete, you can get in over the side. But this isn't a good idea. You're liable to lose it.

We finally got the sailboat out and we found that it was a very interesting thing to operate. The wind, of course, would come over the hill down the cliff. It would hit the water vertically instead of hitting it horizontally. But you could tell by the cat's-paw on the water around you what was happening in time to be ready, because you could be caught. You would yaw and go over if you weren't careful. In our part of the lake it was very tricky, so when the kids learned with that little boat, they could do almost anything. Of course Roger later when he was in high school got enamoured of a girl down the lake because she had a dingy sailboat. He would go sailing without her! [laughter] Her mother told Viola this. Roger only cared about the boat! [laughter] Her daughter was just accidental company.

TUSLER: She came with the boat!

WARREN: She came with the boat, to be tolerated. How antisocial those kids could be!

TUSLER: It sounds to me like your house out there was more home almost than the one in town.

WARREN: It was. But the one in town gave us a lot of fun. The old basement was a mess. It had big coal bins. After a couple of years, we finally succeeded in getting enough money to put in an oil burner. We got rid of the coal bins and the ashes. In retrospect, the amount of ashes and the dirt that got in the house from this process was just fantastic. It was no wonder that the cleaning was such a problem. When we got the oil burner and the filter and ducts around fixed up so that they were clean, too, we reduced the amount of dirt inside. The curtains didn't have to be cleaned but every three or four months. But up to that time, every month they would just get filthy. You could see--even a man could see!

About this time, too, we got a washing machine. It's hard to understand that these things that you have everyday now just weren't available yet. And, of course, we had no disposal. We had a big grease trap outside the porch which we had to clean out every two or three months. Otherwise, the sewerage would run back up into the kitchen.

Well, anyway, I recemented the floor in the basement and filled in all the cracks and holes. Then, about this time, it became obvious to me that we were leaking an awful lot of heat during the winter. All the houses were built this way. They were a quarter inch above the foundation, and the wind just whistled through them. So I went around and filled all those up. My neighbors began to do the same thing, because we all got on to this. We then put glass wool battens, which became available for the first time, in the attic underneath the shingles. Finally, we got some plasterboard, which just came on the market; and I made a ceiling. Well, the snow didn't melt off our roof anymore; the leaks were greatly reduced, and the oil bill went down quite a bit. If you spent only $150 to $200 at that time on your heat bill for the winter, it was quite something. I got it down to about $90.

We had to build a garage and put in a new driveway. The children used to play in the backyard. When they were small at first, we had the swings and slides. But the popular thing at that time was to let the water run over the back lawn. This then would make a little skating rink. But in those years we didn't have it cold enough to get enough ice to skate. It would be bumpy and there would be holes in it. The kids would slide on it, but they couldn't skate. So we would all get in the car and go to one of the local parks that had a little skating pond. This was very shallow and would freeze over.

The boys were about seven and eight, and Jane was eleven. I had never ice-skated and I thought that maybe I should. So I looked around town and I spotted a pair of old messenger skates which were flat-bladed and had a curl on the toe, a wooden footrest and straps. Well, I thought that was something I could practice with and that I wouldn't fall down right off. We got the kids regular skates. They wouldn't have anything else. They turned their nose up at what I got. But they tolerated what the old man was going to do.

I'll never forget that one Christmas Day, while Viola was cooking the dinner, she said, "You take the kids and go skating." And so I did. I brought my old skates and we went out to this little pond. One of the professors, Dr. [George W.] Corner, turned up with his two children, and the place was just crowded with a lot of other people. He wanted to know what I had and I said, "Well, I don't know what to do, but I'm going to try these." And he said, "Well, that's a good idea. If you can do it, I'll try them."

So I went off in the corner of the pond where there wasn't anybody and I put them on. My kids, of course, went way to the other side. They weren't going to have anything to do with father. Well, you can imagine this giant standing there with a couple of funny-looking, flat skates with curled noses. These were really antiques. They were Holland type, and actually messengers did use them because then they could go on the streets or anywhere and they didn't have to have perfect ice. I didn't know this till later.

Well, to make a long story short, I stood up and gave a couple of strokes and was doing all right when all of a sudden my feet slipped out from under me and I went "kabang!" The kids just mobbed me, you see. The cop came over and said, "I think you'd better get off the ice. It's kind of thin and you're attracting so much attention that you'll break the ice." So with great chagrin I took the skates off and never put them on again! [laughter]

TUSLER: That was the end of your skating career?

WARREN: That was the end of my skating, and the children still remark about the ludicrous episode that father had.

Well, of course, we didn't have skis. In California as a child, we tried to stand up on barrel staves on grass. Of course, we made sleds to go on grass and we could go very fast. But, of course, the grass would wear out and then you'd be on rocks, and this would be kind of chancy. But we never were very successful in trying to slide downhill with a barrel stave on each foot. There was a piece of rope or string or something through some holes to the toe.

When we went to Boston I thought, "Boy, now, I'm going to try to learn to ski." So I went down to one of the sporting goods houses. Herman Pierce, who was a resident then, went with me. He had tried a little skiing and thought he was an expert, and I, too, thought he was an expert. We were going to Blue Hill Park or Reservation that weekend to try out some skiing. There were some small hills there which had snow. So I bought this pair of skis. They were supposed to be three inches longer than I could reach. So you can imagine; these turned out to be eight-foot skis. All they had was a little toe strap. There was no idea of having any kind of a stick to help you. He had a much shorter pair and was bewailing the fact that his were too short, that mine were the right size.

Well, we got out to Blue Hill Park and he went ahead and did ski very successfully. I think we had a hill about six feet high with a very gentle slope. I started out and I got about halfway down and then I just cartwheeled beautifully! I broke one ski so that fixed that. So when we got to Rochester, I tried it a couple of times, but I thought the toboggan was better.

I specialized on the toboggan, but it turned out to be a very dangerous thing. If you'd go over bumps while you were sitting, you could compress the lumbar vertebrae. I saw a lot of X-ray films of people who had come back from weekends with busted vertebrae. A very common toboggan accident was to hit a tree. The first one on the sled would straddle-leg the tree and have a broken pelvis, which wasn't a nice thing. So I was very careful in training the kids to slide with toboggans or anything. They used Flyer sleds. They were pretty fast on hard snow and you could get up to maybe forty miles an hour or more, depending on the steepness of the hill. Rocks and trees can come up pretty quickly. And the kid is right there with his head, you see. But fortunately, we didn't have any more troubles with that.

The war came, and it was necessary for us to move to Oak Ridge for security, the idea being that the enemy could steal a member of my family and then I would be in the soup and might give some secrets under such duress. The better thing was to just move the family. Then what would we do with the house? We could shut up the lake place but what about the city home?

TUSLER: You intended to go back to Rochester when the war was over?

WARREN: Yes. We had a renter, but the renter was a "pixie" who had monkeys. They tore up a lot of the wallpaper, and the kids marked up everything. So then we decided that we had better sell. Then the renter moved out in the middle of winter and bought a house and didn't care about any responsibility to us. This precipitated the sale. When they moved out, I went up there. I was in uniform, of course, and it was a terrible night. The temperature was about ten degrees. The wind was blowing and the ice and snow were blowing. Our tenants had just moved out that morning. So I went in and set the oil burner at the lowest level to keep it just above freezing. I forgot that in taking the drapes out the heat would be lost through the glass, and with the wind and everything. My neighbor called me up and said, "I think your furnace is out; I went in and you're frozen up." (He had a key.) But I couldn't get back for a week. When I did, one of the toilets on the second floor had been lifted out of the floor about three inches. It was still cold as the devil. One of the sink pedestals also had been lifted up and the sewer had frozen.

TUSLER: By the force of the ice?

WARREN: By the ice. The meter had frozen as had several of the standpipes. So I got a plumber out of the Rochester medical school to come down. It cost us about $1,000 to get the plumbing fixed before I could really put it on the market. Then we sold it just for what we paid for it in the beginning. There was no inflation until a year later, when it was sold for almost twice as much.

The same thing happened to the lake place. Viola stayed there some of the time, when I was in Bikini, because when I went to Bikini I was no longer able to keep a residence at Oak Ridge. The family followed the man, you see. So she went to Oakland for a while. Then finally she came back to Rochester and waited with Roger. Later, she stayed down at the lake place and then that was put on the market. We sold it for $10,000. And, gee, two years later it was sold for $25,000. Now it's worth $50,000. Well, they've put gravel on the road, and this makes it a little easier to get in and out. We drove around there last year when we came west. It looked just the same. They still had the marks on the doors where we had recorded the growth of the children. The furniture was the same. All the beds and things were just the same. Well, it was built of durable wood. It will last for centuries.

TUSLER: What a marvelous place to live and for your family to grow up in. It seems ideal to me.

WARREN: Yes. When I finished the war, I went back to Rochester. Almost immediately, Dr. [Robert] Sproul asked me to come and be dean of the UCLA medical school. We got back to Rochester after being mustered out, Dean and I--he was in the navy--on the twenty-third of November. So we decided we would take a month and go salmon fishing on the Margaree River in Nova Scotia, where Dr. Whipple, Mr. Park, and I had gone formerly. It was still open, and there hadn't been any snow. So Mrs. Warren, Dean, and I got in the little Ford and drove up there. We stayed in the Margaree Inn and went fishing.

Dean had a lovely time. He caught a salmon late one afternoon. (They had shut down all the fishing on the river because nobody was catching much.) Every time the fish leaped, his reel jumped off the pole and fell in the water. And, of course, he was standing in water about two feet deep with boots on. He didn't know to behave any differently, so he didn't get excited. He just reached down, got the reel, and put it back on; and after an hour he landed a salmon [laughter] The fish would wait, you see, then make this furious running leap, and the reel would pop off the seat and fall into the water. Then it would sulk and wait until Dean got everything all ready. As soon as he got to reeling in again, the fish would start running and leaping.

Well, after we came home on that trip, Mrs. Warren was kind of upset. When we drove up, we promised to stop at antique shops when we came back. On the way up, you see, we saw them and she said, "Well, I want to look." And we said, "No, we'll do it on the way back." On the way back however, we had two salmon in the car, and the dry ice, of course, wouldn't last too long, so we couldn't stop very well at any little old antique shops. This was particularly true when one morning on the trip back we got up and there'd been a frost. There were cat tracks on the car giving evidence that he had smelled the salmon.

So the salmon was getting a little high just as we were coming to these antique places in Maine.

TUSLER: So you were saved by the salmon.

WARREN: Saved by that.

Well, the negotiations with Dr. Sproul went on and on and on, and we couldn't get any decisions. I was invited here, and I came out on a winter day in December. I had left Rochester in a snowstorm. These scoundrels here had a dinner for me at the Bel-Air Hotel with carnations and snapdragons on the table. You know I was just homesick for California as the devil. I wanted to come back here to California even as a janitor, but I wanted the conditions to be fairly good. There was all kind of chitchat about autonomy from the north, problems of representation, and questions of access to the president. Would I have to go through all kinds of committees and things? Dean Paul Dodd was helping me in getting this all cleared, along with Provost Clarence Dykstra, Professor Vern Knudsen, Professor Bennet Allen, and Professor Albert Bellamy. They were on the committee here. They were all lovely people.

I thought the site was right and the time was right. I was ready for such a thing. I had information from the Manhattan District from all over the country about men and materials and architectural costs and so on. I had built three hospitals, or located the building of three hospitals, I had essentially planned all three. So I was ready.

Well, in January of 1947, I phoned Paul Dodd. By this time we had moved into an apartment in Rochester, and the owner was anxious to get us out because she wanted to come back there. It had just been a temporary thing. So Paul Dodd said, "Well, we're going to do it anyway. If you only would! Why don't you send the family."

We had two cars and had to decide whether to put the furniture in storage or put it in an apartment we could rent somewhere. We had all this monkey business to worry about. This became so familiar to me later when dealing and maneuvering to appoint faculty.

So Viola and I talked it over and decided it was worth the gamble. Dr. Whipple said, "Oh, it wouldn't work, they're not going to do it. They're a bunch of braggarts. They always were." And so on.

I telegraphed Paul that I was going to ship the furniture and send the kids out with the car and Viola. One of the great crises in Viola's life was seeing the van picking up a cast-iron garden seat--you know, one of those things about this big, that she had found in the junk shop and purchased for our California home. The truck left with this on the back in a snowstorm! [laughter] The die was cast, and really we didn't know about the future. So I stayed in Rochester where Roger was still going to school. Finally, on January 25, I got a phone call from Dr. Dykstra saying, "Your appointment has passed the regents. I am authorized to tell you that you are appointed dean. Can you be here February 1?" And I said, "Yes."

TUSLER: This was 1947?

WARREN: It was 1947. I hadn't really gone back to work at Rochester. I had just had my vacation and was trying to get the Manhattan Annex there fixed up so we could return to civilian activities. They had promised me that I would be made dean there and all kinds of things. I did not want to be dean in a place where I had grown up with the fellows. You just don't do this well.

So, anyway, Roger and I had to push the car from the back of the medical school up the avenue, to get over a little bit of a rise so that he could get me to the airport. This was on the night before the first of February, on a day like today, you know. I still was in uniform and had my old boots on. I met Dr. Dykstra in the middle of Westwood Boulevard. We walked by the outdoor theatre which had been built with WPA help with wheelbarrows, picks, and shovels. He said, "This is a good location for the medical school." And I said, "Yes, but what about the theater?" He said, "Well, it's no good. There's something wrong with the acoustics. Last year during commencement they heard people over on the track starting and swearing and everything. You could hear it almost louder than you could the speaker. So Provost Dykstra said, "We're going to give it up." (This was the place where we sat later on the bank and wrote and thought.) So I said, "OK, why not build the medical school here." And that, I think, ends the Rochester business. I think there's only one thing about Rochester I didn't mention, and that was: after the discussions with Dr. Hodge, the Manhattan District agreed to double the size of the laboratory building for the toxicology experiments. And it was constructed during the last part of my civilian consultations there.

TUSLER: Was that just before you went?

WARREN: It was just before I went into the military, before I was commissioned. We had all kinds of very interesting things going on there, which I will describe later; they were precursors of today's kind of experimentation on a large scale. One example was the breeding of 150,000 mice to determine the tolerance of a daily dose of radiation for a period of two years, counting every newborn, measuring it, describing it, looking for abnormalities, and, of course, getting the lethal curves and so on. This is where Dr. Curt Stern got his start in genetics with the drosophila fly. He had on hand for almost an entire two years 100,000 or more drosophila flies. There was a whole gang of technicians doing very careful measurements using the million-volt machine we had obtained for castings as the radiation source. By the time that we got this built the Symington Company had finished its contract for tanks, and Kodak had already done the parts that it wanted to have studied. Therefore, we were released from anything more than an occasional sporadic thing which we could fit in quite well, particularly at night. They didn't want these big castings to go through the streets anyway and be seen by people; so they were very glad to have it done at night.

We finished our commitments for the donors that gave us the money for the start. Then we transferred the whole thing into the Manhattan program and went on from there. Today it's an important part of the laboratory program of the university and the medical school. So I left a permanent mark on the place.

TUSLER: Yes, I should say you did. Who was left in charge there when you left and went into the military?

WARREN: Dr. Andrew Dowdy was in charge. He became the director. He was my confrere in the Department of Radiology and was also working with shock. We had a committee composed of Drs. Andrew Dowdy, William Bale, and Harold Hodge, and later, Fred Bryan. Later, I took Bryan into the military to do some of the industrial inspecting.

Before we knew what we were after and before I knew what I was going to be involved with, we thought it would be a good idea to do a lot of interesting tracer experiments with radiosodium. We propositioned Robert Lee Evans, who was running the cyclotron at the Massachusetts Institute of Technology, to make us a gram of radiosodium; so he did. He shipped it by airplane. I thought he had given up because it took about a month or so of bombardment. But he called and said, "I've got your sodium; I just put it on a plane. It will arrive at such and such a time." Well, we were just building the annex part of the Manhattan District building and had a big truck there. We loaded some bricks on the back and said, "We don't know what he's sending it in, but this will be far enough away from the driver, and the bricks will help protect him; so let's go get it." So Dr. Hodge and Dr. Bale went down to get it. The pilot had gotten off the plane with this package and said, "Are you from the University of Rochester?" And they said, "Yes." Then he watched them with great interest while they took it up carefully and put it quickly on the back of the truck and then stepped back. He said, "What is that?" (Of course, there was no security yet on anything. We didn't even know what that was in our kind of an operation.) The boys said, "Oh, that's some radio-sodium." He said, "Well, is it dangerous?" They said, "Well, sort of." He said, "Well, I had it under my seat all the way in the plane." And they said, "Oh, that's all right. We're just doing this as an exercise so we can teach the students how to protect themselves against this sort of thing." And they drove off quickly.

Well, the pilot wrote the manager of the airlines. Later, I had to lay down all the criteria for shipping these things. I had to make clear not only that it wouldn't hurt the passengers or the pilot but that it wouldn't fog the undeveloped film which was being sent to Kodak in Rochester for development, or anywhere else for that matter.

TUSLER: Oh, it was capable of doing that?

WARREN: Yes. Did I tell you about the episode when Mr. Francis W. Bishop and I got polycythemia. Well, we got Kodak to build us a screen that would fluoresce more actively than most to X rays. Then we got them to make us some green sensitive film for which we had a movie camera. It was green sensitive film because this was the major light of the fluorescent screen.

We then tried to get X-ray movies of the heart of a rabbit. (This was in the early 1930s. We were just twenty-five years ahead of the game.) So Mr. Bishop, my scientific confrere, took a hundred feet of hose in order to water cool the X-ray tube and not have the 100,000 volts short, or go to ground, or kill somebody. Then he made a switch so that the X rays would run only when the current was positive and not when the alternating current was negative. This saved a certain amount of destruction of the target. Next, we set up the tube in a lead box with holes in the side through which the glass ends of the tube could extend and through which we ran the hose and the wire to the terminals. This was set on the table and the rabbit was on the board just below the tube. We wore X-ray dental films with a clip on them just to see if there were leaks, and proceeded to go ahead one night. It took us four hours to set up, ten minutes to make the run, ten minutes to develop the sample to see if we got something, and four hours to take down the equipment. We used up practically the whole night.

After we had finished and sent the main roll of film to Kodak to be developed, we went in the darkroom and developed our dental films. They were black. We decided, "Well, heck, it was a hot night and the developer was hot and old and maybe this was just a mistake." About a week later, we got word that the film was pretty grainy, but they could see the heart. And when we projected it we could see the thing contract and expand. So we thought we'd do a better one this time.

We again spent the whole evening setting up. We ran the film again, and again took it down. It was about four o'clock in the morning when we finished, cleaned up, and developed the dental film. Again we could see that it was black, but we could see the paper clip; so there certainly was radiation. We then set all the apparatus up again. We took a portable fluoroscope screen and held it above the lead shield over the control stand.

We could see the bones of my hand above this protective lead screen around the cubicle. This showed we were getting the backscatter that I described earlier. This was the first knowledge of this kind of large scale backscatter. We were using such high intensities that nobody had had this experience before. The X rays had gone through the rabbit and the table. They bounced off the floor and off the ceiling and behind the screen. Presumably, in the two nights we had received a total of about 300 roentgens of radiation.

Well, we were kind of worried a bit. So I had blood counts made of both of us. About three days later, our white blood cells began to drop. They went down to 4,000, I think, and then back up. I think it went up to 10,000, then back to 9,000, and then 8,000, where it stayed. Then the red blood cells started to increase in number and, fortunately, to become smaller. For ten years Bishop and I had small red cells, with a count of around 9 million, which is twice normal. Instead of twelve to fourteen grams of hemoglobin, we had about eighteen or twenty. We were quite rosy. Well, fortunately, this subsided just before I went into the service. If they had found this out I probably would have been denied admission. Fortunately, I've had no trouble since.

TUSLER: You mean that it is possible that it would recur now?

WARREN: Well, we were always interested to see whether one of us would get leukemia out of this. From then on I figured I was on borrowed time, and that anything could happen. [laughter] It's interesting that once you have resolved you are on borrowed time, everything is velvet. You don't fear a great many things that you do otherwise. I had a couple of experiences during the war when I was sure that I was going to die. But it didn't seem to matter too much. Then afterwards when I didn't expire, it was a great relief and life was quite different. I'm not afraid of anything now; it doesn't make any difference, you see. I faced it and I found I could face it. The only thing I was sorry about in those two times was I had no chance to say good-bye properly to my wife.

TUSLER: Was that because of radiation exposure?

WARREN: No, it was on an airplane. I'll tell you a weird story about being lost over Hiroshima and Nagasaki.

TUSLER: And you thought that was it, you'll never get out?

WARREN: Oh, sure. We had green pilots. Well, I'd better tell you later as a separate episode, because I get quite disturbed at the end. My increased heart still goes on!

TUSLER: You still relive it all? Let's save that for the proper place in the story.

WARREN: Some other time, yes.

TUSLER: I think you've done quite a tour de force today and this tape is close to the end. Do you want to be off with it?

WARREN: Yes, I think this covers most of the important things in Rochester.

TAPE NUMBER: IX, SIDE ONE

JUNE 30, 1966

WARREN: We had just finished reviewing the construction of the Manhattan Annex made possible from Manhattan Engineer District funds. This was on a site just across the street behind the University of Rochester medical school. It was an addition to the building which had been funded on the tank casting radiographic program of a year earlier. This tank casting program terminated at a very appropriate time because the Symington people were finished with their contract. The Manhattan Engineer District took over the cost of operation of the building but still permitted some contract work with Eastman Kodak, Symington, and other industries in town who needed to have a million-volt X-ray image made of some of their castings.

In this new program the Rochester group took over the odds and ends of programs that had not been covered by Dr. Robert Stone's group at the University of Chicago. They also took over other programs which became known to me in San Francisco, Berkeley, New York City, and at MIT. Each aspect of the research was directed by one of the Rochester specialists. Dr. Mayo had the instrumentation problem. He was responsible for the production of sensitive and portable Geiger counters which we could use in the factories to make measurements of the uranium daughter products--uranium X^1 and X^2. I think I mentioned these earlier. For every ton of metal there are abour forty curies produced every ninety days in all of the discard materials. These are strong gamma emitters, so they are a hazard. Therefore, good housekeeping and good discard practices had to be developed. It was important to have a portable Geiger counter that could demonstrate to the management, the labor steward, and the men working with these materials, that the care and protective mechanisms we insisted on were realistic and had a purpose.

Again, the problem very often was one of security. We couldn't disclose the presence of radioactive materials very well, so in most of these factories we called it "tuballoy." We said tuballoy had danger and that we had to carry out this special approach so that we could measure it easily. We announced it was hazardous and just as bad as some of the gases--the war gases--with which they were familiar. Most of these plants had had some prior experience in making some war gas for the Chemical Warfare Corps.

Dr. Bale succeeded finally in building a Geiger counter that would fit in a suitcase. You have to remember that just prior to this a Geiger counter occupied a whole laboratory bench. This new counter was quite a triumph at this time. However, the same thing was being done in many other laboratories in order to get it small enough to be portable. It was battery operated, in part, so it could be taken out into the manufacturing plants. It had a loudspeaker and would very conveniently make a roaring noise from the radium dial face of a watch. This was the amount equivalent to the tolerance level. It was the amount that we could permit.

This was first taken up to Niagara Falls Electromet plants where management had been a little bit hesitant to do all the things we wanted them to do. Even though they were on a cost-plus contract, they didn't want to put in anything that increased the expense. I think they were looking toward continuing postwar production of these materials and if they could avoid some of the expensive supervision, they could improve their profit situation. I don't think this was very deeply entrenched; but, anyway, it was a kind of instinctive reaction.

Well, parenthetically, I might remark that by this time I was in the military and that these inspection trips were always made in civilian clothes. Contact was made with the area engineer of the Manhattan District who was stationed in Buffalo. This was conventional, of course. There was always an engineer stationed at a central location near several big contractors that the Manhattan Engineering might have for production of materials, or for design, or whatever it might be. This man, also, was in civilian clothes. He would make the appointment for us and go along with us. He saw to it that the contractor carried out anything we suggested needed to be done--and promptly.

On the first visit to Niagara Falls Electromet, we brought this suitcase and loudspeaker in. Management sort of smiled, thinking that this was more longhaired, monkey business. They took pride in believing that their factory was clean. But we went around with the Geiger counter, and in the corners and edges of the rooms and the various places around the machinery, you could get a good indication of radioactivity. We waited while they swept, mopped and vacuumed. Then we tried again and it was gone.

Then we we went through the plants where we found one of the workers whose hair was a little greenish and who had green dust in his nostrils and ears. Obviously, he was not wearing the masks and keeping his personal hygiene up. So we brought him in, along with the labor steward, and showed them that his hair was radioactive, and that while this was still on the safe level, it was not good. While we didn't believe the inhalation was too dangerous, nevertheless, the fact that he had this dust in his nostrils, that we could take a piece of cotton, plug it on a toothpick, make a swab, and then show that the toothpick swab was radioactive had great effect. This was such a spectacular success that we had no trouble. They just cleaned up everything! The plant then had a very good record as a result.

TUSLER: It really worried them a little bit.

WARREN: Yes, we could show them that there it was, no matter what it looked like. The Chinese have a saying, "A picture is better than a million words." You can write orders of all sorts, but unless they understand what the orders mean and why they should be carried out, they won't work.

Because of this demonstration, we had willing cooperation, instead of grudging cooperation under the military or even the civilian scientific control. This was not very palatable, so we had to learn how to achieve this. Often, in the big establishment, we could take the company's physician in our confidence. We'd have to get him cleared first. Security would look him up and be sure he was not talkative or a gossip or had bad associates. Then we would sit down and have maybe an hour's talk about this problem. We would call it "tuballoy." He wasn't to know that it was uranium, but he soon suspected. You can be sure that after the conference he went to the library and looked up a lot of references and was knowledgeable. So, while we would both use the word tuballoy, we knew that he knew it was uranium. This was all right because it was possible for him to think about the hazards on his own. He would be warned to do blood counts and urine analyses, looking for damage from something that had escaped the precautionary program.

Well, there were a lot of other problems that began to show up. (I think we may as well stay on the field operation to get a complete sequence.) General Groves heard about a big shipment of uranium ore from the Belgian Congo mines to Belgium where it was to be refined for the radium. (I'll have to look up the specifics on this for the names but this was a very interesting international trade.) The first arrangement was that the Manhattan Engineer District would ship the ore instead to the United States for refining and take the uranium out. Then the Belgians could have the ore back.

The return of the radium-bearing ore later turned out not to be practical because there was too much uranium ore. It had to be stockpiled on a small reservation somewhere when they were through with it because there was so much of it. When this material arrived on the wharf in New York--it was, of course, on a classified pier--then it was put in railroad cars and shipped to plants in Buffalo or St. Louis or other places where the Manhattan District could find somebody that could or would do this kind of work.

Of course, since the barrels were shut tight, they began to accumulate radon, which is also a daughter product of uranium. It is the active part of radium. It's a gas and has a half-life of 3.85 days. You can suck it from the air above a solution of it in a flask and put it in glass capillaries. These are the radium seeds which are used for cancer treatment. This is a very delicate and hazardous process, too.

Anyway, Dr. Hymer Friedell went down to the pier with a Geiger counter and an electroscope. It was quite clear that there was a lot of radon around. So what to do? As long as this was out on the pier in the open, the wind took the radon away. But when it got in the freight cars, it was liable to accumulate in the freight car with the door closed during transit. So regulations were issued for transport specifications in the car. One of the physicists of the company would meet the car in the yards on delivery. They would open the doors and, if necessary, use big fans to ventilate the car before they moved the big drums out.

TUSLER: What was the danger from this radon?

WARREN: Inhalation and direct exposure to the gamma radiation from radon was the danger. It could rise to four or five times the tolerance level quite readily. Inhalation was not good because the inside of the body was bombarded with it, and this was a very effective way to kill bone marrow and other cells. We had to be very cautious about this inspection because the security people didn't want it known that anybody was very much interested in this ore. The whole idea was that there was no interest in it--it was just some innocuous stuff. This apparent indifference was particularly important since the waterfront and the warehouse men on the waterfront were infiltrated with Communists. This was a hazardous transfer as far as security was concerned. But in any case, it was carried out all right.

A huge amount of Belgian Congo ore with a very high concentration of uranium was procured under this contract. The reason for importing the ore was that we didn't have very much of our own ore in the Colorado Plateau. The uranium was procured wherever it could be found. The Germans didn't have control of the Belgian Congo even when they took over Belgium. Most of the people who were running the operation in the Belgian Congo in the head office escaped and came to New York City where they could continue the operation of their program.

TUSLER: The Belgian Congo was one of the main producers?

WARREN: The Belgian Congo was one of the main producers of uranium at that time; it still is, too. We knew about the Schneeberg mines in Czechoslovakia because uranium compounds had a rather wide use in ceramics as coloring agents--a beautiful orange and a green. Most of the uranium ores were mined rather casually for ceramic colors and more actively if they had a high radium content. But the radium market wasn't too good. It was about $60,000 a gram or a curie. Most hospitals had some, but just at the beginning of the war the market was pretty well supplied, so the price of radium was coming down and production lapsed. These companies like the ones in the Belgian Congo were very anxious and glad to have a market, you see, for the uranium.

Of course, the Manhattan Engineer District had an active mining and prospecting program which was run as a secret operation, too. I don't remember what the materials were that they said they were looking for, but it was easy enough to look for vanadium ore because this ore has a lot of uranium in it. In fact, they bought up the tailings of a vanadium company, American Vanadium Company, at Grand Junction in Colorado. Then they set up a subsidiary refining mill at Uravan. This was run by the Manhattan District, itself, under the area engineer and a big contract with the Vanadium Corporation. The contract involved reruning the big stockpile of tailings--almost a mountain of them--with very high concentrations of uranium from the previous milling operation.

One of the things that I found out--I didn't get on to this until the second year when I went out there to look --was that they were putting their discard, namely the radium, into the Colorado River, and it was coming down to Lake Mead. Los Angeles's water was part of this sequence. Well, we couldn't find any evidence in the water at that time. Later on we found out why. This material was sequestered by the clay in the water, and this precipitates it out. So this was not too hazardous, although I think Los Angeles's water has a higher, general, radioactive level than most waters in the United States, except perhaps for the Chicago water. That water comes from deep wells which have a very high radon content. There are some other areas around the country where this is true, too.

TUSLER: That's not a very comfortable feeling.

WARREN: Well, when we set up the project here and were looking for controls for the Chupadera Mesa cattle from the area of the Alamogordo, New Mexico test site, we took material out of the slaughterhouses here. We had a higher radioactive content in the controls than we did in the field animals. Of course, they were both so low that they were only of academic interest, but the ones from the Los Angeles feed lots were about twice the ones that were in the Alamogordo area. Of course, the Alamogordo contamination was so dilute; it was just above the limits of the equipment.

Well, to get back to the period of 1943, 1944, and 1945, the field inspection became quite a problem because Dr. Friedell and I couldn't do it all. We finally procured Dr. Fred Bryan from the army. He was among the Rochester group and was commissioned and worked out of our office and also out of the Rochester Manhattan District Annex. He brought many bits of information about the dust hazards and had many ideas about the design of a chamber in which animals could be exposed to these uranium dusts. (I'll come back to that in a minute.)

I'd like to describe our trip to Port Hope, Ontario, Canada, which was the Canadian uranium center based on the radium extraction there which had been going on for about fifteen years. After a great deal of negotiating, we were permitted to go up there. Of course, we were invading a foreign country, which was a lot of trouble to arrange. But the fact that the Manhattan District was buying the stockpile of ore discards after the radium was extracted made it possible.

Well, I was shocked. I had heard about this plant as a place where radium was produced. I imagined it to be a modern, very carefully policed production plant, but when we got there, what a shock we received. Here was an old building, dirty, run down, with just a few people around. The head chemist had been doing the final extractions in a big, open ceramic dish over a gas flame. The radon, of course, was escaping directly into the air. He did the final precipitations and got the salt down into small, compact masses which were then put in vials. None of this was done with any great protection. It's true, he used long-handled forceps.

I saw that he was pale and wan. It was the same kind of general appearance that Mrs. Curie had when I saw her in France in the 1920s. I was sure he had an anemia. Well, we asked about blood counts and other examinations. And yes, oh yes, they had done some. But when we located the doctor they referred us to, he had a very sketchy record. The whole thing was without good control. By doing a little inquiry ourselves, we found that it was common practice to keep a worker for maybe six months and then when he began to look a little puny they discharged him. Some of these people had remained on relief in the community with no responsibility taken by the company to do anything about their care or follow-up, or to see whether they had an anemia or not. This was a hangover from the British labor practice.

When we tried to insist that they put in some precautions, they refused. Then I got the devil from General Groves when I got home. He said, "You've kind of spoiled our contractual arrangements. They won't become a part of our contracting group and carry out your requirements. We'll just have to buy the uranium as a product and not have anything to do about the refining of it. We will stipulate that we are buying an ore with no stipulated requirements, responsibility, or anything else."

You see, in every other case, because of the security, the Manhattan Engineer District would set up an insurance and a medical care stipulation. If there were any sequelae which caused injury to the workers in the plants, the Manhattan Engineer District then felt responsible and would take care of this. This was part of the bargain. Later, very shortly after the beginning of the program, the company would carry out the instructions given by the area engineer without asking any questions. They would undertake security arrangements and contractual relations with their men. They would put in the proper medical examinations--urine and blood counts if required. No questions were asked and then if anything happened afterwards, the government would pick up the bill. But we were fortunate in the fact that our regulations were sound. They were based on rather sketchy experimental work, but a lot of thought was put in on this so that we covered all the hazards. There were no sequelae of any consequence, except from an occasional violation or an accident of some sort. And these were very few. In fact, the whole thing went very well. Even the construction workers didn't get hurt with the frequency that they usually did, because the company was so interested in getting the job done, and done properly. If there were too many accidents, this would cause inquiry and this would violate security, you see. So everybody was a little bit more careful than usual, I think. And the companies put their very best men on these jobs, too.

TUSLER: Because their contract, you mean, would have been threatened with termination if they didn't comply?

WARREN: Yes, if they didn't; but they were paid at cost plus also, so they were suffering no pain as far as management was concerned. The profit was stipulated. This turned out to be all right. Many times you'd think that the contractor would just load it up with things in order to increase his cost because he got a percentage on his cost as his profit. But, of course, they also had the area engineer looking down his nose at them, watching every step. He would have to OK any extra costs. They really were inspected in a way that was not repugnant to them, although there was the usual bitching back and forth, but it was not really deep opposition. There was really great cooperation and a fine spirit. I think the taxpayer got his money's worth out of it.

Well, this Port Hope thing was a kind of a jarring experience. This was why, very shortly after that, I went down to Grand Junction in Colorado and continued to inspect the Ouray operation where we had a direct responsibility for safety. We had had difficulty in getting a doctor to go out in this mountain country and look at these people, so we had to do this ourselves. We had to import an X-ray machine to Ouray and set up a doctor's office at this little spot on the river where the Manhattan District was refining the ore. The Vanadium Corporation would take anybody that was warm and willing to work in the mill. Then, if they so much as sneezed, they discharged them and then the Ouray plant picked them up.

Well, we found all kinds of silicosis cases at Ouray. One man whose job was to lift soda lime bags weighing about a hundred pounds off the truck and above his head onto a platform complained about a little bit of shortness of breath, but not much else. When we x-rayed him, he had an aneurysm on his aorta as big as an orange, about eight or nine centimeters in diameter. The thing could have ruptured at any time from one of these lifting episodes. He was very angry, of course, when we took him off the job. This was probably of syphilitic origin. It had existed for several years before he had been employed and was not an occupational disease.

We had just had experience with some compensation cases in Rochester, New York, where sandblasting had been used for a very short time and several cases of acute silicosis were produced. A lawyer named Clay had everybody that had ever worked for the company come in. He sued on the basis that the workers had been exposed and were therefore harmed. One of these patients died who had had an aneurysm from syphilis, and no silicosis was found in the autopsy. But the lawyer got the family and the wife to come in all teary and in terrible clothes. The four children were all dressed very badly, in rags, and with unshorn hair. They just looked like the devil and, of course, the jury awarded the family about $30,000, which was a big sum for those days. The lawyer got half. He was making money out of this kind of situation. The Manhattan District lawyers were very much aware of this particular case and a series of other cases in Rochester because they were precedents. We were aware of them, too, and were therefore looking to prevent, wherever we could, the conditions that might set up even a spurious situation.

It soon began to be clear that we were involved in many hazardous extraction processes in the building of K-25, which was a part of Dr. Harold Urey's gaseous separation plan. I will describe that a little later. There were several things we had to anticipate, and the Rochester laboratory was the only one that could do the animal work. This was a new project and Dr. [Robert S.] Stone's group in Chicago was pretty well filled up with older problems.

For instance, in making the hexafluoride of uranium, as was done in the plant at Oak Ridge, the elemental fluorine was used. Elemental fluroine is a very hazardous, corrosive gas. If there is a little speck of carbon in a valve, when the valve is turned, enough friction is generated to produce a little bit of heat, and the fluorine will ignite and burn the valve and the pipe clear back to the source of the gas. If this occurred, free fluorine gas would cause the immediate production of hydrofluoric acid. This would be in the air and everybody around would inhale it.

So we had to do a very extensive survey of fluorine and the fluorides at Rochester. Part of this study, of course, was an offshoot of the research of a small dental group there who had been working with fluorine in teeth. Dr. Harold Hodge had been running this; he was the pharmacologist in the University of Rochester. So he took on the testing of fluorine, both for burns and other effects in exposed animals. He determined the lethal doses to exposure to the gas, and so on. This went on very rapidly, and his previous experience with fluorine was very helpful.

Another problem involved the toxicity of the solvents that were used in cleaning the pipes before they were put into the production machinery. We needed absolutely clean pipes to carry the fluorine. The contractor had constructed a big vat which was twenty-one feet long in order to handle the twenty-feet-long pipes. There was a chain hoist above the vat which would take a bundle of pipes, swing them into place, lower them into the solvent and then hoist them up again. Then they would go through several drying processes. Well, the solvent turned out to be very toxic. The personnel using the hoist and doing the cleaning process would have to wear masks constantly unless they could find a less toxic solvent.

Well, of course, all kinds of solvents are toxic. Hydrogen sulfate and carbon disulfide are very toxic; carbon tetrachloride is also toxic. But they finally found one that wasn't very toxic. Then, of course, this had to be produced by the ton, or by hundreds of gallons, to fill the vat. In three days Dr. Hodge could do a complete run on rats and rabbits to get a crude estimate of the relative toxicity. So the corporation would call Dr. Hodge and send him a sample. Sometimes he didn't know what it was. They just gave him a number. In three or four days he would call back and say "low" or "high" toxicity. Then the call would be followed by a written report.

Finally, this whole procedure was worked out all right. The operation only lasted about four months while they were installing this equipment. You can see why there was need for hurry and for quick animal testing, but this was not a procedure that was conventional at the time.

There were no previous methods for such quick and early analysis. But Dr. Hodge was able to accommodate himself to this. A lot of researchers and scientists don't like to be involved in industrial occupations. They want to work on the fundamentals. Well, Dr. Hodge did, too, but in the process he wanted to do something that was valuable for the war effort. This industrial experience was a very useful one. He did industrial testing on any kind of thing that involved dust or solvents or gases. These then were put aside for later basic experiemental work. This was a great gain for industry which has been overlooked.

Well, let's go back to Fred Bryan and some of the engineers that he gathered together in the Rochester program, both before and after he went into our office. He designed dust chambers for exposing animals to uranium and other dusts to see what the hazards were. This is still a very difficult thing to do.

Up to that time, Saranac Laboratories in northern New York were working with rabbits. They were working on silica and silicosis and tuberculosis combined. If a patient had tuberculosis and worked with sandblasting, his tuberculosis was apt to exacerbate if he didn't die from acute silicosis.

It was about that time that we began to be aware of the fact that the production of acute silicosis was certainly possible if a worker used sandblasting equipment without a mask. He could inhale the fine silica particles and within six weeks have fibrosis of the lung, with alveolitis and pulmonary edema, and die from respiratory difficulty.

We were just beginning to be able to measure these fine particles. They were about a tenth, or a little larger, of a micron in diameter. When these would land on the surface of the alveoli, the local phagocytes would absorb them and then they would be collected in the local lymph nodes. These would begin to get full of silicon in turn and a little silicic acid would be produced from the silicon dioxide. After this, there would be a deposition of fibrous connective tissue, and the whole lung would become hard. The resilience of the lung was lost. The reaction was permanent; there was no recovery from it.

Well, I made a special trip to the Saranac Laboratories. The way the rabbits were exposed was quite crude. They had a small, noisy kind of stamp mill arangement in the room. It was on top of a table and rabbits in cages were put beside it. The room was full of siliceous dust. It was all powdered up and was floating around. There were no controls on the way the air was circulated. You couldn't tell what the concentration was. It was an admittedly crude sort of first trial experiment.

Then we tried to find out from the Bureau of Mines what they knew. They knew almost nothing about it, although Dr. [Robert A.] Kehoe since has challenged me when I said that the Manhattan District did the first systematic, really scientifically controlled experiments on a large scale. We had to do them on a large scale because we had only about six months' leeway. We had to come up with an answer at the end of that time because this had to be put in the factory design or the reactor design, in concrete and steel, and there was no time for messing around. We couldn't do it over again.

Up to this time, a scientist was accustomed to doing three dogs and three controls or three rats with controls in an experiment. First we got Morey Wartman, he was a good statistician, on the job, who began to do things in numbers of sixteen, twenty-five and so on. These large numbers made it possible for us to come out with a statistically valid number.

Dr. Bryan never did succeed in getting a pressure chamber, but he got metal cubic meter chambers with a well-regulated input of air, which allowed the dust or gas to be added in regular amounts and in different concentrations. Then he could suck out some of the air and measure it so that he could get some idea that he was in the concentration range that he wanted. With radiation experiments, of course, turbulence of the dust was created by the animal also, so the results were very erratic. If the rabbit sat up, as they often did, or as he changed his position, the turbulence of the air around his body made the concentrations different.

TUSLER: It's fantastic that it could have this much effect.

WARREN: Well, if you had, say, four or five rabbits in the chamber at once, you had a certain amount of efficiency. This was because the exposures were a half-hour, an hour, two hours, three hours, or four hours, you see, and some of them were eight hours. You had to simulate the working day. First, we had to find some toxic levels so that we could identify an effect that could be measured, and then go back down from that. This is kind of chancy. So we did the toxic effects first and found the ten-day toxic effect. It took two or three days to set it up and took a couple of days to get the autopsy and all the chemical materials examined before we could know what to do for the next step. So a month was used up pretty quickly even after we got all the equipment built. But everybody worked overtime and there was always "Push, push, push, we have to hurry." The morale was just wonderful. Everybody was there actively thinking all the time about how to do these experiments. The gases, of course, were easier, because they didn't settle out, but the dusts were the most difficult.

Finally, many of these experiments were done with a single animal tied down in a chamber. The animal was tied down on a board. Anesthesia didn't seem to be necessary because there wasn't any great discomfort. There was no pain accompanying any of this experimentation. It was discovered early in the experiments with the gases and the dusts, particularly with the latter, that if you were trying to study what was inhaled and what was absorbed by the body, you didn't have a simple situation. The animal would clean his fur as soon as he was released and swallow an unknown proportion of the contaminate. This varied with the amount of cleaning he did and the amount that was on the fur. So we had to run the animal's stools and then subtract those amounts. Of course, when we sacrificed the animal and looked for body burdens this was easy to partition. But it was quite surprising when we realized for the first time that the fur was going to be a problem.

There was a certain aliquot of the material absorbed through the intestinal tract that came from the fur. Ciliary action in the lungs brought the fine dust that had gone deep into the lungs up to the throat where it was swallowed. This was another entry to the intestinal tract. It was hard to detect what amount went into the lungs and what went through the intestinal tract. In so far as the worker was concerned--the damage to the kidney, if any, or the deposition in bone and so on--it didn't matter. He got it, in one way or another; whether he got it through inhalation into the lungs or through absorption from the intestinal tract when the material was brought back to the throat and swallowed, he still got it. But in general, for the worker it was through direct inhalation. For the animal it was inhalation and ingestion from the fur. This took quite a bit of time to unravel, too. It was not too easy. You know a cat or a dog will lick itself, particularly a cat, but to realize rabbits and rats do too was a surprise.

Well, there are a great many things I could describe about the Rochester program and the field. We finally had Captain John L. Ferry join Dr. Bryan. Then Dr. Joe W. Howland joined the group, so we had three people traveling all over the country during the last year of the war. They were in and out of the uranium metal production plants. Westinghouse was a big contractor as well as Eastman Kodak and the Electromet Buffalo group. Another was the Mallinckrodt [Chemical Works], which you know probably as a medical supply house. They produce gall-bladder dyes and fine chemicals.

Mr. [Edward J.] Mallinckrodt, [Jr.], himself, took on the contract and did the first uranium concentrations in a bathtub in the factory. He finally found a way of doing it on a bigger scale. To my surprise this was a rather crude operation. He used soda lime and sulfuric acid.

One of the hazards in going to Uravan and to Grand Junction was to go down the Million Dollar Highway, which was carved out of a cliff a good part of the way. If you've ever been on it, you know you want to be on the cliffside in the car instead of on the outside, because you can look down 500 to 1,000 feet from the edge of the road. It is called the Million Dollar Highway because the tailings from the gold mines were used for the roadbed. It turned out the road could have been refined for the gold still in it.

In the winter, the first time Mr. [Francis W.] Bishop and I went there together, Mr. Bishop was bringing a Geiger counter with him from Rochester. It was my third trip, but I didn't appreciate the hazards so much in the summer as I did in the winter. I had an army driver and we were always in a Ford or a Chevy sedan. The snowplows would push the snow out over the cliff edge and gradually a shelf would be built out at the edge. If you looked ahead at a curve, you could see the shelf of ice stuck out about three or more feet. This would be the accumulations of the winter or, say, a couple of months.

Well, the driver would try to keep going at fifty or sixty miles an hour, which is too fast for the winter roads. But he wanted to prove to the military passengers that he could get to our destination within a certain time. It was chancy too, because the big trucks carrying the soda lime and the acid to the Uravan vanadium mills would be coming towards us on the road and it was a one-track road.

TUSLER: It was not wide enough for two cars to pass each other?

WARREN: Barely, you see, just barely. It was a gravel road, so in the summer you could skid behind and around (you aren't old enough to remember this trick on a gravel road). Anything above thirty miles an hour took advantage of the skidding of the rear end on a gravel surface as you went around the turn. In the winter, even with chains, the same technique was used. Well, just imagine meeting a truck at one of these turns. When this happened, I always had the sensation we were out on the shelf, and I expected it to part. Mr. Bishop got so disturbed that he finally crawled over in the back, put his overcoat over his head, and went to sleep. I just sat there and suffered, mentally helping the driver, but not daring to say a word. Well, that was pretty rugged. I always felt very tired after that trip.

The extraction in the mill was very simple after they had made the mixes. They used filters composed only of sacking. The mud or slurry as it was called--the ore mixed with the soda lime--would precipitate out the uranium. It could be separated then by simple filtration. They had rotating drums covered with sacking. This sacking acted as a filter and separated the material with relatively low losses. They got everything but 4 or 5 percent of the uranium out of the ore.

That concentrate was shipped to the Mallinckrodt Company in Saint Louis. When they received the concentration it contained, I guess, from 18 or 20 percent up to 25 or 50 percent uranium concentrates. The Mallinckrodt Company reduced it to the uranium oxide. Then Westinghouse, or sometimes some of Mallinckrodt's friends or others, made the oxide into a cake and then incinerated it to get the metal. That metal, then, was fabricated into a bar which had to be shipped somewhere else. It was a bar about four or five inches long and an inch and a half or so in diameter, and was quite heavy. This was then canned in aluminum. In other words, an aluminum sheath was put around it. That was done in order to hold in the zenon and the ashes when this slug was put into the reactor to "fish" (to provide fission).

Later, the bar was dissolved in a big pit at the Hanford Chemical Recovery Plant. We could see the slugs--this was all handled by remote control--being put in water before they went into the chemistry plant. We could even see the glow from the radioactivity given off. Then they were dissolved and the plutonium and uranium separated out. The rest was ashes which had to be kept in some kind of a disposal. This was quite a problem, too. How do you stockpile this radioactive stuff? Well, they built a great big, underground reservoir, double walls, very thick and very heavily reinforced, because if there were a crack then the material would leach out and perhaps get into the underground water. They have done a lot of study since then on the underground water in wells put in strategic locations around these reservoirs to be sure the waste isn't leaking out. If it were, they could take the radioactive material and put it somewhere else.

TUSLER: Does this material eventually lose its radioactivity and become harmless?

WARREN: Well, it's very hot, and the half-life is quite long. In fact, it would be a good source for heating city buildings if it were stored in an underground reservoir and was passed through in a pipe to be heated. The water would not become radioactive because there are no neutrons involved. For many years you would have these ashes producing heat, usefully. But they're hard to handle, and you have to have them encased in great big lead or concrete vessels of some sort. The weight is such that you couldn't transport very much in a railroad car at any one time. It's too heavy for trucking in any amount. You can extract some of these and use them for sources of radioactivity. If you can come up with any solution it would be a great boon for the AEC [Atomic Energy Commission].

TUSLER: [laughter] I'll go to work on it!

WARREN: We had this problem with the Belgian Congo ore. When the Buffalo plants got through with the extraction, there was a lot of residue to dispose of. We found an old abandoned reservoir and studied its drainage and the drainage of the area. Finally, we agreed that this would be a good place to stockpile it until the war was over and disposal could be made of it. Just about the time the war ended, that reservoir was full. We didn't have to worry about finding another site.

TUSLER: How perfectly charming!

WARREN: There were no leakages as far as we know, and none ever discovered in the local streams or in other areas.

TUSLER: Where were you quartered in all of this period?

WARREN: By this time we had moved to Oak Ridge.

TUSLER: Of course you were moving around so much that you really weren't in any one spot through all this.

WARREN: No, I was working out of Rochester a good deal of the time until the family moved into Oak Ridge. And also, I was trying to get the program at Rochester set up and activated. At first, the field operation was centered at Rochester because it was the location of the instruments and the testing that was going on. The University of Chicago operation was focused entirely around the reactor because Fermi had the experiment with uranium fission going on. This was done under the Stagg Stadium stands right off the central campus.

They had piled up a lot of graphite blocks and put some uranium inside. I think they had a control rod. I'm not sure. It was a control rod made up of beryllium or something that captures neutrons. Some of the other very light metals are of that type. Those elements have a high cross-section capture factor. Neutrons don't go through them very well, so they are stopped. A neutron which is wandering back and forth through a carbon atom has a chance to hit the uranium and cause fission. But if it hits the control rod, it is then extracted and captured and that phenomenon cannot occur. The rod is like the throttle. The whole reactor is activated or shut down by pulling the rods out or in. When the rods are out, there are more and more neutrons available for scatter and fission. When they push the rods in, it effectively shuts the reaction down. You see, the chain reaction is on a very small margin. It starts out with the neutrons that are in the air. Each hit produces two or more neutrons for the one that's hit, and it just goes on this way. So it doesn't take much reduction to shut the thing off. When they made the design they put these reactor control rods around in strategic places in the carbon shield or in the reflector. The carbon is just a reflector; it keeps the neutrons from scattering away from the uranium, and the scatter is focused towards the uranium by the graphite. Now the Germans wanted heavy water, and the British wanted heavy water. This was because the heavy water does the same thing. Hydrogen, by itself, is a little more efficient, but water is kind of hard to handle.

This is why the heavy water plants in Norway, which had the hydroelectric power, you see, were so important to the Germans. It was one of the reasons why the Germans went into Norway. The British had to rescue Niels Bohr when he was up there looking at the heavy water plants, I guess, as a consultant. He avoided German capture thanks to the underground. They got a message through to the British, who then sent a bomber over one night. Bohr was in the proper place, the timing and everything worked perfectly, and they picked him up. Well, they gave him an oxygen mask, but since he was Danish, he didn't understand English very well, at least not enough, and he was so excited that he didn't use the mask properly. They had put him into the bomb bay; this was out of the sight of the pilot and copilot. Of course, everybody was anxious to get the hell out of there because the Germans might come over with one of their planes and bother them. When they arrived in England, Mr. Bohr was unconscious. They were in a little tizzy for a while getting him enough oxygen, but they got him back. Very shortly after that he went to Los Alamos where he remained as part of their staff there.

TUSLER: That was a close thing for him.

WARREN: It was a close shave for him in two or three ways: the Germans might have gotten him, he might have had an accident, and he might have died from lack of oxygen, too.

We had a heavy water plant, too, at a place called Trail in Canada. This produced hydroelectric power. It was isolated and in a place where a big plant could be set up under Canadian contract. Some of the area engineers were up there. I never got there nor did any of my people, but we knew about it. We didn't know this at the time, but the Germans, when they produced some heavy water, were trying to make a shield of ice cubes with heavy water. This was a fantastically difficult process, you see, because you had to keep the water frozen, and they would have to get rid of the large amount of heat produced by the fission. I don't see how they thought they might carry it out if they had any quantity of fission. But, anyway, we were not overlooking any possibilities. If the graphite shielding did not work or a reflector did not work, then we would have been forced to use heavy water. But fortunately, there was enough graphite, and it did work.

TUSLER: And was it a much more practical substitute?

WARREN: Yes, you see, it could be made in blocks.

TAPE NUMBER: IX, SIDE TWO

JULY 14, 1966

TUSLER: Dr. Warren, you have with you this morning a very intriguing little object. Would you describe what that is, and the part that it played in your mental retardation activities?

WARREN: Well, this is an embryo of a little wild deer mouse which was put in plastic by Dr. Baird for me before I went to Washington. Throughout my professional career, I have found if very useful to have a gadget when you go to interview somebody, particularly when you are going to raise money, or try to get votes, or something like that. And I always try to have something that I can keep in my pocket that doesn't take up much room but which is quite clearly something that could be of interest to the beholder--something that you could make a little story on. If you can break the ice, you can get in; it's an old trick of the salesman.

Well, I was looking for something to take with me to Washington. I ran across Dr. Baird in the hall one day in the medical center. He's an ingenious, rather imaginative, young man who is working on hypoxia and anoxia. He'd been doing some experimental work on White Mountain along with others from the University of California who were studying high altitude effects. He had trapped some of the local mice to study the development of the embryos and the fetuses.

Well, he showed me some specimens which were just about three-eighths of an inch long and quite suitable for my purpose. He became interested in what I was going to use it for; the next week he came into my office and threw down this little cube of plastic into which he'd embedded the embryo. The plastic cube is about the size of two cubes of sugar. In the center you can see this somewhat opalescent embryo about a quarter of an inch long and an eighth of an inch across. The most obvious thing about it is that it has a large head and you can see a little round dot which is the retina.

Now, normally at this stage, the retina would have been concealed in a well-developed eyeball, or nearly concealed, because of the semitransparency of the tissue. And in looking at this, particularly with a hand lens which I used to carry, you can not only describe the fact that the eyeball didn't form normally, but that the little black, wire-like object behind it is the lateral circulation of the brain's blood vessels, and that the actual bony covering is gone, so that the brain is exposed. And then you look at the nose and the face: it's all deformed and not well developed. The same pattern occurs throughout the rest of the embryo.

Now, in practice with this, I would go into a congressman's office. You see, you would make about two appointments for a morning to get started in the House building, then you would have to play the rest by ear. There are some 250 men that you have to see eventually. And of course, they have all their administrative assistants and secretariat. So after the formal appointments, at which I used this also, I'd go down the hall to the next office, walk in, and ask if I could see the congressman. Of course, not having seen me before, the secretary would stick her nose in the air and say, "Have you an appointment?" And I'd say, "Oh, dear, no. I realize this is an imposition. But I just thought if he happened to be free, dictating or something, I might have a minute about these bills on mental retardation." Then I'd take this curio out of my pocket and put it on the desk before her and say, "Here's a little deer mouse that illustrates exactly what we're aiming to prevent, a damage to the fetus during pregnancy and childbirth."

I'd go through the description of it and by this time I had her fascinated. By this time, too, the other one or two girls in the office would be clustering around. Before you knew it, I had the whole story out without any pain. Sooner or later, one of the girls would grab this and take it back to the congressman in the inner office. I'd hear him say, "Show the doctor in." So I'd go in and sort of repeat the story. They never forgot me after this! I would see these girls at cocktail parties, and while I couldn't remember their names, they would remember who I was and would always bring up the deer mouse study. They'd ask my wife what I had in my pocket. [laughter] I think this accumulated a great many votes just by this corny approach. It's old-shoe and all true. If the girls wanted, I could talk a little bit about birth injuries and the problems with anesthesia. Most of them were married and had had babies, or their friends had had babies recently. It was all very current. Now it's interesting that, within a year, I didn't need it any more.

TUSLER: You were well enough known.

WARREN: I was well enough known, and the bills were then up for vote and were very soon passed. I didn't have a gadget like this for the next steps, which included the governors. But I still used it when I went around in the states to some extent because the secretaries were always susceptible to this kind of a pitch and had never seen an embryo. The second they could get over the shock of what I was showing them, [laughter] why then they were fascinated!

TUSLER: And you found this approach worked better than making a formal appointment and setting the thing up right?

WARREN: Oh, yes, because these men had all had that kind of approach before and they were designed to resist.

TUSLER: They get out of it as much as possible?

WARREN: They get out of it as much as possible and they give you the bum's rush. And it worked even if we had a particularly difficult fellow. Even old Senator [Harry F.] Byrd was susceptible to this.

TUSLER: Really?

WARREN: Yes. He was probably the hardest man to deal with because he was like Mr. [Calvin] Coolidge. He didn't say anything--he just stared at you in a very cold and distant way. Then he would make a sarcastic remark--whatever he could think was the right thing to chill you off.

TUSLER: Was that just his personality?

WARREN: It was his personality and his technique, too. He was chairman of the Appropriations Committee for the Senate and did most of the balancing of the budget. He really was a very big man and a shrewd financier--witness the fact that he could balance the government's budget on one hand and make a fortune in apples on his own farm. His son [Harry F., Jr.] is very able, too, and has followed him now. This is the famous Byrd family from Virginia. Well, they are like the people here. Though I don't think they owned any newspapers, like the Chandlers do.

TUSLER: But they had that same kind of influence.

WARREN: They had that same kind of influence in the community. They really had a political machine.

TUSLER: So, I can see if he was the moneyholder he was the number one man on your list to convert.

WARREN: Oh, yes. He and Judge [Howard W.] Smith. There were four or five on that finance committee that were quite recalcitrant and better organized than they are now. Mr. Johnson has sort of undercut them all so that they are more accessible and more malleable, I think, to the president's policies and programs than they were in Mr. Kennedy's time.

He'd use all kinds of devices. There was a man from Pasadena on this committee (I won't mention his name) who was once in charge of the security for Lockheed. So the pressure channel for him was to go through Lockheed, and this worked. It's interesting that it should, but it's not reprehensible, either. I mean this man had not a great intelligence, but he had the good judgment to ask for good advice from his sponsors in the community. And since most of his sponsoring was backed by Lockheed in his elections and they had very shrewd and good points of view, he succeeded.

I realize that's a kind of a tenuous reed, but that's the way it happens all over the country. If you are going to manipulate things, which is what we were trying to do, you need to know the sources of the power structure in the life of the politician. Well, anyway, this is all right, because if the power structure behind him is comfortably agreeable to what you want to do, then the politician is in good shape to agree to vote for your proposal. Where the struggle comes in is where there's a dissension and a difference of opinion between the sponsors of the politician, either among themselves or against what you want to do.

This is where the antivivisectionists get in their dirty licks. So many of the nice old ladies who left the endowment to the antivivisectionist movement didn't realize that this then would become part of a powerful machine, or would furnish the resources to a powerful machine, which would not always work in the best interest of animals and certainly not in the best interest of mankind. It would come about in this way.

A typical illustration is Mrs. [Sally] Moody here in town, who is a very bright woman. She was a young woman when I first came here. She's an ex-movie actress, at least she attempted to be an actress, but she was not very successful. Then she became involved in the antivivisection movement and finally became the executive director. Well, she gets a very good salary out of these endowments, which go on forever, you see. Only the interest is used. They can hire very well paid public relations people and publicity writers. And Mrs. Moody is not about to give up her nice job, even though she might not be completely convinced that what she's doing is proper and right, because she wants the income.

Now you can find a person like her anywhere in the United States in all the big metropolitan areas and in most of the state jobs doing the lobbying against research. Of course, she has the vocal group of nice old ladies. I say that kind of bitterly because these dears are in a bad spot. They are lonely. They have a cat or a canary. And they are, right now, very, very active.

Before Congress now are a dozen bills on animal care. Most of them are punitive and ostensibly say they want to prevent the theft of dogs and cats. But this has nothing to do with it at all; they are trying to stop research on animals. Did you ever attend one of the hearings for the antivivisection bills? Well, if you want to hear something that's unbelievable, you ought to go down to the supervisors or to the city council when one of these bills is up before them. It's the same group who have followed Edward Roybal to Washington from Los Angeles. I went into Mr. Roybal's office just before I left, to say good-bye and wish him luck. He said he wished I would take these people off his neck. It was Mrs. Moody and four or five of the wealthy old ladies with the strength and endurance to go to Washington. They just haunt his place. They'll call you murderer, sex deviate, anything that comes to mind while they're before the microphone testifying. I had them spit at me when I left the council chamber once here in town. There were three of them in a line and I had to pass through the gauntlet in order to go out the door. All three spit and said, "You foul murderer!"--just like melodrama, you know. They'll take anything and distort it.

I'm particularly a target because at the end of my research program at Rochester, just as I was getting involved in the war, I worked on crushing shock. I think I explained it a bit. If a person in the bombing in London, or anywhere for that matter, were pinned down by a beam, or some masonry, for five hours, and then the weight were lifted off, they would be apparently in pretty good condition. They had no fractures and maybe no abrasions. Then they suddenly would just fade and die. Well, one of these antivivisection public relations fellows sat in the library and filed my references. So this is the best advertising they have! In all these battles my crushing shock work was mentioned as one of the things. Yet, we were careful to give the animals anesthesia. But they picked up the statement that under the ice pack on the leg, the animal did not seem to have pain and did not seem to need anesthesia. So they would say that "he just stated in the crushing shock that they did not seem to need anesthesia, when any fool knows that this is a very painful thing." A lot can be made of this. Yet, those experiments influenced the temperature of operating rooms and treatment that I think saved many a leg. They don't count that. That's out of sight and out of mind.

TUSLER: Were they active against your work in the mental retardation program?

WARREN: Well, we had no obvious animal experiments, so they didn't get on to this. They don't like to fight against things that are concerned with children. They know that this is a delicate subject. Even though a great many of these women are spinsters, they are afraid to tackle anything that has a child involved. They don't care if the child dies, they want to save the dog! It's really that straight forward. You can get this kind of admission out of them by indirection; that is, you talk about the child, the child would be saved by the vaccination, and about the experiments that you would do. And then if you mentioned the dog, there it is right there; that's the big thing.

Christine Stevens is very active in this movement. Her father was Dr. [Herbert] Gasser, a very famous pioneer physiologist who worked the latter part of his life, for twenty years or more, in the Rockefeller [Institute for Medical Research]. Toward the end he became mentally disturbed, along with his senility, and he began to be an anitvivisectionist.

We will have to admit there was a lot of bad practice used in the care of animals. But then most of the animals were treated like the farmer would treat them in many ways, except when the animal was brought in and kept in a cage. Then the hygienic conditions were not of the best and the smell was bad. Very little money was spent in getting good quarters built. At that time there were lots of cockroaches and rats and things, but these were all through the buildings anyway. Humans had no different situation.

Christine married a very wealthy man who is a big wheel in the Democratic party and she's been very important on the Washington scene. When she came out here, I knew her quite well and fought with her for many years. She came out when we had just finished the UCLA medical school and had been in it a couple of years. She came to call on me to tell me how bad all this was. And I said, "Well, have you ever been in a good animal quarters?" And she said, "Oh, yes." And I said, "Well let me show you a good one." So I called the veterinarian, and I took her down there. Everything was all tile and just as clean as it could be, you see. So then I took her over to the children's ward and I said, "There's no difference. In fact, the children's ward is not air-conditioned like the animal house is. Here are all these babies in the nursery, and some very sick ones crying." I had her really disturbed, you know. I asked if it were all right to work on these animals to prevent the agony of a nearby child? The effect didn't last long, however. It was gone as soon as she left Los Angeles. But as a result, she has avoided me ever since.

TUSLER: She doesn't want to hear what you have to say?

WARREN: She doesn't want to hear and she doesn't want me to bring up the fact that I had her somewhat jarred by the fact that she was undoing all this.

TUSLER: Well, it's a really extraordinary, topsy-turvy set of values.

WARREN: It certainly is. She, for instance, wanted inspectors and told me that in all of England it only took three inspectors. Well, I pointed out to her that England had a population about like that of the state of California. And then I said there was the state of New York. So there were three inspectors to each. Since there's fifty states, you've got a big hierarchy of inspectors right off, and how are you going to manage this? Well, she'd never thought this through. If England could do it, my goodness, you know. Well, I've kind of wandered afar on that.

The antivivisection fight has been present for a relatively long time. I first ran up against it when I was a medical student up in San Francisco. The medical school there gave us students a vacation to fight anti-vivisection. We went around and put up handbills--we divided up the city of San Francisco into blocks and we all went around with a big package of handbills and put one on every doorstep. This was 1916, I guess. The antivivisectionists lost, but boy it was a tussle. It was the same pattern and these were the same people. As they got older, of course, they died and dropped off. But it's changed slowly. That's pretty near forty years of effort.

Well, they'll come close to passing some of their bills. The administration has got a bill this time which is pointed at the animal dealer. There's no doubt about it that a lot of these dealers bought stolen animals, but the strange thing is we can't get a universal pound law so that animals that are not wanted are turned over for experimental purposes. Otherwise, these animals are just gassed or given cyanide. They could be useful in their last bit of life. They could be useful in developing things that would be beneficial not only to humans but to animals, too.

TUSLER: Sure, and why is that being blocked?

WARREN: Well, it's the same people, you know. Once in a while, for some time, we got animals from the Orange County pound. But we never could get them consistently from the Los Angeles pound. The animal caretaker down there was a political appointee and he was named by the Humane Society, which was run by the antivivisectionists. Now, there are some reasonable people in the Humane Society; but in general the radical group I would call them, the antisocial group, are vociferous and working day and night. They're dedicated crusaders so they tend to dominate the policies.

TUSLER: Well, minorities can be very vocal.

WARREN: Yes, you bettcha!

TUSLER: Well, do you feel like picking up at this point and going back to your wartime story?

WARREN: Well, it's kind of a wrench. [laughter] Did I talk to you much about the Columbia River fish problem?

TUSLER: No, not at all.

WARREN: Well, why don't I talk about that because this last weekend I went to Seattle to attend a twenty-year celebration of the Columbia River salmon experiments. In putting the reactors at Hanford--the big piles as they were called--there was, of course, considerable worry about the cooling water which was taken from the Columbia River. It was practically made into distilled water, and then it was put through the reactors, and finally put back into the Columbia River. There were two or three things that could happen: one, the amount of heat picked up by the water could raise the temperature of the river, even though the river was a mile wide and eighty feet deep and traveling fifteen miles an hour past this area. That's an extremely large amount of water. But it was possible to raise the temperature of that river a tenth of a degree. And there was, it turned out later, enough to do that.

The entry of the water into the stream had to be carefully adjusted, not only in temperature but also in the way in which it entered the stream, because it at first couldn't be much less than five to six degrees different from the Columbia River water temperature. So it was possible that it would make a thermal barrier to prevent the upstream migration of the salmon when they came back to spawn. And that could shut off millions and millions and millions of fish. Not a lot was known about the salmon, except that they did come back, and it was a good commercial venture to fish for them.

Part of the trouble was that where the river was deep they spawned and then died and didn't come to the surface, so they never were counted. They didn't know where these big spawning areas were. It was not always in the shallow stream. The Pacific salmon, contrary to the Atlantic salmon, has the instinct to return to its home base where it was raised up to the time it was a fingerling, about three inches long, at which point it went to sea and then came back three years later. Then it was a fish about three feet long and weighing anywhere from twenty to sixty pounds.

There was some work going on at the School of Fisheries, University of Washington at Seattle, by Dr. [Lauren] Donaldson. He was attempting to replace the salmon in the Fraser River. About 1918 the Canadian Pacific Railroad workers, going down the Fraser River canyon, had dynamited a wall of the mountain into the river in order to get roadbed space. If you've ever looked down on the Fraser River canyon, as we did last summer, you can see why. Well, this narrowed this huge river enough to speed up the current passing this point beyond the ability of the salmon to go upstream. So Indians 1,500 miles up in the branches of the river didn't get any salmon and were starving. And Professor Donaldson was engaged in inventing the fish ladder model. He also had some wild ideas, at the time, of holding some of the salmon in a refrigerated pen for a year so that he could plant fingerlings that covered a two-year span--one for the current year, one for the previous year. He was just about to do this when I first met him. And I might say that his experiments were successful. They went 1,500 miles upstream and then planted the fingerlings. This is a very successful return now. The fish go up the ladder and around this bad place, and the Indians are eating again.

Well, he had been found by Dr. Robert Stone out of the Chicago grouping, who was the director of the biological-medical research program for the Chicago operation, which was the Fermi pile or reactor program, and that was to be run by the du Pont Company. The first experiments, of course, for the reactor--Fermi's trial--were done under the Stagg Stadium stands in Chicago. Then a pilot was to be built at Oak Ridge called X-10. People were trained and the safety regulations were laid down while they were designing and building the big reactors at Hanford. The medical experimentation had to be carried out to set the ventilation factors, the safety factors, the wall thicknesses of protection, and the gases from the stacks, and all that; the Columbia River was an important element here. As big as its volume was, it still couldn't dilute anything because the quantities of pollutants were so fantastic.

Well, finally, Dr. Donaldson and I got together because the Chicago operation couldn't contract out. So this had to be done by my office in the Manhattan Engineer District. I made a visit to his laboratories (they were in temporary buildings in 1943). Part of this had been discussed with Dr. Stone, too. If you can recall, I was a little green yet with all of the ramifications of this program. But I could understand readily the problems with the salmon, because this isn't any different from the problem of X-ray exposure to rats and rabbits that I had been working with before.

It appeared that it would be a good idea to test the fish against various X-ray doses at the egg stage. So we made a contract with him, and I sent Mr. Bishop out to help design his X-ray laboratory so that he could do this without killing anybody. You know, they use this big X-ray machine with about 80,000 volts and water running all over the place. It was pretty risky for shock hazards--not the radiation so much as the shock.

Well, doses had to be calibrated for irradiating the fish in these troughs in water, or irradiating the eggs in trays. Then they were artificially inseminated. Then, of course, he kept them in carefully temperature-controlled troughs. They were fed special diets. All of this was just beginning to emerge--the fish culture--which was rather a new thing and was used by the state departments of fish and game around the country, but not well controlled. Standards were not very clear. You didn't know what kind of mortality you were going to have in the young fry. We were on, to a certain extent, rather tenuous ground.

It was agreed that he could do one salmon per dose over a series of doses--just one dose in the adult. And then he would try to find out what the mortality was from the effects in the fertilized egg, in the fry, in the embryos, in the fry, and then in the fingerlings, and then hopefully mark them and get them back. At this time, the only procedure that was possible was to put them in a little tributary way up the river, or off on the side, so that they would be sure not to get caught in the Bonneville Dam fish ladders, or caught in other dams. Of course, salmon had to run the hazards of all the fishermen, including these great big stationary barges that had a wheel on the back that just shoveled the fish out of the river.

Well, fortunately for us, Dr. Donaldson was a member of an international group that controlled the marking of salmon for study, so he arranged for cooperation with Canada. We couldn't arrange anything with Japan, of course, because we were at war; but it didn't matter because the fish didn't come back on the Japanese side. They would be over there, but they would come back to the United States side of the Pacific and would come up the right river.

When the time came for these fish to come back, the technique was to have a watcher on the stream and to put a white board across the bottom where the water was about a foot deep. You could then watch the salmon as it swam up, and look for the cut fin which was the mark for that one fish or for a batch of fish. And the interesting thing was that before the war was over, he got some twenty-seven adult male and females back. Of course, at that location you could just lift them out of the water and put them in a preservative, or autopsy them, or take what you wanted, or bring the fish back in a small tank. Quite a few were brought back to Seattle. These, then, were spawned and very careful records kept. Some salmon that I saw last week-end are the progeny of this examination.

This was not the only problem with the Columbia River.

The other one was to see whether the radioactive materials that were in the discharge water were of sufficient concentration to be a hazard to the fish. We knew by this time from experiments that the Chicago group had done that radiostrontium and other things would collect in the fish just like they would in animals--in different organs. We knew that the cholesterol portion of the egg was apt to be quite a good collector, so the eggs were therefore susceptible to bombardment from alpha and beta particles. It served the purposes, fortunately, of the engineers to make distilled water of the Columbia River water, which was essentially coming from melting snow. Very little came from springs and therefore the big runoff was in the summer, which is the reverse of most streams. The water was pretty pure to start with, but they did not want to have any mineral content, if it could be avoided, because it produced radioactive materials as the water went through the reactors and was bombarded by neutrons. So they practically made distilled water out of it.

Thousands of gallons per hour had to have this processing, as it was called. They used iron oxide and many other procedures. It was remarkable to me to see that they could do this on such a fantastic scale relatively economically. It was not done economically enough, however, to make it a good irrigation source, or a way of treating water for drinking purposes. As the material came out of the reactor it was steaming hot. They had a holdup pond arrangement. It was a kind of maze through which the water went in order to have enough time to cool off in temperature. This also gave it a chance to allow the fantastically small amounts of radioactive materials in there to decay. Even though the transport time through the holding pond was maybe an hour, this was enough to get rid of some of the radio activity that might have been hazardous if fish had gotten a large quantity of it very promptly.

Well, as it turned out, the operation could be conducted perfectly safely with almost nothing detectable. However, we had to be certain of what happened. This water was kind of a yellowish red due to the iron oxide cake in the last stages of it. This was not considered to be a pollutant because iron oxide was a common component of water, anyway. Water flows over beds of soil and gravel which contain iron oxide which precipitated out very quickly.

Dr. Donaldson and then, later, the others there on the river went up in a small Piper Cub plane and took photographs of the color of the river where the water came in and flowed down. Fortunately, the inlet was upstream to a bend in the river so that this water hugged the bank as it went around the bend. After about three miles, you couldn't see it anymore, and a lot of temperatures were taken. Within half a mile, you couldn't detect any change in temperature. So this was considered all right.

Later, after the war, it developed that algae along the bank would specifically pick up these isotopes and concentrate them. Then the algae would break loose in masses and float down the river. Well, the question was: would these get in irrigation districts and ditches, or would it otherwise become a hazard? It could be food also for certain fish that ate algae and for polliwogs which then were consumed by fish and so on. The cycle just goes on and on. But precautions were taken to stop these algae rafts as they came along to the screen across the irrigation ditch as it took off the river. Well, this didn't develop until two or three years after the war, but it was one of the precautions that needed to be taken.

Dr. Donaldson's work, at first, didn't seem to have any more importance than the work done by Curt Stern in Rochester on the drosophila fly and the work of [Don C.] Charles, a geneticist in Rochester working on the mouse genetics and radiation exposures. These two Rochester experiments were mainly designed to find a tolerance level, but Dr. Donaldson's were designed to show kill of the fish which might influence the commercial problems, or how they might pick up abnormalities. Well, it was quite clear, right away, that the salmon would never get doses that would influence the lethal aspects and, therefore, would not diminish the population, either from temperature or from the radioactivity. This opinion was agreed to by the end of the war, so then "let's shut it down" was the cry.

I felt that this experiment was very important because Dr. Donaldson had the opportunity, very inexpensively, to follow these fish in subsequent generations; it was merely a matter of breeding them, releasing them, and letting the ocean take care of the feeding of them. You had all the trial of nature to determine whether they were fit to compete. So when you got a return, it was a pretty good indication that these fish were competent to compete.

While I was still in civilian clothes and a kind of carry-over director of the medical program of the new Atomic Energy Commission, I set him up in a good way with experimental funds. Then the successive directors, with some hesitation, continued this. There were two or three times when I had to go to Washington and plead Dr. Donaldson's case because he was about to be washed out on the basis that his experiments weren't necessary anymore. This would have been tragic because of what he had done. (I haven't yet talked about the work done at Bikini.)

But to finish up his Columbia River experiments, very shortly after the war, he was able to convince the

Washington State Fish and Game Department, which had been loyally supporting him all these years, to help him get a building. And the University of Washington agreed; but this was before the time of federal matching funds, so it all had to be state money. Well, he built a laboratory right on the salt water of Lake Union, which is also right on the edge of the campus. He raised some private money to get a pond which is like a corral. This made it possible for him, in this building, to raise all these fish under careful breeding conditions and feeding conditions and to hold some through maturity and to let the rest out to sea with marks on them.

I had the fantastic experience of seeing, last weekend, the rainbow trout which came in a little later. They were important market fish, too, as were, of course, the steelhead and the salmon. I saw a rainbow trout, two years old. The normal and control rainbow trout of two years under optimal conditions is about sixteen inches long and weighs a couple of pounds. It is a brilliant fish--fights like mad. A three-year-old fish is probably eighteen inches and maybe will weigh three pounds. You and your husband probably have caught this kind with great delight, as have I.

All right, of the ones that have received radiation in special selective breeding, the two-year-olds were almost twenty inches long. You won't believe it, but they weighed fifteen pounds. And the three-year-olds were three feet long and weighed twenty pounds or more. And they still had this great big, brilliant scarlet stripe along the side, but they were chunkier. They were deeper from back to belly and thicker through. One of the remarkable things was that instead of having 5,000 eggs per ovary in the females, they had 20,000. Now the breeding potential, you see, of these fish is just fantastic.

TUSLER: Well, now what is the explanation of this?

WARREN: Radiation and selective breeding. You see, this group took six years to evolve after radiation and careful selection. These are fresh and brackish water fish. The steelhead and salmon are saltwater fish; so he has both kinds. He showed me a steelhead that looked like a big salmon, but the steelhead and the salmon under these same conditions were chunkier and bigger for their age. They had the increase in egg production and were more vigorous. And some of those had come back and were in Lake Union right out in front of the laboratory. Dr. Donaldson told me that they had seen some that the fishermen had caught. And some had come into their inlet. They were their own fish that they wanted back, and that had been branded. They were just covered with fishing gear. The normal salmon and steelhead fishing gear wasn't strong enough for these fish. You could tell when one of these was on a boat just offshore by the yelling that went on and the jumping. [laughter]

Now there's an interesting problem here. It is that these fish consume what amounts to a can of kennel ration per day per fish. The point is, can these rainbows find this amount of food in freshwater streams and lakes in order to develop into this size? The body type is probably fixed genetically by the radiation and the selection, and the food is what does the rest.

So Dr. Donaldson is planning on several interesting experiments this fall. They have a big lake, forty miles long and twenty miles across, in Alaska, with a nice inlet. It also has an outlet to the sea. He's going to put 100,000 fingerlings in that. He also has contracted with the state of Michigan to put 100,000 in Lake Michigan with the hope that they won't go over Niagara Falls, but that they'll find the lake system big enough so that they'll have plenty of food. The lampreys have practically extinguished the lake trout and light fish in the Great Lakes. While they've got the lampreys under control now pretty much, the fish are so depopulated that they don't expect there's enough to spawn and come back. So this 100,000 put there would be a nice experiment because there are no rainbows in that lake system, nor steelhead. They will probably put steelhead in also, but then there's the problem of getting them over Niagara Falls and back.

Then he's going to stock the Columbia and Fraser rivers with an equal amount and see what they can do in competition with the rest. But these are huge fish! You just can't imagine the trout, three feet long and about that thick. [demonstrates] They were just boiling in the water. When somebody would throw food in, it was just like a stampede. Oh, it was fantastic!

TUSLER: So this radiation effect on them is actually a positive value?

WARREN: Yes, all of the deleterious effects of the radiation have resulted in extinguishing those survivors. It's only these bigger, stronger ones that remain.

TUSLER: Isn't that interesting!

WARREN: You see, I'm depending upon these results for part of my theory in my new concept of the paleobiological time clock. When you have sufficient numbers, the Gaussian curve for 100 percent kill finds small support in the data. On the tail end of the curve, at around 100 percent, most studies will express it as E^{-1}. In other words, they got about 99 percent, but they couldn't get that last one to fit with a sharp end point. There was always a stinker in the set that would stand almost twice as much. I found quite commonly, in going through the literature, that they'll give you a figure and they'll get survivors in the number of

10^{-5}; that's a population of a 100,000. They'd have a population of 1 million bacteria, say, in a sample; and you'd kill all but the last 100,000. So they considered that an end point because they couldn't get that last one very easily.

So that's what you depend upon here, too--the number of survivors you can get to come back to spawn. If the female now has four times as many eggs, there is more than adequate sperm available as milt, which just goes to waste. You've got a chance, then, to develop a population in a volume of water like the Great Lakes, or any one of these systems, provided the food supply is good there. This is why most lakes produced by dams are so prolific in fish at first. The decaying vegetation gives a nitrogen that will support the algae and the plankton and the food chain. Then, after a while, that nitrogen is used up, fish are taken out, or the material is diluted--it goes over the dam--and the fishing diminishes. About that time, too, somebody puts carp in, and they eat all the game fish eggs. I though it would be interesting, but I couldn't quite get to this point to see if he could make an aggressive fish out of the carp instead of a bottom feeder. Of course, these people consider the carp as we would consider pigs. They're cleanup animals.

Let's finish the story on Dr. Donaldson. When we had the Bikini Atoll operation, it was obvious that we needed to have a full-scale survey of what happened in the contaminated lagoon. Dr. Donaldson was willing. Dr. Charles Pautzke, who was the director of the fish and game department for the state of Washington, was also willing. He furnished a lot of energy and extra people. Dr. Donaldson was able to get a successful party to go to Bikini. They lived on the U.S.S. Haven with us. (I'll describe this later.) But they collected shells, fish, and coral, and seaweeds. They got a pretty good idea of what was there in the population. Of course, this was also done by the Smithsonian and the Beltsville Department of Agriculture and the navy. A lot of other people did some of these things, too; but they were more interested in the morphology and the presence of sports. Bikini turned out to have a tremendous number of sports. Shells were somewhat similar to snail shells found at other islands, but they had characteristics of their own. And it would appear that they were normally having a very rapid mutation. This was important, you see, in later studies to determine whether the mutation had been effected by the radiation. It would have been certain that if we hadn't done this ahead of time, there would've been great claims of mutation changes, which, of course, wouldn't have been so.

There wasn't much for them to do after the first detonation because there wasn't much contamination. But after the underwater detonation, they had a field day because the vegetation and the coral took up the radioactivity in avid amounts. The herbivorous animals--denizens is a better word because it was everything that ate algae or vegetation--took on radioactivity. There's a beautiful little illustration of a saltwater guppy of about three inches long being laid on a photographic plate. It made its own radiograph. The stomach was just full of algae and weeds that were very radioactive and the fish had absorbed enough strontium so that the skeleton was very radioactive. You could see the skeleton, the eye sockets, and the vertebrae--all just from its own exposure, from its own content. They brought a tremendous amount of specimen material home, although they were able to do some measurements on the Haven (they were provided with a Geiger counter or two). But the main thing was to collect the wide variety of materials that were available.

Dr. Donaldson has outfitted a party to go back to Bikini to make a resurvey about every third year since. So they have followed up on that and have a very good record of what has happened. The lagoon, you see, has a crater in it that's full of coral mud that's just loaded with contamination. It's fortunate that the tide and the wind-driven waters come in from the east and pass across the lagoon and out on the west through a lot of channels that have a tremendous flow across the surface of the atoll. This is a purging effect which, by now, has taken away a tremendous amount of the soluble radioactive materials which have been there. Fortunately, Bikini is about 1,200 miles from Guam and other areas where people are. Migratory fishes get in there only rarely and not in any great quantities, though tuna occasionally go in and run; but it's not many fish--witness the fact that the Japanese don't fish in those areas because they are kind of desert areas once you get out of the immediate area of the atoll itself. Each atoll, therefore, is kind of an isolated population center.

When the fallout on the Lucky Dragon occurred from the hydrogen bomb detonation, Dr. Donaldson was asked by the AEC to go to Japan and allay the apprehensions of the Japanese that the tuna were badly contaminated. The hysteria was such that the tuna market collapsed for about two months, but Dr. Donaldson went around and was on the TV eating raw tuna.

TUSLER: Lucky Dr. Donaldson!

WARREN: Well, when you think of the fish parasites that he could have gotten, but then he didn't think there was much of a risk.

TUSLER: Who supports that program now?

WARREN: The AEC.

TUSLER: Are they still doing it?

WARREN: Yes, it has had rough sledding, though. About every two years there's a committee site visit. And there's a risk that they'll close it down. There are a lot more things that Dr. Donaldson is doing. He told me that he is going to resign as director so that he can carry on with these fish. Anyway, he thinks it's time there was some new blood. He's sick and tired of the wear and tear of the politicking. He's had a couple of gastric hemorrhages. The last one he had on a visit up to Alaska at Point Hope where a plowshare was being thought of. (A plowshare, at least this one, is a harbor excavation experiment with a hydrogen bomb to see if they couldn't excavate in places like that where the tundra and the permafrost make it almost impossible to do much in the way of excavation. It would be very expensive to get the machinery up there to do it. But one detonation would loosen up the area enough so that you could make a harbor relatively cheaply. The same is true for building a canal across Panama or Nicaragua. This has been studied a great deal. If we hadn't had the test ban we probably would have done this by now.) Well, anyway, he was up there doing a survey on the fishing culture of the Eskimos who lived there to determine how much fish, whales, seals, and other marine life might be affected by a detonation and a possible small contamination for a temporary period of time. Well, he had a bad hemorrhage there and had to be flown back in steps. It took him about a week to get back to Seattle. He had some of his stomach removed, so he's fine now. But the rest of the program, then, and all these field operations will be conducted by a new director. He [Donaldson] will continue with his end of the marine work.

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JULY 21, 1966

TUSLER: Dr. Warren, today, to get back to the wartime operation, you said you would talk about the Chicago part of the operation.

WARREN: The Chicago operation was focused around the interests of Dr. Arthur Compton, professor of physics, and Dr. Norman Hilberry, a member of his department. Both had become interested in the possibility of a reactor which might produce controllable fission. They also were interested in making plutonium in large quantities. This was also a possible bomb fuel, or at least it might be a power fuel.

Very early, Dr. Compton was made a member of the Scientific Advisory Committee that was organized under the National Science Council. It was called S-1 and was the uranium advisory committee. It was formed very early at the suggestion of President [Franklin] Roosevelt after his conversations with Professor [Albert] Einstein. I've forgotten the other man's name now, the one who went with him, who pointed up the urgency and the possibility of developing an atom bomb. Dr. James B. Conant, Dr. Vannevar Bush, Dr. Ernest O. Lawrence, Dr. Harold Urey, and several others at different times were also on this committee. There was a Dr. [Eger V.] Murphree from one of the big oil companies. (This is kind of sketchy in my mind right now. I have copious notes on this from the material I prepared for the Army Medical History section a couple of years ago.) Anyway, it was possible for this S-1 Committee to recommend funds for urgent experiments (without further loss of time). These studies were then carried out by Dr. Urey at Columbia, by Dr. Lawrence at Berkeley, and by Dr. Compton at Chicago. There were other ventures, too, but at a much lower level.

TUSLER: Was this actually part of the Manhattan Project?

WARREN: Not yet; this was before the Manhattan Project. Dr. Enrico Fermi had been invited to join the Chicago group, which involved the beginnings of quite a large concentration of physicists. About two years later this S-1 Committee began to talk about this problem. It was clear that fission could occur from the experiments of Dr. [Lise] Meitner and others. These were quickly verified by, I think, all three, Drs. Lawrence, Urey, and Compton. The Chicago faculty who were interested in the problem began to get organized in a big way. Very shortly after the appointment of General Leslie Groves, and the organization of the Manhattan Engineer District, a large contract was undertaken with the University of Chicago which was negotiated by Mr. Harold of their business office. He played a very prominent role in the subsequent development of their program. From the business standpoint, problems of acquisitions of buildings, equipment, personnel, and salary policies--all had to be worked out. Not the least of the problems was securing draft deferment for civilians or of procurement of men out of the military who had already enlisted but who had scientific training important to this venture.

Arthur Compton and Dr. Hilberry did most of the organizing which very soon resulted in what was called the Chicago Metallurgical Laboratory. This was later shortened to just the Met Lab. Very shortly, too, Dr. Fermi, Dr. Hilberry, Dr. [Walter] Zinn, and some others began to design and then erect the first atomic pile, as it was called, under the Stagg Stadium stands. It was the only place where there was thick concrete and some work space close to the physics department. As you may know, the University of Chicago is in the middle of Chicago and really surrounded by a ghetto. There weren't very many places where this work could be done.

As soon as this program began to get under way, it was quite evident that they were going to have to handle large quantities of uranium ore in order to obtain the metal to put in the reactor. It was also evident that they were going to have problems with radiation. So just about the time that I was approached to join the Manhattan Engineer District, Dr. Robert Stone had been invited to come from the

University of California in San Francisco to head up the biological and radiation safety procedures in the experimental program. He was also to devise the rules and regulations for safeguarding all the personnel in this operation, which was rapidly becoming larger and larger, more and more important, and potentially more and more dangerous.

Now I probably will say over and over again that the great effort to protect the personnel was based on a mixed set of feelings. Of course General Groves and all the rest didn't want anybody hurt; this is rather obvious. On the other hand, the industrial practices of the day were not always safe. Probably, it would not have been possible in normal times to enforce the stringent safety regulations that finally were set up, because they increased the cost and delayed production until the safeguards were built in and people were trained to use them. But under the circumstances, security was so tight and so overpowering everywhere; everything had to be done to prevent anyone from getting sick and injured from something going on that would give a tip-off as to what was being done.

TUSLER: It might give a tip-off to the press?

WARREN: Yes, to the press, or it might have given the tip-off to the local people. It would have interfered not only with the secrecy but with the procurement of people. If the word got around that this was a secret, dangerous thing, and Joe came home and was anemic and finally died, and it was all mysterious, people wouldn't work there. So we had to create safeguards against the dissemination of radioactive materials and other chemicals into the airstream and onto the ground, where they might be detected, and we also had to see that no one was hurt. Well, this enabled us to organize excellent procedures for safeguarding people. This was first started by Dr. Stone because of the imminent need of these safeguards.

One of the things that the chemists and physicists did was to start an ore refinement procedure. You have to remember that uranium was not sought after much, except for ceramic colors; that's about all. It provides beautiful greens and oranges and makes a nice glaze. So the chief mining was done in Colorado, in small amounts. It didn't take much ore to overpower the market. Of course, I described the procurement of uranium ore from the Belgian Congo and from Canada. At this time, these sources were not yet available, but large amounts of concentrated ore were brought into Chicago, and methods were devised for refining it.

It was quite clear that they immediately had to face a dust problem in the handling of the powdered uranium ore in the various concentrates. There was a problem of uranium

X-1 and X-2 collections because, as I pointed out earlier, about forty curies per ton of metal develop every ninety days. This gets into the discard and has to be worried about. These things were all being found out. And immediately, Dr. Stone had to organize a group of toxicologists, pharmacologists, and biologists who had to begin to think in engineering terms about airflow and ventilation.

But within a short time--I'd say within three or four months of the organization of the Mahattan District--the [E. I.] du Pont [de Nemours and] Company was given a contract to build the first pilot reactor at Oak Ridge. They were given this contract at the same time that the group were designing and laying the groundwork for the huge reactors which we later built at Hanford. These were just beginning to be thought about. Then they were tied into all of the mining and processing industrial complexes that had to be brought into this situation. This became a vast network of industrial processing from the mines through all of the companies that could be persuaded to take this on, like Mallinckrodt, Electromet in Buffalo, Monsanto Chemical Company, and, of course, du Pont, all of which had a tremendous industrial capacity.

Now it was necessary to train all kinds of people along the line to safeguard these plants when they went up. So Dr. Robert Stone had a group ([Kenneth S.] Cole, [Herbert] Parker, [Clifford L.] Prosser, K. Z. Morgan) who did the biological testing. It turned out that strontium was going to be important as a by-product, as well as some other things; so they did some work with that. They also began to work on the toxicity of uranium. It was about this time that I came in contact with the program. We began to have a clear division in our office of people interested in supervision of research and those interested in industrial problems, such as the specific answers on airflow and dust concentration. The number of particles per cubic meter that could be surrounding a working force with or without masks, for example, and things of this sort became very important.

It was found early that masks were effective, but they cut the working potential of the individual down to about 20 percent of his normal capacity. Also, it had a psychological effect that was bad. If you could fix it so that the workman didn't have the dust exposure or that he didn't have to wear the mask, you got more out of your production, which meant, then, closed operations with large ventilating fans and good monitoring procedures. And, too, the matter of personal hygiene came in. A great deal of work was done by Dr. Stone's people together with the experienced people from du Pont.

Then there was the problem of gloves, of some kind of gown, and footwear in really hazardous areas where contamination might be tracked around. I can remember long conferences over whether sneakers could be cleaned. Shoes couldn't be cleaned very well. There were problems over whether the contract would provide things that the individual couldn't be expected to buy. This was a kind of socialistic decision. Industry very often required the man to buy his own stuff and if he got acid on his suit, why that was just too bad.

Well, this was a war program. It was agreed that it was in the government's interest to provide these things. Therefore, we would buy on contract the proper kind of clothing and apparel that was needed. So we got caps, bootees, special gloves, and special gowns which all could be put on by the individual. This meant that the laboratories or the operations had to have what was called a change house with lockers. There, a man was permitted to change, put his own clothes in a locker, and pick up all of these things. The apparel was specially laundered and monitored to be sure that it was cleansed of radioactive materials.

The first of these change houses was built as a mock-up in Chicago. Later at Oak Ridge, it was part of the full-scale operation of the pilot reactor, which was called X-10. From the outside, this complex was just a big block building with a large chimney; that's all you could see. These change houses all had showers. Then we began to look at the problem of washing the hands of large numbers of people as they came off shifts--how many would have to shower. Drinking fountains with a foot pedal were put around so that if you got something in the eye, you could lean over the drinking fountain, press the pedal, and wash the eye out with a stream of water. There also had to be showers in the corridors so that if a man got acid or contamination on him, particularly on his face or hair, he could run and jump on the treadle and wash down as he took off his clothes. In this way, we prevented a great many burns and other injuries. The full credit should be give to Dr. Stone's group, and to the du Pont group, and a little later--maybe six months later--to Eastman Kodak, because it was soon obvious that Dr. Lawrence's modifications of the cyclotron were going to be effective, too.

This latter program was taken on by Kodak with the intent of building the full production plant--at first a pilot program and then the full production plant--at Oak Ridge. Kodak, which already had a very competent industrial safety group under Dr. James Sterner, began to send men to Chicago for training. Then some of these were sent to Berkeley because Dr. E. O. Lawrence's staff had developed quite a competence, too, in safeguarding personnel against direct exposure to radiation and to dust and other things.

At first, I had no concept of why these people were involved, because this was all secret and I was only told about the troubles. But after listening to some of the seminars that Dr. Stone ran for exchange of information and indoctrination of his own people, it began to be quite clear that the reactor was going to be a big thing and that Hanford, Washington, was going to be the center.

I was permitted to go to Hanford to take a look. There was nothing there but the desert and a big bend in the Columbia. There were a lot of little orchards that had prospered for maybe fifteen years. The peaches were just gorgeous--great big things--just coming into their prime. The people had to be moved off. Of course, they were paid a goodly sum, but it never quite satisfies the nesting impulse of the human, I guess, to be moved off of a place he has worked so hard to develop and where the children have been raised. But a number of them went across the river, and bought land with enough money from the sale of their property to set up again.

Anyway, we found the problems at Hanford began to be quite numerous--particularly, the problem of the contractor. He had something like 50,000 men out there at one time, living on this desert in Pasco, which was fifteen miles away, first in tents and then in barracks and trailers. They were constructing the reactor site, the buildings, and the chemical separations equipment. I had to visualize what was going to happen in the future. It was difficult even for Dr. Stone and his people to paint the exact picture because, often, they didn't know what the design was going to be. In fact, the engineers didn't know, because they were waiting for Dr. Stone and the other experimenters to come up with the figures to say how thick the walls would be, how much the fans would have to push, what kind of electrostatic precipitator arrangements and other dust collecting devices might be required, and so on.

It may be interesting to record that Mr. [Robert G.] Le Tourneau got the contract to develop this great big earth-moving monster. There is a diesel engine up in front on two wheels, which draws a huge bin, that scoops the earth as it goes along. These were designed for the Hanford program. It was interesting to go out there to inspect what was going on and to go by the site where an enormous hole was being dug. There would be a tractor pulling and a tractor pushing this big monster which had, of course, special tires which were tremendous. I guess they could pull thirty or forty cubic yards of earth. Even then, they could travel thirty miles an hour with a full load, which meant that they could move dirt at a fantastic rate of speed. There was this great big hole being dug right out in the desert with nothing around, and about a mile away a great big building was going up.

TUSLER: People must have wondered what was going on.

WARREN: Yes, well, I got word that there was a meningitis epidemic among the contractor's personnel. (This was before any engineers and scientists were out there at all. Those people were all in Chicago and other places, making drawings, making arrangements, and training personnel.) There wasn't much you could do about meningitis at that time. Sulfanilamide had not really been tried and all we could do was to isolate the people. Well, the contractor had his own doctors. We got in touch with them, and I went out there to make a personal inspection.

About all we could do was to isolate the patients and those who had had close contact with them. Fortunately, the epidemic died out in about ten days to two weeks with no new cases. You can imagine how difficult it would be out in the desert in a tent to have isolation precautions with water and antiseptics in bowls, standing on little tables. It was so hot and so dry the water would just evaporate in a little while and was hard to come by. Fortunately, flies weren't a problem, and there were no mosquitos and other things to help transfer the disease. I think that, in general, in a group, meningitis is transferred by coughing and by contact, so that in this dry area the moisture in the little droplets from any coughing, just dried up right away. The bacteria were just blown away or fell to the ground and were killed by sunlight. By separating the patients during eating and working, the epidemic fortunately quit. Now if it had spread we would have had a mass migration of the personnel, and the whole operation would have been shut down. So it was very important to get this topped. We brought in a few doctors as consultants. Today, we would have had less trouble; but you remember what we had at Fort Ord--a report of some inductees coming down with it, and a few deaths. Even today we can't really say we can stop it with drugs in every case.

TUSLER: Were you in charge, at this time, of the safety regulations at Hanford and for the whole overall program?

WARREN: Yes. But I wasn't yet allowed in at Los Alamos, New Mexico. But we did set their policies. Anything that Los Alamos did in the way of handling these metals or the ores or other things followed the same policies that were used in Chicago and, later, at Oak Ridge. These policies began to develop at Rochester, and some research was done in Berkeley by Dr. [Joseph G.] Hamilton and Dr. [Kenneth G.] Scott and by some others there.

Now while we're still with the Chicago program, it was quite clear very early from the Fermi reactor experiments that they were going to have to have large amounts of graphite fabricated. One of the questions was "Would we have miner's lung disease (black lung), because it was a very dusty operation?" The answer turned out to be no because there was no silicon. The carbon had to be so pure that there would be no silicon in it. Carbon is a reflector and prevents the neutrons from scattering out of the reactor. They're reflected back so that there is more efficient use of the neutrons in the fission of the uranium.

The Germans were using heavy water, or had planned to use heavy water for this. The British, too, had started on some heavy water production. The Norwegians also started heavy water production. This is why the Germans went into Norway so early, so they could get these hydroelectric plants where heavy water was produced. But heavy water had a bad problem. The Germans were prepared to freeze it. Well, you can imagine the problem of putting it in ice cubes and keeping uranium in valuable heavy water baths, because when uranium fissioned it would produce tremendous amounts of heat. One of the reasons for putting the reactors out there on the Columbia River was not only the land and the power supplies from the Bonneville Dam generators availability but also because it was near the water for cooling. It's very important to have huge quantities of water. Well, the Germans never got that problem solved. They never got quite that far. But this was one of our problems, anyway: to see that every step of every operation was devoid of hazards.

We got into the use of beryllium early, because beryllium was one of the metals that could stand high temperatures in ceramics. It was used also in some of the control rod operations, although other metals came into this, too. The point was that these metals have a high cross-section capture for neutrons, and if they are put in the neutron field, they absorb them and keep them from being available for the fissioning of the uranium. They could be used as a control. The neutrons would be reflected by the carbon and then could be absorbed by putting rods of these other metals down in the middle of the uranium bath. This is like the throttle on an engine.

There were lots of problems with the design, the fail-safe, and the shutoff. The rods were put in at the top and they could be put in all directions, of course. I think in the Fermi experiment, they were put in from the side, because Dr. Fermi and the other students tried to push these in and out. You can imagine the thrill they must have had. This is very dramatically described in Mrs. Fermi's account of Enrico Fermi's life, how they listened for the clicks on the counters which they had developed to detect radiation. When they pulled these rods out, the counter rate increased. When they pushed the rods back, then they diminished; and they had the control right there, you see. This was the whole mechanism for the reactor. After that, it was just a matter of proper design to handle the power it developed, the heat, the gases like zenon and iodine that came off, and a lot of other incidental problems --leakage, distortions, swelling from high temperature, and all these things. But, in principle, a reactor is a very simple thing, once you get all these safeguards and the heavy concrete built in to stop the gamma rays, the neutrons, and other things that are emitted. I don't think that they're inordinately costly. I don't see why they haven't gone ahead faster with developing them, particularly in the desalinization of water which is always a tantalizing problem.

Well, I had a couple of very interesting physical experiences at Hanford. One was in inspecting the first reactor. They built the foundation and all the plumbing arrangements. Then they erected a cube about thirty feet high in which the reactor was to be assembled. It was sitting right out in the desert without any buildings around it. They were beginning to bring in the big two-foot-by-six-inch graphite blocks which were to be assembled. Eventually, there were to be holes in this wall where they would put in the uranium and control rods.

Colonel [Kenneth] Nichols (later General Nichols) and I went out on this inspection trip. The only access was at the top, which was where a lot of things were loaded and a lot of controls would be. They had to be sure that there weren't a lot of cracks or defects in the concrete. This was obvious, of course. So much was inside and hidden, so it would be difficult to detect it in a wall, but you can pretty much tell whether the concrete work is good or shoddy. You can also tell how much rock there is in it and what the mix is, just from looking at it after you've seen a lot of it. Of course, Colonel Nichols was very expert at this, being an engineer as well as a good chemist.

Well, we approached in a car, got out, and walked over to this concrete mass. The only access to the top was through a contractor's little elevator rig run by a small gas engine. When the gas engine turned on, the mast where the platform went up and down sort of trembled in the air. The platform was big enough for a wheelbarrow and a man, not much else. It was about six feet square and was supported on one side of the mast as it went up and down by a track and a chain to pull it up and down.

Well, the elevator operator was what you'd call a hard-headed "bull-hunk." He looked at us uniformed brass who wanted to be taken up. Well, the foreman had told him to take us up, and the foreman was always right! So he said, "Well, you get on this platform and I'll hoist you up and you can walk off."

So Colonel Nichols and I looked at each other, and he grinned because he'd done this before and I hadn't; this was my first trip. I was a little apprehensive because I have altophobia on that kind of contraption. Although I can climb around mountains quite well, I have trouble with buildings. Anyway, I got my courage up, and I walked up nonchalantly with Colonel Nichols and stepped on the platform. We hadn't anymore than landed on it, when the fellow gunned the engine and we went z-o-o-o-m, right up about twenty-five feet or so! We trembled and wobbled up there. You were looking all around at nothing, and there was about a six-inch gap between the platform and the building. That gap was just a horrible barrier to me, but I finally made it with great effort. I guess I was pale. I know I was sweating freely. But that wasn't so bad as wondering if I had the nerve to step on it when we came back, you know.

We spent about an hour looking this over and finally agreed that everything looked all right. And, of course, it would be tested after they got the reactor in, with very careful measurements all around to make sure that it was not full of voids and holes. Well, the time came to go down. Colonel Nichols, of course, deferred to me, I being the doctor. He and I had the same rank at that time, but he was my commanding officer. And so there was nothing for me to do but almost close my eyes--which I almost didn't dare do because I might step in the wrong place--and step across the six-inch gap out onto the platform which had no sides or anything.

TUSLER: There was nothing to take hold of?

WARREN: Nothing to take hold of. Then I could see the fellow down below, looking up with a big grin on his face. I knew he was just going to fix us, because this was the only opportunity he had for any fun, you see. So the platform just dropped like a sky rocket, going the wrong way, and then bounced up and down. Fortunately, we were both able to keep our feet, but I guess we must have bounced four or five inches off the platform until it settled. I almost stumbled in stepping off of it, because you had to drop about two feet to the ground. But I managed to make it with the best grace I could, very nonchalantly. We thanked him, with a broad grin on our faces, too, and we understood perfectly what he had done to us.

The other experience occurred when we finished the vats for the chemical separation of the residual slugs of uranium metal. There'd be a lot of uranium that hadn't been fissioned. Of course, the rest of it was called ashes.

It's all radioactive material with some stable isotopes derived from the fractured uranium atoms. These slugs are pushed out of the reactor with a rod and fall into a bin on a track which takes them over to a big pool of water. This runs them down to the bottom where they can be looked at from above. At that point, they're so radioactive that they glow. They have the same bluish glow that's above that atom bomb picture [on the wall]. It's known as Bremsstrahlung. Strahlung is rays and Brems is brake. You could see the slugs down there. Then they were transferred to big vats of acid. The metal was dissolved, the chemical separation occurred, and then the uranium salts were recovered. The rest--the ashes--is set up for storage. You can't just throw it out because it is radioactive, and this became quite a problem: What in hell do you do with these ashes, which are now in a brine? This is the best way to handle them, because as a dust you can't handle them very well; the brine can be used as a secondary source of heat. There's so much radiation given off that when it's absorbed, it becomes degraded to heat.

These big separation vats, which were to be full of ashes and other solutions, were about seventy-five feet deep. This is what these tractors had been digging out in these canyons, as they were called. They were strung in a row. Each canyon was about 200 to 300 feet wide and 500 feet long and almost 100 feet deep. So this made quite a hole, with the sides constantly falling in. It was all desert sand, fortunately, but it was easy to move the sand and gravel. Well, they had finished the pouring [of] the concrete in them. They were shaped like a flask. They had a narrow top and then were expanded about three times their diameter as they went down all that distance. There was a rung ladder that was put in the concrete like a fire-escape ladder. And "little Willy" had to go down that to look for cracks.

Well, I understood that Dr. [Herbert] Parker, who was to be the radiological safety man for Hanford, and who was being trained in Chicago, had anticipated me and gone all over this a couple of days before. But he wasn't there when I arrived. I only heard about it from the foreman, so I went to do my own inspection. He said, "Dr. Parker's been all over this; you don't need to." I said, "Well, I'm responsible and I'll have to." That was a foolish thing to say because I hadn't yet looked at the pit.

TUSLER: Had you known!

WARREN: Well, the trouble was that when you went down in the bottleneck and then went on a reverse curve, your feet tended to hang out in the middle of the air. It wasn't so bad going down as it was coming up, because you had the physical effort of climbing. Of course, I had my paratrooper boots on. This was a great help in this kind of inspections because you had hard, solid footing that you could deal with. The only other way to have done it was to have gone barefoot. Then you could have perhaps clung with your toes, but it would have been painful because the iron was rough and you would have gotten your feet scarred. Anyway, I think I lost ten pounds in the descent and ascent. [laughter]

It's safe to say there were no cracks, because if there had been cracks, there would have been leakage--leakage into the water table of very high radiation intensity material. There was, of course, a good deal of evidence that the water table was connected with the Columbia River. This had been a former channel of the river. The bend had formerly been straight and was now full of gravel and sand that had been deposited there by flood action. So the water table was probably almost at the level of the surface of the river. It would have been very easy for this material to spread there. This was later verified to some extent by the drilling of wells all around the storage pits, because large underground reservoirs were made to pipe this waste radioactive material into them for storage. These were made double-walled. Of course, this wasn't required until about a year later. In fact, the big storage reservoirs weren't really used very much until after the war.

TUSLER: What happens to that material eventually? Does it just collect there?

WARREN: The hope is that some use can be found for it. They mine some of it for isotopes. The long-life isotopes are very useful for various things. And if you come up with a real use for it, you'll get a prize.

TUSLER: I'll go to work on it! What would have happened if you had fallen back into the pit? You just would have been so filled with what?

WARREN: Well, there was nothing in it at the time. This was before anything was done.

TUSLER: I see, yes.

WARREN: Anyhow, all kinds of arrangements were made for transporting these uranium slugs from the reactor to this area on a railroad car which had automatic loading and unloading equipment. The car was pushed by an engine quite a distance. There was lots of lead for protection between the load and the operators. One of the interesting things was that these big extracting vessels, as they were called--really big reservoirs--were controlled by valves which had to be operated by magnetic wrenches behind an eight-foot-thick wall which was about fifteen feet high. It was here that television first was applied to large-scale, industrial operations. A man sat on a little movable platform tied into little rails. He went up and down the big barrier with his television camera and his controls of the wrenches, which were on cranes and tracks on the other side of the wall. He couldn't see them except by the television. This operation was conducted quite accurately and safely for many years, although it was one of the first operations of this kind of hidden control.

TUSLER: When was this? During the war years?

WARREN: Oh, yes. This was built as part of the beginning design. How else were they going to control these valves. They had to change pipes, too, for several reasons.

TUSLER: Television was a very new thing then indeed.

WARREN: It was very new and it wasn't until a little later at Bikini that they used television to watch the control panels of drone planes that were devised. That was right after the war. The drone planes had just begun to be thought about at the end of the war. Really, this was the beginning of rocketry, you see. They were fast little planes. I showed you a movie of some of them, didn't I? Well, I'd say this was done in 1944 because these reactors developed enough plutonium to make one of the bombs. This meant that everything had to go full scale all at once. Actually, the X-10 operation at Oak Ridge anticipated the full-scale operation at Hanford by only about six months.

But the answers provided by the reactor experience at Oak Ridge were vital to the conduct of the operation at Hanford. Every bit of information that was usable in any way was used across the whole Manhattan District and across all the industrial companies. You have to give industry and their administrations tremendous credit. They conferred with each other--there were no secrets-- and they disclosed all of whatever was necessary to carry out an operation.

TUSLER: It was a tremendous job of coordination.

WARREN: Oh, tremendous, yes. It's interesting that General Groves and General Nichols were able to fit in this coordinating role so well. And the university group, too, was able to fit with the industrial group. While vocally objecting to all the controls the army put in, chiefly the security and the secrecy part, nevertheless, they liked it, when you came right down to it, because they felt it was important. They also felt they were doing something for the war effort which, if successful, might end the war. And I think it did. I think it saved about half a million American lives. Many Americans would have been killed if we had not dropped the atom bomb on Japan.

I think that's pretty near enough about the Hanford operation except a final point. After the contractor got through and moved out, Dr. William Norwood of du Pont became the local administrator of the medical problems and Dr. Parker became the administrator of all safety, industrial inspection, and of safeguarding measurements. A tremendous amount of instrumentation was developed by the Chicago group for the Hanford operation. It had been tried out at Oak Ridge. In fact, the last year of the war, maybe a year and a half, Dr. Stone moved most of his experimental group down to Oak Ridge to make actual measurements of the intensities from the X-10 reactor.

Of course, we were all interested in the meteorology of Oak Ridge because it had inversions of air currents. If something toxic came out of the stacks of the reactor or the plants, we had a population of 70,000 people that we had to worry about. Professor Phil Church studied Hanford weather very carefully. These reactors, by this time, were known to give off radioactive iodine, which was a gas, and which became zenon, a noble gas. This was stable after that and inert, but this was to be a problem. So a lot of work was done with radioactive iodine. Dr. Church also devised meteorological towers from which he let off smoke in order to analyze the air currents. By the time the reactors were ready he had quite a bit of information on the average meteorology of the area in that desert. Inversions there were quite prominent also.

This information, however, didn't help me later in the worries about the first bomb test and what would happen to the fine dust, but it did give me a general appreciation of the mechanics and the possibilities that were present. Dr. Church and I used to have an hour or two of discussion whenever he and I could get to Chicago at the same time. We would try to figure out what would happen--how all these things would mix. Of course, meteorology, in spite of what people may say about it, was an art without much real foundation. Dr. Church's experiments with smoke were among the first real precise data-collecting experiments. And then, of course, later, I felt that a careful watch of the detonation of atom bombs would be just the world's greatest and best tracer experiments for weather, because you could identify at the time where all this stuff went and you could measure the amounts that got there. This is a lovely thing. It took about five years before the Weather Bureau got to the point where it was interested.

TUSLER: Where were you based all this time? Were you still in Rochester?

WARREN: I moved my family in November 1943, to Oak Ridge. It was considered that this was important, that this would eliminate any chance that somebody would do something to my family or children, or that they would begin to suspect that I, as a radiologist, was more involved in something than I should be from just some general scientific reason.

The policy was to move people there. We had a hard time renting our house, at first. I think I told you I got all the water system frozen up, but I finally sold it at a depressed price. We put the money in E bonds. Then I was suspect. Who had paid me off for secrets? Even today, our income tax is always reviewed. They start back with the war years financing and how did I get that money that I put in E bonds. Well, once you're in a highly classified program your life is an open book and everything must be suspect.

TUSLER: Why were you worried about your family? I don't quite understand that.

WARREN: Well, I don't think it's unrealistic at all. The security people had quite a number of tales--not of any of our people yet but of those during the early parts of the war--about people who were intimidated and even killed. Operators were killed.

TUSLER: Were they killed for information?

WARREN: Yes, and also they were getting too much information about the Germans and the Russians and others. The ones that were feared the most were not the Germans or the Japs but the Russians. I got a lot of this information from [Peer] de Silva, who was a security agent from Los Alamos. He was a very fine young man with a family that he had moved to Los Alamos. He had had personal friends killed in

Washington in an alley, you know. It was quite clear that this was done by Russians. So the price was awfully high. In any case, we didn't want anything to leak out; so the best way was to move people down.

TUSLER: How much did your wife know then of what was going on?

WARREN: Nothing.

TUSLER: Nothing. She just knew that you were doing something.

WARREN: Only the day that the bomb was announced over the radio did any of the women know. I think that's true of Mrs. [Arthur] Compton, who was called Mrs. Holly out there in Oak Ridge. I described that part for you, didn't I?

TUSLER: No, I don't remember that.

WARREN: Didn't I talk about the school children and the navy men and the scientists getting some name other than their own so that anybody picking up a personnel roster would not suddenly suspect the collection of large numbers of physicists and chemists in one city? The children were registered in school by their first names and the final initial. My children were Roger W. and Dean W. and the graduation announcement was made that way.

TUSLER: At Oak Ridge?

WARREN: At Oak Ridge. And Viola could tell you I brought home a lot of people and said, "This is Mr. Smith." And

I never mentioned the name again. We talked about innocuous things. The women were always curious as heck, but they realized that this just wasn't to be talked about so they didn't press the issue.

TUSLER: They knew something big was up and that was it.

WARREN: In fact, the houses were allotted on the size of the family and not on the rank. So you couldn't tell whether it was a plumber with five kids that had the big house or that the Hollys were Nobel Prize winners. The Comptons had the smallest house because they had only one boy and he was away in school, so there were just the two of them. It was the same way with Colonel Nichols; he had a small one. We had two bedrooms because we had two boys living at home and going to school.

TUSLER: It was real democracy, then.

WARREN: Yes, and the women would have a little tea at three o'clock. It probably rained like heck so everybody took their shoes off on the porch and left their boots or galoshes on the porch and went barefoot inside in order not to get the house muddy. You couldn't tell until after the bomb dropped who was the plumber, who was the scientist, who was this, and who was that. Obviously, some were better educated than others, but that was all. It was a lovely environment. Everybody was on his own merits, really.

TUSLER: A special world.

WARREN: Yes, for the time. Well, the Chicago operation spread for training into the Berkeley area where Tennessee Eastman Company was training some safety people under Dr. Jim Sterner. Then there were various contractors involved in the building of Dr. Urey's proposal--the gas separation procedure. We didn't get into this until kind of late because they'd had great trouble with the nickel or finding the proper barrier. Well, to go back.

There were four methods to split the atom. The Chicago one was the reactor. The Berkeley one under Lawrence was amounting to a cyclotron, which really was a tremendous mass spectrograph. It had an ion source in the vacuum. The scarce uranium and the common uranium was fed into the vacuum. Under high voltage it was cast down a tube past a magnet. Then the magnet would separate the heavier particle from the lighter particle. The lighter particle would be shifted enough so that if you had two slits at the other end, the heavier particles would go in one, the lighter particles would go in the other. So you could separate the rare isotope from the more common one. The reactor made plutonium, and the other methods separated the common isotopes from the rare isotopes.

A great deal of the experimental work of Dr. Lawrence's program was done with the big cyclotron that he had built with Rockefeller funds. And others were built as pilot programs. Then the design was laid for making a whole series of these in a rough circle at Oak Ridge. This was called the race track because it was a huge area. As a matter of fact, there was something like enough steel and iron for a couple of battleships that went into the magnets at Oak Ridge.

The safety requirements were essentially the same. You had the X-1 and the X-2 problem. Then you had problems with the source of these mass spectrographs because the voltage that was required to throw the atoms from one end across this vacuum past the magnet was about 50,000 volts. So when you had a filament which caused the ions to be produced, you had in a sense an X-ray machine. So boys who looked at what was called the arc to see if the beam was going in the right direction got their eyes exposed. Cataracts in the eye were one of the hazards that developed.

Now one of the processes used and developed chiefly by Tennessee Eastman was the conversion of the uranium to uranium chloride by use of carbon tetrachloride. Carbon tetrachloride has an unfortunate property. When it's put on a hot plate, or gets hot, it produces phosgene gas. This is why carbon tetrachloride fire extinguishers have gone out of existence. Because if you use it to put a fire out in a closet, you get phosgene gas. You can produce enough to kill some people.

TUSLER: You mean it's lethal?

WARREN: Yes, it's a war gas, quite lethal. So I went to the Chemical Warfare Service at Gravelly Point, right out of Washington, to ask what kind of diagnostic procedures they had for detecting minor changes and how lethal was it and so on. We had to worry about this.

Well, in fact, we lost a chemist at Berkeley in a very interesting way. He had been working with carbon tetrachloride as a solvent in part of this process. He had broken his arm, and so his arm was in a cast. He was working at his desk with these materials and had about 200 cubic centimeters of carbon tetrachloride in a flask which he had in his hand that stuck out of the cast. A long-distance call came in, and he tried to manipulate the phone and this carbon tetrachloride. In the process he dropped the vial, where it broke right in front of him while he was answering the phone. He had a couple of breaths of very high intensity; he became very sick. Fortunately, Dr. Sterner was there at the time and put him in the Cowell Hospital, which is on the Berkeley campus essentially across the street from the lab. They tried everything that was known, but there wasn't much known. There still isn't much that you can do about it. The chemist evidently developed acute heart damage. They had just taken an electrocardiagram when he died, just like that.

And he was one of the very important chemists. He was second in command, actually, of the chemical processing of these procedures that backed up Dr. Lawrence's effort.

TUSLER: What was his name?

WARREN: I've been trying to think of the chemist who was there. I used to see him every month.

TUSLER: Never mind, we can fill it in. [Stanley Reuben]

WARREN: Well, I can find it out. We'll have to get this sort of thing out of the records. We can do this when we go over the file and get the manuscript down. At Berkeley they were also working with thorium. The biggest known source of thorium was the black sands of India. And we had some black sands in Alaska. The question was, "Could thorium be fissioned as easily as uranium?" All the calculations, theoretically, showed thorium as a pretty good power producer, but there are problems with it--none of which I remember. I can look it up. But, anyway, they had put most of their effort in the uranium and they thought that this would be the metal to stick with, but it meant that we had to devise some experiments to find out how toxic thorium oxides were, along with other thorium salts which would be used in its processing. This was kind of a second order of priority. Dr. Harold Hodge and Sam somebody in the Sinai Hospital in Chicago took on feeding experiments to determine the toxicity of these salts. And then, towards the end of the war when it became obvious that they weren't going to use thorium, this was not carried beyond the preliminary stages.

I didn't have much problem with the Berkeley people because Dr. John Lawrence, Ernest's brother, and Dr. Joseph Hamilton had already laid down the safety criteria for the cyclotron operation. John had gotten interested in some navy work so he didn't participate much in this, but we relied on Dr. Joseph Hamilton. Dr. Hamilton had easy access to all the new fission products from the cyclotron group right there and then doing what we call quick and dirty experiments. First of all, they determined whether it was a highly toxic material, whether it was a bone seeker that destroyed the bone marrow, how rapidly was it excreted, and so on. He was a beautiful experimenter; he did all of this on three points per dose level, which meant three rats. It was very cheap and very quick. And he could sacrifice his animals at intervals of days or weeks. He would come to a meeting every month and give day-to-day reports. We considered him a kind of explorer. He didn't want to do any of these long-term, big-scaled things. He was not that kind of an operator. He had a mind that was very quick and very imaginative and he could take these small amounts from the cyclotron and in a very short time [finish the experiment].

TAPE NUMBER: X, SIDE TWO

JULY 28, 1966

TUSLER: Dr. Warren, we've just been viewing a film made by the Japanese of some of the aftereffects of the atom bombings. I wonder if you'd like to go on and comment on that now on tape.

WARREN: These films were originally on 35 millimeter film. They were moving pictures taken by the Japanese and obtained by the United States [Atomic] Bomb [Casualty] Commission which was studying bomb destruction of all sorts in Europe and in Japan. They had collected about 40,000 feet of this film material, had cut it up, and put some comments on it. But when looking at them just as 35 millimeter film, they were so dry after all this time--since 1946--that they kept breaking. I was able to get the Laboratory of Nuclear Medicine to get them reduced to 16 millimeter with sound. This improved the lighting somewhat and made it possible to use a normal projector, which means I can look at them whenever it is convenient. However, the clips are so short--ten to fifteen seconds--that you just about get your eye fixed on some object and then the scene changes. It's hard to study what is there. It's difficult to hold a frame because you might burn it and these are pretty precious.

I got these right after the war as duplicates, mainly to preserve them historically, never realizing that these films would have been viewed and then essentially filed. As far as I know, almost no use has been made of them since the war. It may turn out that there is very little here that would be useful, however.

I have, as you know, showed them to you earlier, as well as the pictures of the Bikini detonations and of the attempt by the navy to clean up the contamination from the underwater test and the difficulties attending that. These films were prepared for the civil defense educational training programs. It might be possible, out of this group of films I'm looking at now, to get maybe a thousand feet that would be quite suitable for training. If so, this is what I'll try to do.

Unfortunately, when the commentators ran out of words, the military put in background music which isn't very appropriate. I don't know why they do this. We constantly objected to this, all of us. Things like this were being made after the war, particularly the simulated noise of the atom bomb, which was a very synthetic affair. Actually, the noise of the detonation is kind of a rumble. The expansion of the blast waves are so slow from the detonation that you get a push rather than a sharp blow. And that is almost impossible to imitate in movies.

TUSLER: Why didn't they record the actual bomb sound itself?

WARREN: Well, they have several times, but it was considered to be such a peanut noise. [laughter]

TUSLER: It's not dramatic enough!

WARREN: Nobody would believe it, you see. But this phenomenon is called brisance. This is a rather indefinable term, but it relates to the speed and force of the explosion of dynamite, baritol, and other high explosives used in artillery shells. They have a very quick beat and this is why they give such a sharp noise. The frequency of the compression pulse is very high. On the contrary, with an atom blast wave, the pressure rises, hits a kind of a plateau, and then diminishes. And there are almost no frequencies separate from that one pulse. Therefore, it's a kind of a disturbance and a push rather than a vibration.

Well, anyway, I've looked now at seven rolls and it's kind of a sad thing to do. Even though it was taken in October and November, the scene looks very much as it did earlier in August, with the exception of the grass and some of the other things that have grown. You have to remember that it rained and that this was the typhoon season. That's why we had to leave when we did. The typhoons were coming in. A bad one hit Okinawa just the day after we passed Guam on our way home. We would have been badly shaken up, perhaps, if we had been in that.

There's little change in the debris and no cleanup yet in these films. Of course, some of the streets have been cleared so that vehicles can now get back and forth; but, in general, it shows the rubble from the collapsed buildings and the disintegration of some of the larger buildings. The one that is still there has been made into a museum in Hiroshima. It had a dome and was an old observatory. It is now skeletonized. And the building is canted and looks almost ribald, you might say. It's still preserved. We were there five years ago and that's unchanged, but all the rest of the city has been built up.

Well, the contamination studied by the Japanese was in the areas of these films. They show the use of electroscopes. They had no Geiger counters available for field work at that time, though they had some in their laboratories. So they depended upon electroscopes. One of the films was collected by Professor Yoshio Nishina, who was their prime nuclear physicist at that time. It was he who told the military and the emperor that this was an atom bomb. He was responsible, in the advisory group, for answering the three questions which the military posed. The military found out the next day that the emperor had asked the same three questions, "Is this an atom bomb?" And the answer was "Yes." And "Can we make one?" And the answer was "No." And "Is there any defense against it?"

And the answer was "No."

Well, I think this is a very interesting thing to record. I was told this by Admiral Masao Tsuzuki, who was my guide and protector when we went through Hiroshima and Nagasaki. He was present when this interview occurred. He was part of the party because he was a medical admiral in the Japanese Navy. He was also very friendly with the emperor. Since this was something that they could not make or defend against, it was now in the hands of the Shinto gods and was not something that the Japanese had to deal with or to face. They, therefore, could surrender without committing hara-kiri. This was a very important consideration. Because if it were beyond them, the whole nation could surrender, because the emperor had surrendered, without committing hara-kiri.

Now, while we're on this subject, I might as well tell you what I learned in these evenings when we were grounded by the beginning monsoon. While we were trying to survey Hiroshima and Nagasaki, we would have a dinner composed of "kennel rations" and maybe a little Japanese fish and some other things that they could scrounge; the Japanese had nothing much available for us. We were living in Hiroshima and stayed in a boys' military training school, so the bunks were all too short for me. When I went to bed I had to keep my shoes on because, even with the net over the whole bunk, my feet would come up to the screen and the mosquitos would feast deliriously on my soles! [laughter] And I had to keep my hat on at the other end for the same reason.

TUSLER: Where was this school, just outside of Hiroshima?

WARREN: It was on the edge of Hiroshima, behind a hill, so it had not been damaged very much. It was on vacation so there were no students there. Most of the students had gone to work in the fields--that is, in the rice paddies and farms in other places throughout Japan. This is why the mortality among the children was so low in both of the cities. (In Nagasaki the same thing was true.)

Well, anyway, I think the Japanese military were convinced that they were going to lose, but that they were going to make the price awfully high, as high as they could. When the final day came, they all were going to commit hara-kiri. It was also the understanding throughout the nation that the prominent people would, too, and that most of the people might also commit suicide. The evidence for this came from some of the islands that were bypassed where Japanese families walked into the ocean and drowned and where some of the military committed hara-kiri. Others just stayed holed up, not believing that it was possible for the empire to fail.

I described to you, didn't I, the doctor's duty to execute his patients who couldn't walk out. Well, I think I talked about Matao Motohashi, who was Admiral Tsuzuki's aide. He was a major and a medical man, a cardiologist. He had not had to do this himself, but his brother had. His brother had told him with great distress how, when they had to leave a site because of the enemy approaching, the doctor would go around--these were his orders--and order everybody out. Those who could walk out went. After a little while, when all those who could walk out had gone, he'd come back and urge those who were still in bed to get out. If not, then he handed them a hand grenade. They were supposed to commit hara-kiri with this. After a suitable interval of four or five minutes, he would again go around with his pistol. Those who had not had the nerve to use the grenade were shot. It was his duty to shoot them in the head so that then he could move out and follow the evacuating troops. Thus, the advancing enemy, namely us, would find nothing but dead Japanese and nobody to help--either to give information or to be against them.

Now, I don't think this was a protection against assistance to the enemy so much as it was that these people didn't consider death the end of all. It was supposed to be the beginning of something better than what they had. During their charges if they yelled "Banzai!" this was the welcoming in the Shinto religion to the hereafter. They were announcing their coming. So they could throw their lives away with perfect freedom. It's quite a different thing where we try to preserve everybody. We feel that it's a duty and part of our ethic to do everything we can to preserve life. Their whole idea was to have the soldier able to fight. If he wasn't able to fight, then he wasn't a member to be kept alive. They paid no great attention to wounds and suffering except from the point of view of keeping the military in the field and active.

It seems to me that I told you about their whole policy as it was established at Mukden when they went into Manchuria and finally cast the die for their Asian empire. The rule went around that every woman should have a child every year. I told you that, didn't I? Well, this I'm sure was quite true. It was part of this same Shinto philosophy. The whole thing was a sort of a biological approach without any sentiment, or without the kind of sentiment we have.

I think the Japanese are a very sentimental people, very sensitive, very proud people, but in an entirely different way from our approach. I wouldn't have felt comfortable in this environment if I hadn't been raised in California and had many Japanese as my associates. I could understand some of this fairly well. And did I describe the visit to the Shinto shrine in Hiroshima?

We landed on the field in a DC-3 with considerable difficulty because the field was potholed with bomb craters. There was a welcoming party composed of the local mayor and just scads of cases of beer. Apparently the Russians had been there from Tokyo the day before and left just before we landed. They had demanded beer and all kinds of things and threw their weight around quite considerably. The Japanese couldn't understand the fact that we didn't want the beer, that we didn't want any celebrating, but that we wanted to get to our hotel as soon as possible because we had to get our Geiger counters all callibrated so we could get to work the next day.

We were taken from the airport in a bus that had a big funnel on the front dashboard, to the right of the driver. There was a five-gallon glass carboy on the floor in the front. The engine was on the front, as usual; but on the back they had an arrangement where charcoal was burned with a minimum of air and produced a lot of carbon monoxide, which was combustible. They had a crank on the charcoal burner which would enable the driver to fan the charcoal and get it glowing. Then he'd get back in, his associate would pour gasoline into the carburetor, he would start the engine and turn on the carbon monoxide. If everything was going right the engine would continue to run but at greatly reduced power. This had to be done because of the shortage of gasoline, which they wanted for the airplanes. This was the way they ran most of their buses. Everywhere we went we'd see buses stalled, with the chauffeur out back trying to get the charcoal to glow.

It was quite a sporting proposition. When the engine started to choke, the driver's companion would get up and pour a little gas in the funnel, with the truck bouncing all through the potholes. Frequently, the gas would spill all over everything. If we had had a fire we'd have been in a lovely mess.

Well, we drove out to a ferry, the normal transport out to an island. We returned there five years ago. There was the same ferry, the same gates. Anyway, this is the island which was a big resort area. It had lots of hotels on it and places for the Japanese to have a vacation. It was covered with a park, lots of monuments, lanterns, and paths, but no vehicles. Right near the ferry was a huge very old shrine with the gateway out in the water. The trunks of the gateway were made of great big cedar logs about six feet in diameter, very old. It looked just the same when I was there this last time. Anyway, we were walked from the ferry about half a mile up into the park and were bivouacked in what was a very famous restaurant and hotel. We, of course, landed all dusty and dirty and hot; so we wanted a bath. There were about twenty of us: GIs, officers, and medics. The GIs were sergeants who carried the Geiger counters and batteries and stuff.

Well, we were all bivouacked in little houses which they had around. Colonel Ashley Oughterson and I were bivouacked in a hut that was fifty feet or so up the path from the dining room. This house was a typical structure made of very thin--almost cigar box thin--wood and lots of glazed paper. We took off our boots at the entrance and put on geitas, wooden slipper-type shoes with thongs between the toes, left our barracks bags there, and got undressed.

There was a maid, of course, and she kept ducking in and out of the room and giggling. When she saw us in our shorts, going down to take a bath, she was horrified. She made signals to wait, ran out, and came back in a couple of minutes with kimonos. Well, Colonel Oughterson was about five feet eight, so the big Japanese kimono just about fit him. But it came almost to midthigh on me. [laughter] Oh, the giggles that that caused. Anyway, that was all they had and so there was nothing to do but accept. We tried to walk down the path to the bathhouse a couple of hundred feet in these wooden slippers, the kimono clutched tightly about us, carrying a bath towel which they had found.

Well, we did get down there, and there was another maid. She wouldn't leave the doggone bathroom. So we decided to just go ahead and take a bath--the heck with it. After all, these were conquered people, you know. So we proceeded to get in the tub. This tub was about six feet square and was made for about eight men. There was another room that was made for about the same number of women. Well, the men had all the priority. The oldest man used the water first. Then the younger men down to the youngest got through. Then the water went over to the women's side, and they could have the water.

TUSLER: They all used the same water.

WARREN: All used the same water. The water was awful hot and after you had dunked awhile and softened up all the material which had contaminated you--dust and so on--why then you soaped up and the maid came in with a bucket with less hot but still very warm water and poured this over you while you stood beside the pool. Well, of course, she couldn't pour it over me because she was only about five feet two. I wasn't about to have this happen and I was quite a bit embarrassed, you know, being stark naked. Colonel Oughterson was, too. We were not used to this, so we got her shooed out of the room. She left two buckets of water which we poured over ourselves. The giggling that went on outside was just hysterical. You can imagine all those women around trying to get the Americans through the bath process. Well, we did get through and we got back. And I'll tell you, walking over gravel paths with wooden slippers that aren't fitted for your feet is just something, and to try to do this with any dignity at all-- [laughter] Well, we didn't worry about the dignity.

When we got back, we dressed and went down to dinner. No women served us at night. But since we were very orderly--we did not get drunk and we didn't throw things or anything--the women came out the next morning. Also, I had purchased and paid fifteen cents cash in American money for two little wooden frogs, which I brought home. I thought they were very nice carvings. They fit in my pocket. I was offered them free. But I said, "No, the policy of our government is not booty." Of course, the Japanese, on the other hand, had stripped everything everywhere they had ever gone, so the word had gone down in our ranks, "We're not to have booty stripping. We'll have no assaults or rape. Be polite and don't cause any row." In any case, we were there without any protection. General MacArthur hadn't moved in yet. We were the first ambassadors of our country, you might say.

Well, the next morning, as I said, the women appeared to serve us our breakfast. I ought to say that we slept that night rather uncomfortably, not physically, but in other respects. For the bed had a great big kind of a mattress roll of cotton batting. It was a comforter arrangement which they store in the little cabinet on the side wall. You don't think the room has any sleeping arrangement, but they just move the furniture back a little and out comes this bed.

Well, that was all right, but here we were in the enemy's country. The surrender had just occurred a couple of weeks earlier. This area was not yet pacified. Our troops had not yet come in. So what to do? Well, we all had a little session and decided that the best thing was to act nonchalant, but to sleep on our guns. Each of us had a .45, and I had this lanyard so that the .45 was attached to my wrist, which I finally figured out later was foolish. If you've ever tried to sleep on a lumpy .45 revolver, you'll appreciate that this is something. Except for the carbines which our sergeants had, these were the only arms we had with us. Of course, we had the caduceus on, and this gave us a certain amount of status without any problems because the medical caduceus was respected everywhere.

TUSLER: What is that?

WARREN: It's the insignia of the Army Medical Corps. It's the twisted snake and staff of Aesculapius. Well, about eleven o'clock we heard footsteps outside. They went down the path and then they came up and they were regular. There was a bright full moon, so Colonel Oughterson and I got up and quietly slithered it open a little bit so that we could look out. There was a gendarme with a machine gun cradled in his arms, guarding us, pacing up and down the whole pathway. And apparently there was another one below him and another one above him. They weren't taking any chances on anybody clobbering us. So we went back to sleep. The next morning, just at dawn, we heard a funny sliding noise and half the wall opened up and there was the maid, all set to get us up, you see.

TUSLER: To give you a bath again.

WARREN: Well, we refused the bath, and we told her to get out. And she understood that. Then we walked around. We hadn't had time the night before. The bathroom situation was quite interesting. They have what they call a banjo--that is, we called it a banjo. It's a ceramic bowl set in the floor, where you move your bowels and pass urine. There is a bucket beneath this, underneath the floor. The house is about a foot to eighteen inches above the ground on stilt foundations. They're very careful to save all this material. This is all collected by the "honey bucket" man who comes around with two big buckets slung on a bar across his shoulder. He stops at each house and empties their buckets into his big buckets. Then he goes down the street to a wagon which is hauled by an ox. It's then hauled off to the central collection place. The farmer comes in and takes his allotment out. Then that's diluted and put on the rice and the vegetables for fertilizer.

TUSLER: Are people paid for this?

WARREN: Oh yes, there's a whole family life. It's almost a caste system of people who do this collecting. A great many of them, you see, were killed, so the whole system broke down. Of course, there weren't any more households to supply this service either. In Nagasaki a lot of the people who ran the barges that were the collection and distribution end of the line for Nagasaki were killed. The barges just sat there in the harbor getting fuller and fuller and stinking more and more and more. And there was no way of getting any people to move them out for about a month, I guess.

Well, we, of course, weren't used to this business of using the squatting vehicle. Also, the mosquitos came under the house and up through the hole in the bottom of the banjo and you were in a very vulnerable position. These great big mosquitos could come zooming in and you'd just hear "zoom" and feel the pain. We knew there wasn't any malaria, but, nevertheless, we weren't sure of other things. We didn't like the mosquitos, but we finally got used to the banjo.

At breakfast the girls were very shy, but at dinner that night you could see them come up close behind our boys and smell the hair. They hadn't smelled the hair or the body odor of an American for, say, ten or fifteen years. Apparently, we have quite a marked odor which is offensive to the Chinese but not offensive to the Japanese. At least they didn't let on that it was. You are shocked a bit to realize that you have an odor and that it is offensive to the Chinese! [laughter]

TUSLER: Was that because of the diet differences?

WARREN: Presumably, yes. I know I used to know a lot of Chinese and they have an odor, too, which I could recognize. Well, that day we spent in the ruins.

TUSLER: Was this near Nagasaki?

WARREN: No, this was in the harbor at Hiroshima, the island picture that you saw in the movie.

TUSLER: Yes.

WARREN: There's a very famous shrine there. The only way you could get there was by steamer. The Japanese had figured out that this was a good idea to have us bivouacked there. First, they'd have us isolated against incidents, and second, this was their best accommodation and it was well preserved. There were just a few window panes busted but no other damage. It was about five miles down the harbor, I guess, from the city of Hiroshima, well out of the influence of the radiation.

Well, the next night when we came home, the village stores had heard about my purchase and they put all their stuff out on the sidewalks. When we walked up the first night, everything was closed up tight, except for a few bold shopowners who had put out tables with toys and all kinds of gimcracks on it, thinking that we would pillage and take everything. So they had planned to give us their cheapest stuff. Well, the next day, it looked almost the way it did five years ago. There were no decorations, but all the material they had for sale was out. Of course, we didn't touch anything. We left it to the hotel manager to bargain if the boys wanted to get anything, but they weren't too much interested. They bought only some dolls and things. The trouble was how to get this stuff home. In a barracks bag it was pretty chancy. Well, the second morning the place was full of kids, just over-running with kids. They would all line up looking very sober. Every once in a while one would make a V for Victory sign and try to say "American" and a few words and were very friendly. In fact, they got to be a kind of a nuisance after that.

That same second morning we began to be aware of the fact that in the bushes in this park were vague forms with white bandages. It turned out that this wasn't such a good haven for us after all because there were probably 10,000 bombing casualties being treated on this island in a kind of outdoor evacuation and hospital organization. And if some of these had been war veterans, we might have had a little problem. Fortunately, there were none. Actually, they didn't want us to see them. We asked, "Are there any of these that we can do anything for?" We had penicillin and plasma with us and things that we were preparing to give to the Japanese. But they said, "No." This I was very glad of. We restricted ourselves, then, to the survey of the city.

TUSLER: Why didn't they want you to see them?

WARREN: Well, pride I guess. They were still trying to conceal how many people there were in the city and how many were killed. A local castle had been taken over by the military. They had a big evacuation hospital there, about several thousand cots anyway. There were various estimates, 10,000 to 20,000--some said 30,000 or 40,000--troops all around that castle, because it was headquarters. All those, except two men who were in the basement where they stored some files, were either killed outright or died later from the radiation. In fact, the day we got there, the commanding officer sent word that he couldn't come to attend our meeting and to greet us along with the mayor because he was sick. Then we heard the next day he was dead. He'd been in the upper part of the building and he had been badly irradiated.

The castle, of course, was just a wooden Japanese-type castle, so it was all crushed and was just debris. There was one part that was made of brick, which had held offices, where some of the military were. It was in the basement of this building where the two survivors were found. Of course, Kure, the big naval base, was out of town about twenty miles. The military from there had come down to try to establish some order in Hiroshima. It was their representatives plus the mayor, who lived out in the outskirts, who came in and met us the first day.

Now our Japanese companions, Admiral Tsuzuki particularly, had arranged with the local police to have all these people come to talk with us. So we met in what was the chamber of commerce building. This had been badly wrecked. Very few rooms had windows left, and the roof leaked. We decided not to make this our headquarters because our batteries and our other equipment shorted; so we decided to go outside the city. We did like that island bivouac, but we didn't stay more than about three or four days there.

I then returned to Tokyo and went on down to Nagasaki. I also expected to meet Major Friedell with the other half of our party. He had been taken to Zamboanga. We'd been split after we had left Guam. The part under Major Friedell went to Zamboanga. They were supposed to come ashore with the Third Amphibious Corps if we didn't have a surrender. We went to Okinawa and were to come ashore with the Fifth Amphibious Corps. You can just see us leading the shore assault with Geiger counters aloft. We'd seen some of the descriptions and heard some of the discussion of what had happened in Tarawa and at Iwo Jima. And we prayed it would take whatever Superior Brain there might be that we didn't have to do that on Japan itself.

Everywhere we went it was quite obvious that the Japanese had prepared for our assault, which they had correctly figured would be in November. They were busy carving out caves on all the roads. There were only five or six places where you could come ashore in Japan. That was where there was an inlet. Of course, the biggest place was the Tokyo plain. But other places on the islands had little bays. The land went up almost immediately from the water. There was a kind of a volcanic peak or a ridge so that the road from the dock went literally straight up, circling around the hills. Every hundred yards or so they'd have a cave with the dirt from the cave out in the middle of the road. Then in the cave were machine guns, up to 50 calibre, and ammunition, clothing and food. Each one of these would have been a very difficult task to root out.

We found out in Okinawa that when the Japanese had a cave below a crest, our airplanes would go by and bomb the hell out of the crest. As soon as the smoke disappeared and the shrubbery quit vibrating, the Japanese would run out their six-inch rifle on a track. They'd be zeroed in on vessels in the harbor. All these other inlets had caves. We got very well acquainted with them in Nagasaki, in trying to follow the fallout about ninety miles to the east. Every possible landing place for even a small boat had two caves right across the entry from each other with a track in it and a six-inch navy gun with plenty of ammunition. They had camouflage nets over them and from above you couldn't see them. And the guns were zeroed in at just the right place so that when the ship got to a certain place, why, bang! They would have direct hits. This was proven at Okinawa; we lot a terrific amount of naval craft at Okinawa in Buckner Bay. Some of the boys who were there told me how some of these rocket ships that were supposed to be so effective would come booming in and be just about ready to fire when all hell would descend on them. They'd just sink, right now, the men and everything. So the navy didn't say much about Buckner Bay.

TUSLER: How many of these cave fortifications were known to the military before the detonation?

WARREN: Well, I think they were suspected from the air pictures because you could see the debris on the road. And the debris had to come from something like a cave. Of course, it could have come from the bank of a roadbed. All these hills were terraces and they had canals and bridges. The bridges were just one vehicle wide, very delicately built; a hand grenade would have destroyed them. We had designed "weasels" which were supposed to be amphibious tractors. They were able to land in swamps and everywhere. But our boys had never seen these terraces. Well, a terrace with a wall over four feet would have been an unclimbable obstacle, so they couldn't have gotten beyond the shore. They would have had to go up the roadway. It would have been a bitter fight. Dr. Tsuzuki and others had agreed in one of our conferences that they had expected to commit hara-kiri, and that in the bombing and the fighting for Japan they would probably lose a million people; but they were going to take a half a million of our boys with them. And I'm sure they could and would have done it.

TUSLER: This, of course, was the reason for the bombings.

WARREN: Yes ma'am. The kamikaze planes had the last gasoline. Each base had a little airstrip just big enough for a kamikaze to take off from. Kamikazes were essentially human bombs with an engine and a couple of stubby wings. There was one kamikaze outfit on each promontory behind every one of these little bays, so that the capital ships that came in to support the landing would have been sitting ducks for the kamikazes too. We had a lot of them surrender to us. We were not in any shape to accept a surrender, but they'd come running out, when the boys in the jeep with Geiger counters went down the roadway following the trail of the fallout. Suddenly, there would be a couple of officers gesticulating wildly with swords, not drawn. They would wave the whole scabbard with the sword in it hilt up. They'd bow and try to give the sword to our men and they wanted to surrender to somebody. They'd heard of the surrender over the radio, but nobody had ever appeared to pick them up. They were partly frightened and disturbed, you know. We were a little disturbed, too, because they still had all their ammunition and their guns. These weren't collected until we got ready to leave there. About that time, General MacArthur got in and started collecting all these things.

We had been bivouacked in a very famous hotel in Nagasaki over the hill from the town on the seacoast. While there we had had to go back and forth in this great big bus which had the gasoline fed to it at intervals and was run by charcoal. About the second day after we arrived in Nagasaki, all of a sudden ships appeared in the harbor and docked. The trains began coming in with hundreds and hundreds of prisoners that the Japanese had had (the train tracks had been repaired by this time). They were Australians, New Zealanders, a very few Americans, and a lot of Javanese that had been working in the defense plants. The trains brought them down to the harbor. They were picked up by these ships. It took a whole day for the trains with ten cars each, jammed with these fellows, to arrive and discharge their passengers. They were taken aboard these vessels and moved out immediately. They did not contact us or say anything to us.

We had heard through a rumor from the Japanese that General MacArthur was going to land on such and such a day. About a month after the detonation, just as we were about to leave, the Wichita came in with a whole bunch of marines. So we lined up in our jeep at the beginning of the pier. There was also a little jeep, with two officers in it, that belonged to the Japanese. They were the welcoming party. We had wondered why the night before, the city emptied itself of what there were in the way of people. They all just disappeared; there wasn't a soul around. So here were these two officers who presented themselves at the pier and handed their swords over to the landing party. Out poured several thousand marines, loaded to the gills with arms, expecting trouble and hoping that there would be trouble, because most of these boys had not been in any fighting. They were disappointed in the fact that there wasn't going to be any trouble. Well, we didn't want to get involved in this so we went back to our hotel.

I neglected to say that half our people were housed in a hotel in the middle of town. It was still in fairly good shape. The prefectural governor had done everything he could to help us. The night before, he had supplied us with some entertainment because it was our last official day. A geisha girl had come and done some dancing and singing. The boys, of course, couldn't go inside without taking their shoes off.

Well, the next night, all the officers had gone over the hill leaving their men in this place. These men had arranged a final banquet for themselves. You know how boys are: they can find all kinds of goodies that the officers never could find. And they were really having a dinner. The prefectural governor had just come and gone. He had said good-bye to them as a special thing. Talking with sergeants, you know, was not done in Japan, but he had done it. In fact, at that visit, he gave my executive staff officer his harà-kiri sword, saying thank God he didn't have to use it.

When I arrived the next morning I was greeted with the news that my boys were all jailed. They were all found off bounds. So I went to General [LeRoy P.] Hunt's office, where I was treated very nastily: What was I doing here, and wouldn't it be nice if Walter Winchell or somebody heard that these big shots were caught in a geisha house, and all that sort of stuff, you know.

I said, "Well, that's fine. I can officially tell you that the area is clear from radioactive contamination and you can send your troops anywhere." He said, "Oh, the hell with that, I don't care about that." I said, "Well, you might have cared. That was one of my jobs." And he said, "Well, let's see your orders." Well, all I had was a little mimeographed sheet saying, "You will proceed et cetera." [laughter] It was signed by the secretary of defense. It was also a War Department order and it superseded General MacArthur's orders and General Hunt's, too. Yet, he wouldn't recognize it as being anything. He was giving me a hard time because he knew I was not a military man. Anyway, I was Corps of Engineers, and I had been in there for three weeks. This just burned him up because he wanted to be in there first, you see. Well, this was fine. So he dilly-dallied, and I wasted about a whole day through all this harassment. Finally, they let my boys out of durance vile. Of course, the men didn't care; they were having a swell time goofing off, sleeping, and eating. They didn't have to go out and work in the ruins again, which had been a very dusty job. Anyway, they were packed.

We were visited by Admiral William H. P. Blandy, who later was the Bikini commander, and Admiral [Thorvald A.] Solberg and a few others, plus Dr. Shields Warren, the navy man who would take over the area since this was a navy controlled area. About this time, too, Colonel Oughterson had made arrangements with the surgeon general of the army to send in some men. Dr. Verne Mason and Dr. [Elbert] DeCoursey and half a dozen other medical men arrived. So we took one more trip around to show them some of the places. We took them to a sanatorium which was on the periphery. This was a tuberculosis sanatorium. It had just accepted a lot of casualties, and it was where some of the Japanese doctors had bivouacked who were investigating the blood changes and other things. They took those movies that you have just seen.

Well, we kind of got into trouble because the new group were very military, and they didn't like our sergeants sleeping in the room next to the medical officer whom they served. So we had to move them upstairs. We said that we would give the new group all the preferential quarters and that they should forget about us. Up to this time everybody had worked together because we had to treat this as a scientific program. Ours was nothing in the way of a military operation. We had to have our working partner with us all the time, helping in writing up the notes. It was far more convenient to have him right next door than downstairs.

I was very appreciative of the Japanese doctor in charge of this tuberculosis sanatorium because I had developed an infection in my leg while walking around the ruins. I was a little worried about it because the purulent material was white, and I thought I had a staphylococcus alba infection, a mean actor, along with some ordinary fungi, or athlete's foot. He made a great show when he brought us to his laboratory of being a bacteriologist. Everything was spotlessly clean. Our food was served to us with tongs on plates that were just unwrapped from their sterilization. I asked, "Could I take a sterile bath?" And he said, "By all means."

So after we had had lunch he gave me a bathtub which was about four feet square and four feet deep filled with very hot water. He must have dumped a quart of chlorine in because it was just reeking with chlorine. This was fine with me. I had a good hot soak in what almost was Dakin's solution. This is a chlorine solution used to clean wounds. Then he gave me some sterile Vaseline, in a little sterile jar, and some bandages. So after soaking in this bath for about an hour I put on the sterile Vaseline and the bandages, and I didn't open that bandage for about a week. It solved my problem, thank goodness.

Of course, this is the military's problem, everywhere. It always has been. Infections start disabling the troops, and you end up with maybe half your army with all kinds of infections--not only typhoid, malaria, and dysentery, but just such incipient skin wounds. In our present war in Vietnam this is one of the very serious problems because the boys are in and out of rice paddies all the time. They're always wet. It rains all the time, and the skin grows mold very easily. The Japanese, of course, were fairly resistant to this because this was the way they were raised. But our tender skins were able to furnish lots of food for these molds.

Well, the Japanese had had serious and sad things happen to some of their medical units, two of them in fact. One tuberculosis sanatorium was on a hillside in a very beautiful location. The army, or at least the needs of the war effort, had made it necessary to cut all the timber, which was mostly pine, from that hillside. Then they pulled the stumps out for the turpentine. So just about a month before we got there, they had had a typhoon type of rain. The whole hillside just slid, took half of the buildings with it, and killed a lot of nurses, doctors, and patients. Some of the key visiting doctors from Tokyo and other universities--I guess from Kyoto as well--had been killed just before we got there. We were relying on them and their blood counts for early information about what had happened. We got their records but had no chance to talk with them.

A similar thing had happened to another sanatorium for the same reasons right at the same time, but it didn't kill more than two or three people. I think those people worried about the slide, so they got out. But these were centers, you see, of laboratory equipment and expertise, and these were very important.

TUSLER: And they were filled with people who had been injured by the bomb?

WARREN: To a certain extent, yes. They had done a great many autopsies there in these places. They were autopsies of people who came in to the hospital and then died in a few days. The evidence that we were looking for, such as intestinal injury, bone injury, and blood count reductions, could be seen in the autopsy findings. Skin burns and things like trauma were common to all warfare. We weren't particularly interested in skin burns, except to distinguish those that were due to the bomb flash and those that were due to the fire. We saw evidence, even within a month, that some of the burned skin-tissue repair would result in keloid formation, and we worried that we would see thousands and thousands of keloids. But it turned out not to be so. These bad scars were not much more common in these patients than they were in those with gasoline burns. Also, we had no idea what the pigmentation effects would be like. A combination of heat and gamma rays and neutrons might produce a black or a red change. We did see some for a while, but then the pigment faded, or the coloration faded. You couldn't tell, looking at these cases when I left after six weeks, that they were any different than any others. You couldn't tell if there had been any gamma radiation or complications from neutron bombardment at all. They looked just like ordinary burns from heat, which they were for the most part.

TUSLER: Did you actually have an opportunity to study the injured people themselves?

WARREN: Yes, we divided our day in half. In the morning we would go around to see casualties. In the afternoon, we would look over the destruction and the ruins, try to make measurements to see where the center was, and what the distribution of downwind contamination might be. Then we had a regular party with the jeep trying to follow the downwind part. We climbed over ruins all afternoon, and this was a filthy, dirty job. If it wasn't muddy, it was dusty. And it stank.

I'll never forget the stench of two places. One was at Naha on Okinawa, which had been leveled by naval gunfire. It was really leveled. The bodies of all the dead, of course, were in the rubble. All the military did, when they finally landed, was to run a bulldozer over it to try to bury this material. It stank just as a pigpen stinks. The human body in putrefaction smells that way. Well, I didn't smell it in Osaka or Yokohama or Tokyo because they had been consumed by fire, exclusively. But for some reason, in Hiroshima, the number of bodies that had not been consumed by the fire, or were partially consumed or intact, that were around, was very great. The flies were very numerous, and the stench was just something awful.

On our first trip through Hiroshima by bus with the mayor, General [Thomas F.] Farrell, and Jim Nolan, our Geiger counters had gotten wet and weren't working. We knew there was some radioactivity there, but we couldn't measure the amount. We could just get an indication. But the flies were so thick that we had to close the windows in the bus in order to keep them from mobbing us. You would look at a woman on the street, or a man in a white silk shirt, and from a distance of fifteen feet their clothes would look polka-dotted. Up close the dots were flies. We did arrange for some DDT to spray the place. I don't know whether it ever got there or not, but in about ten days this all calmed down and the flies disappeared, pretty much.

TUSLER: By that time the bodies had been removed.

WARREN: The bodies had been buried. The Japanese sent in lots of troops to do this. I was in Nagasaki during most of this critical period. Every morning we would go around to the places that had any shelter. These were created by big sheets of corrugated iron, or there might be a building with a habitable ground floor. Although the roof was leaking badly, water didn't percolate down on the ground floor.

I have some photographs of the little building that was cared for by one doctor who dedicated himself to this. He was from the medical school and he was partly in private practice. But, anyway, he and his two nurses were there just to receive patients. The prefectural government would deliver to him every day two bowls of rice and a pinch of tea for each patient that he had there. So this got to be known as a place where the patients could eat well. He had mats on the floor and so many people that they were almost touching one another, side by side, in a building that was about forty feet long and thirty feet across. Outside there was a pile of ashes from bodies incinerated the day before. This went on day after day. We would come and look at these people. Many would have purpura, or little bleeding spots about an eighth of an inch in diameter, on various parts of the body. These were mostly on the face, chest, and arms. Any spot that was slightly bruised had a hemorrhage. They would be a sickly yellow color. We did a few white blood counts and found 50 cells instead of 5,000. The next day when we'd come back, they'd be gone and replaced by others. Their bodies had been incinerated.

TAPE NUMBER: XI, SIDE ONE

AUGUST 4, 1966

TUSLER: Dr. Warren, today we're going to go back and pick up the beginnings of your Hiroshima and Nagasaki expeditions. How did they get started?

WARREN: Well, I think it was about August 12, 1945, that I had returned to Alamogordo, New Mexico, where the first bomb test had occurred, to pick up the pieces, as it were. I wanted to look over the fallout area around the test site. I had to see what should be done with the findings of Dr. Louis Hempelmann and some others which showed that there was fallout north of the east-west road near Bingham's store and the little nonexistent town of Carthage. I suddenly was tracked down by a GI in a car who said the general wanted to talk to me. So I drove back to the base camp and got on the phone and found it was General Groves calling me from Washington. He said he hated to do this to me, but also envied me the opportunity that he was offering me, not ordering me, because the situation was pretty delicate. He offered me the chance to lead a party into Nagasaki and Hiroshima if we could get there. We would have special War Department orders. He would say good-bye for me to Mrs. Warren because I couldn't come back to Oak Ridge. They wanted to get the party off in about two days. We would assemble in Los Alamos. I said we would need all the portable Geiger counters and batteries that we could get. He said that he would assign this to Dr. Hymer Friedell, my executive officer and second in command, who was to go with me. We would essentially have two parties because there were two cities. Also, it wasn't certain yet that the Japanese would surrender, in which case we would accompany the Fifth or some other amphibious corps of marines on the landing in Japan when this occurred--probably in November.

TUSLER: Now how long a time was this after the time of the dropping of the bomb?

WARREN: Well, the two cities were blasted August 3 and 4. And this was the twelfth or thirteenth.

TUSLER: That recently after.

WARREN: Everybody expected the Japanese to collapse, but there was no real evidence that they were going to surrender. In fact, there was a lot of discussion about the fact that they were probably going to commit hara-kiri. Because of their culture they couldn't surrender unless they found this completely hopeless in some way. There were rumors about this time that the Japanese had made indications towards the Russians that they might surrender, but the evidence was not good or clear. In fact as far as our people were concerned, it was denied officially by the Russians, that the Japanese were ready to surrender.

But, in any case, the Manhattan Engineer District job was done. It had delivered the bombs to the air force. They had been used over the two cities with the proper effect, better than they had expected from the military standpoint of view. And there was one in reserve, though nobody would say anything about this. It was just understood that we had plenty. If the Japanese did not surrender, well, there'd be some more of the same. It was pretty clear that the fire bombing had devastated a tremendous number of their cities, and now with this instantaneous extinction of two more--just one plane, one bomb, one city--they had to quit. So, in any case, we were to go and try to find out what amount of damage there was, what the casualties were, and above all what, if any, the radioactive contamination was on the ground. The expectation had been, with the high detonation of the two bombs, that there would be almost none--hopefully none on the ground. And this was one of the things we were to find out.

During the next two days, men who were getting ready to go in our party began to arrive at Los Alamos and at Albuquerque. Our party was made up of about one-third medical staff from various parts of our organization. Dr. James Nolan and Dr. [Henry] Barnett (I think that was the pediatrician's name from Los Alamos) were two. We had about one-third made up of technical sergeants out of the various plant operations who were to do the actual Geiger counter surveying and to be technical assistants to the party. The others were four engineers assigned from Oak Ridge and Hanford to assess the damage. We were to pick up photographers en route, and we had four security personnel who were not going to go all the way with us but who would be important in getting us through the various barriers of transportation and permission. The expectation was that if there were a surrender, we would go as early as possible into the two cities to study the early and late effects of radiation on the Japanese population.

We had expected from our animal experiments to find a great deal of gastrointestinal damage as well as bone marrow damage, in addition to burns and other skin and blast effects. We didn't know what the timing of these clinical changes would be in the human because there was no prior experience, but in the dog we had extensive information about the timing. Intestinal death, with bloody diarrhea, occurred about the fourth to the fifth day. Bone marrow collapse with bleeding and no platelets occurred about the ninth or tenth day. We found out that both of these episodal, lethal effects occurred at a slightly longer interval, but the mechanisms were the same.

Well, after the phone call, I had to make a very rapid trip to Los Alamos from Alamogordo. We had tires on the car that were retreads. The rear right one apparently began to slip its retread and caught fire. If you've ever been in a car with a tire on fire you will understand the urgency with which we stopped, got out the jack, jacked up the car, took the wheel off, and put the smoldering tire over on the side. We had to be careful not to throw it into some grass that might catch fire. Just as we got it off, it burst into flame and practically exploded. We were very fortunate that it didn't do that while it had access to the gas tank. This was not an uncommon thing during the war, the last part particularly, because tires as well as gasoline and food and everything were rationed. The tires were retread so often that the carcass was likely to be just imaginary. Yet we had to travel fifty to sixty miles an hour on these hot, desert roads to get anywhere within a reasonable time. We did a great deal of our travel, as a result, at night. But if you'd try to sleep in a car night after night and work all day in the heat you understand this is not a very stimulating exercise.

Well, we had all of our immunizations done at Los Alamos and all our blood counts and physical examinations. Geiger counters and ion chambers from all around began to come in. We practically stripped the Manhattan Engineer District laboratories of portable equipment. We had no time to make any new equipment. We took along a couple of small radium sources to callibrate our equipment and a lot of batteries. We had no idea what to expect, except that we would have no source of supply once we got there. So we then all drove down to Santa Fe at five o'clock in the morning of the third day with all our dunnage.

In the meantime, my wife, Viola, had been called up by Major Friedell and told not to ask any questions but to prepare my laundry and my extra suits. I would need all my summer clothes. From this she judged I was going to Japan and not to Alaska. This was August and I had only about a minute's conversation with Viola. Just the night before we left, we got circuits through to Oak Ridge, and we understood this was probably good-bye. I wasn't sure I'd get back, so I suggested that she would have to say good-bye to the children since I wouldn't be able to. She listed the things that she'd put in my laundry. This was our way of keeping the conversation at a high level. [laughter] Then we got off.

We went to Albuquerque and took off in a fairly large freight plane, a four-engine job, which had a lot of other people on it besides our own group. We were all dead from lack of sleep. Those who had come from Oak Ridge and other places had come in overnight. Everybody sat around kind of numb until we landed at the town of Fairfield north of

San Francisco, where we had to go through some kind of a foreign-duty assignment customs inspection. We were shown movies of ditching the plane and how to inflate a Mae West vest and how to get in and out of a boat in case we had to ditch. This was not an uncommon situation. Also, we were told that our plane would be heavily loaded and that we should be strapped down so that nobody would shift around. We had all our gear with us, and it was a job to be sure it was all right. We took everything from one plane to another ourselves.

Finally we boarded a C-54 which had no seats but had hammocks on the side. Everybody sat or reclined in a hammock-like arrangement or slept on the floor. And we had our gear all piled up in the center of the floor.

TUSLER: You were all then able to be on one plane?

WARREN: Yes, at long last, we were all together on one plane. And there were about forty of us. So this made quite a lot of dunnage, too. Well, we made it overnight to Pearl Harbor without any trouble. We had some difficulty there with finding where the next plane was which was to take us off. There was to be another plane. The first plane from California was a shuttle.

By the way, there were a couple of our party from Intelligence who came from Washington with special orders. They didn't make the plane out of San Francisco, but came on NATS, which was a navy air transport system. They came deluxe with velvet-covered seats and so on. That was the last deluxe they had. They had breakfast served to them, too, which we didn't. Well, anyway, finally we all got together on the plane, a DC-4, for Guam.

When we left San Francisco, everybody was looking out the windows at Mount Tamalpais to be sure they had a good view, because this might be their last view of the States. After the movie of the ditching operation, which had been a most impressive initiation, as you can imagine, to what otherwise might be a not unpleasant voyage-- Well, about halfway over we began to get into pretty rough weather. And I can remember sitting half-asleep in my hammock. This is a hammock in name only. It was just a net spread on the side that you could sort of get entangled in and not sway out into the middle aisle too much.

All of a sudden I was awakened by violent movement. I looked down the plane towards the stern and here was all of my crew and all the baggage about three feet in the air just as if you put a plate glass under the whole thing. Then all of a sudden we hit bottom and then the plane went whoop! Everybody bounced. And the pilot stuck his head in the back from up front in a couple of minutes and said, "Well, how do you like that? That's just a practice." This helped our feelings tremendously, as you can imagine. But we probably had dropped 1,000 feet in a downdraft. At that time, we didn't know too much about such things. They were called air pockets, but they were really downdrafts and you can't avoid them. If you could see the cloud formations that we were in you would see that the ocean was covered by almost circular small clouds, with little flat bottoms which is typical of an inversion. Of course, these little clouds were the top of a thermal updraft. With the updraft in the center, the side goes down. When you go under one of these formations, you have a sensation of falling and then rising violently and then falling as you get to the other side. After we had learned to expect that and understood what was causing it, our fears were less, though I never got quite over it.

We finally made Guam. Our pilot, having exercised his prerogative in telling us how wonderful the trip was, then proceeded to buzz the field. This consisted of making a dive and coming out of it with a turn to the left and then another dive to lose altitude, he said. But it was purely for our benefit. We were the freshman neophytes, and he was having fun with us. But, later, this turned out, in recollection, to be not so much fun. We hadn't any more than gotten to Okinawa, which was the next stop, when all these DC-4s were grounded because the bolts that held the spars for the wings to the fuselage had broken in several planes. I think there were something like six bolts about a foot long. So all these planes were grounded and taken apart and the bolts renewed. It was a very easy job to do, but it was rather unsettling to those of us who were a little frightened anyway, to know that when you had a downdraft or an updraft or you did a dive, you might lose the wings and be left standing there in midair with no support.

At Guam we were put in officers' quarters. This was where we found out that we had to pay for our food out of our allowances. We didn't have much cash with us--any of us--so this was kind of a chancy situation for most of us. We finally were able to amass enough cash so that we could do this from then on until we got back to the United States. But for about six weeks, except for the time when we were on our own with K rations in Japan, we had a mess bill to worry about. And we were not always confident that the mess manager didn't up the cost a bit at our expense to take care of losses that he might have had elsewhere. So we detailed two of our party each time to do the negotiating both before and after our meals.

Well, we were delayed in Guam a whole twenty-four hours because they were going to transfer us to ships that didn't arrive. You see, the surrender had not occurred yet, but we were on our way. If the United States was going to assault, we would be in the assault party. I can just see how all of us sat around describing how we would go ashore waving a big Geiger counter ahead of us. We'd have to precede the troops, you see. And we had heard, by this time, vivid and gory descriptions of the assaults on Tarawa and Iwo Jima. A Geiger counter is not much protection against a machine gun, as you can well imagine. We finally got our party on a couple of different ships. Three of us were put on a weapons carrier. This is a kind of ship with openings in front and back that enabled the army to ship tanks and other heavily armed vehicles. It was not too slow a ship, but it was a good deal slower than a destroyer. And it tossed a lot.

Well, we got going a ways, and it was decided that this wasn't fast enough. The Japanese had indicated that they were going to surrender; so we should speed up our duty towards Okinawa where we were to take airplanes to Japan. So the three of us were transferred by breeches buoy to a destroyer. This is a harrowing experience for a neophyte, but it was done with dispatch. And there was no monkey business, as I'll tell you about later. This destroyer then made every effort to catch up with the [USS] Mt. McKinley, which was the ship we were supposed to finally get on.

So, in spite of any waves or anything else, this destroyer went like mad. I had a hell of a time walking around. I, of course, was almost twice the size of the commander, who was five feet six or something. He could walk everywhere, but I had to duck and almost crawl around places. He decided that it would be just lovely to show us how the five-inch guns worked. So he gave us cotton to put in our ears, and we stood up front to have a good view, you know. There were guns on either side of us. I had never heard them go off. They shot a star shell in the air and then they practiced trying to hit the star shell as it came down with a parachute. And they did pretty well. They were almost automatic, not quite, but they would fire with great rapidity. The wadding from these guns just showered us.

I began to suspect that we were not in the right place, which turned out to be true, because the commander had a silly grin on his face and sort of beckoned us back. By this time, nobody could hear a thing; this exercise was just deafening. Then the commander shook hands all around and opened a bottle of wine and said, "Well, you did all right." But we could hardly hear for a couple of days! [laughter] It was terrible.

As for the sleeping accommodations, the bunk, of course, was a little short. But that was an advantage for me because I could put a pillow under my head and brace my feet on the bottom. Then I could sleep regardless of the roll of the ship. But how these fellows stood this I don't know. I suppose they liked it. This was to them a way of life and they didn't get seasick or anything. But I was just on the edge of being seasick all the time. Well, the next day it was decided that we were close enough to Point Hook, which was the big assembly point, so that we could be transferred by breeches buoy again.

TUSLER: Where was Point Hook?

WARREN: Point Hook was just a spot on the map. The navy was beginning to collect all of the ships and transport for the assault on Japan. This was early August and was a readiness operation. If surrender didn't occur, then in the next two or three months they would have been able to get all of the landing operation prepared for and carried out. We began to see lots of ships, all heading in one direction.

About daylight of the second day on the destroyer we came into view of a big battleship in combination. It was the [USS] Wichita. It was not really a battleship; it was a headquarters ship. We came up alongside of this ship and arrangements were made for us to cross by breeches bouy. A breeches buoy is essentially about a three-inch manila rope cable which is run from one ship to the other. A light line is thrown over, and then this big cable is hauled over through a couple of pulleys. There's a pulley on each end with a crew of men on each rope so that when the ships go up and down they can keep the cable across under the right tension. But, course, you understand that when the one ship will go up and the other one down, these fellows have to run to keep the thing tight, otherwise it dips whoever or whatever is on the cable into the briny. By this time the boys on our destroyer were out for fun. I didn't suspect anything, and we got two of our people across all right.

TUSLER: How do you go on the cable? You don't fall?

WARREN: They have a thing like a little swing, a one-rope swing, with a stick across. You straddle that and hold on to the ropes and you sway and you rotate and every time it goes up and down, why, you go up and down. Now that stick on which you are sitting, your single seat, has a pulley also. A lighter rope is attached to the upper part of the rope you're sitting on. One crew pulls you over, while the other crew holds you back, because if one ship dips down, you go straight down very fast, unless they hold you back and keep on pulling. So you've got four crews of men who are responsible for your dry passage.

Of course, I had to go last, always, because I outranked all the rest. Even duffel bags and everything went over first. I finally shook hands and got on the seat and they hoisted me up with a big cheer. Then I knew something was going to happen. Well, I got out to about the middle and they kept yelling back and forth, "Our pulley is stuck!" It was a big fib, but they kept me there going up and down, about thirty feet at a whack. This was almost the height of two stories. The ship would roll and this would almost cast me up and then it would roll the other way. It would be synchronized, but I just had the hill and valley motion. They finally got me over. I was pretty wobbly by the time I arrived. Then I got another cheer, so I thumbed my nose back at the boys. They were sorry, but they appreciated it, anyway. And I thought, "Well I hope that's the last."

TUSLER: But it wasn't.

WARREN: No, it wasn't; I had one more. But that one wasn't too bad. The Wichita then started towards Okinawa. The word was that the surrender had occurred the night before. So we got into Okinawa Bay and had to make another ship-to-ship transfer. We had one dinghy supplied us, so we got part of our party over by the dinghy and the other part had to go by breeches buoy. Unfortunately, I had to be last again. The dinghy didn't come back so I had to make it by breeches buoy. And this time it was all orderly because the admiral was looking. [laughter] We were in Buckner Bay, and the water was fairly quiet.

Well, then we had to figure out how we were going to go ashore because we were told we would go on by airplane and I had to get all my party ashore. So we got into the same little dinghy arrangement and tried to go ashore. Well, the idea was that anybody caught after dark would be shot at because the surrender had just been made official that morning. This was the next day, and there weren't any Japanese around; but there was a big party on shore, already, and they had set up to unload all kinds of things. Of course, you have to remember that the week before we had flattened Naha with gunfire. That was south of Buckner Bay and across the island. There still were Japanese in caves up on the ridges who were surrendering rather fitfully. Occasionally they killed somebody with sniping or volley fire.

TUSLER: Perhaps the word hadn't even reached them yet.

WARREN: They wouldn't believe it. You see, they were out of radio contact with their own command so that they couldn't or wouldn't believe it. Well, we got ashore, and the people there had never heard of us. We showed them our orders, which were just general. They read "You will provide whatever is essential for the conduct of this party to Japan and at the earliest possible moment." Well, that didn't mean anything to a lot of people. Besides that, it was on a mimeographed sheet of paper. However, most of the time this was effective.

Arrangements were made finally that we could be bivouacked on the island, but the officers would be separate from the enlisted men. This was the first time we would be separated, and we didn't know what to expect. I was green as grass. Of course, nobody had any organization yet, so we couldn't tell what was going to happen. Well, anyway, we weren't welcome aboard ship anymore, and we had to get off the next morning. It was important that we go back to our own ship right away. Well, by this time, it was getting a little toward dusk. There were coral heads in the bay that had to be avoided. Also, we found our ship had been moved, and we hadn't seen her enough to really recognize her very easily. So we wandered around in the beginning darkness. We would be hailed by the sentries on ships that we passed with comments about our virtue and our origins and queries about what we were doing out there. We were lucky we weren't being shot at by then.

We finally found the ship. It had been moved a whole mile. Just as it was getting dark we recognized the super structure; thank goodness, it had a peculiar and unique look. So we got aboard. The landing officer was very grumpy. He said we had just about missed mess, but maybe he could stir up something. We finally were served a little food, not much. Well, next morning we got all our people and all our stuff ashore. We had about a ton of baggage of one sort or another. The batteries were the hardest things to manage since they were just a dead weight and in one package. But by distributing them around among the enlisted men and ourselves we got everything off the ship.

We waited around almost a whole day before we got quarters. The enlisted men were put something like eight miles away from the officers. This was a very bad situation. However, the men would be fed because they were enlisted men, but the officers had to shift for themselves. So until we got our quarters that night, we went a whole day without any food and our K rations were not to be opened because they were for Japan only. Well, a little later, it turned out we had to open them because every once in a while somebody would move out and the new officer coming in with his troops would not know a thing about taking care of our people, either by intention or because he never got the word.

We had to do several things which were important to keep up morale. In the first place, we didn't know how long we were going to be there in Okinawa. It turned out we were there about ten days, waiting for the surrender ceremony to be gone through, not knowing anything, though, and with no communication. Of course, my boys were restive, and the batteries were beginning to get wet. So we set up some classes. We flagged down a motor transport and the officers and I would get aboard. We would go down to the enlisted men and would try to hold classes. Well, most of these technical sergeants knew as much as we did about the Geiger counters, if not more. And the security fellows were out, trying to negotiate with their counterparts to get us to Tokyo. So they would disappear for a couple of days at a time. They were our only outside contacts, though; so we didn't know what was going to happen.

Well, these classes turned out to be fair. We thought the enlisted men ought to go swimming because there was no way of our drilling. But this turned out to be the wrong thing. Only the officers were supposed to go swimming. Well, we had a little row about this, and finally, our people, because they were special, were permitted to have a private beach for swimming. But they were not to pass the word around that they were swimming, otherwise all the other enlisted men on the island would have to go swimming, too. I can see the point, but nevertheless, the other fellows on the island were slated to go home and our people were slated to go in, so this made it a little different.

We did have side arms and our men had carbines. The last day before getting into Okinawa we did a little target practice. None of our people, you see, had had any target practice, and no drill either. We were just terrible pariahs in the military. So I decided that if we were going to go ashore in Japan and still carry our arms, we better at least know how to shoot. So the armorer of the Wichita said, "Fine, we'll get some boxes and throw them out on the stern and we'll put you out on the fantail where there's a lot of protection for the rest of the crew in case you have bobbles." So they did that.

Just as soon as there'd been a couple of shots fired, all of the crew beat it. They weren't going to be anywhere near our people. There were about fifteen of us, I guess, down there. Some of our boys actually had never had a rifle in their hands before. They were technical sergeants and had been in the laboratory and in the plants all during the war. Some of them were just scared to death to shoot; others didn't mind. A couple of them were pretty good shots. But we decided that we would carry the rifles without any ammunition in them just in case. There was more risk of shooting one of our own people than there was defending ourselves against the Japanese.

Well, we had a couple of days while we were waiting, so we took a trip down the island--we were able to get a car--to see the hospital. Of course, we were medics; therefore we should go and see the doctors. Well, this was very interesting because there was a little Italian doctor--an army medic--who had been given the job of examining all of the local inhabitants who were sick. And, of course, they were malnourished and had been treated badly by the Japanese, who had taken all the food and didn't give them much. They had an epidemic of encephalitis, too. I wasn't too happy exposing our people to that, but we went anyway.

It turned out that we were all right. Except for a few of us medics, the rest were kept out of the hospital. We looked at the compound where the Japanese had imprisoned the Okinawans and where there were still some who were anti-American. There were some Japanese civilians in there, too. Then there was another encampment where the prostitutes were all corraled. There must have been a couple hundred of these that had been brought specifically by the Japanese to Okinawa.

We were given a very interesting lunch by the doctor and his staff. He told how, when he first got there, the mayor of the little town had told him that the Japanese major who had not surrendered was going to move in one night and kill him. The doctor wasn't about to get killed, but he did not have any way of defending himself. He couldn't move out since he had orders to keep his hospital going. At the moment, they couldn't give him any extra troops. But there were some telephone poles that had been moved in prior to setting up his communication. So he decided that he would pull a fast one on the Japanese. The staff worked all one day, not paying much attention to the patients, sawing up these telephone poles so they looked like cannon barrels. Then they piled up anything they could find and put these telephone poles up as if they were field cannons. Then they put a canvas over the whole thing. Of course, the Japanese didn't come out of their caves except at dark, so he told the mayor to show the Japanese all these cannons around the hospital and to tell them that the Americans had secretly brought in a whole company of machine gun men and that he had better surrender. So the Japanese major was convinced, and he did surrender. Then he was madder than heck when he found out that these were just wooden poles that looked like cannon in the dark. [laughter]

TUSLER: That was pretty clever!

WARREN: That's pretty clever. I think the doctor who figured that out should have gotten a medal, and I hope he did because he saved not only a lot of patients but his own staff. I guess about 200 Japanese surrendered.

The Japanese had a very interesting system. The mixture of soft coral and volcanic rock, of which these islands are made, could be hoed out with a hoe. This made it easy to carve a cave. Well, the Japanese had gone along, just below the top of the ridges of these islands, and put in caves with six-inch guns and lots of ammunition. Each gun was on a track with a camouflage net on the front. These guns were all pinpointed to a place in the bay between coral heads where our ships would have to come in. We were told, when we got there, that more naval losses had occurred there than in any major battle before. Our rocket ships would come to the proper firing position, but before they could fire, they'd be disintegrated by all these guns that were trained on them.

Our planes would go over the ridge and blast, but the guns then would be back inside and the planes couldn't see them in all the bushes and tropical vegetation. There was no way of pinpointing the bombing, and it was mostly useless. Later, these caves were attacked with phospherous bombs, hand grenades, and flame throwers. This is what it took to get the Japanese out, eventually, because they didn't believe in surrender. A lot of them committed hara-kiri at the last minute, or they did a banzai charge as they knew they were going to die and sacrificed their bodies that way.

There were still enough Japanese around so that for the week that we were there, there would be quite a bit of shooting at night. Some of it was by our own soldiers who were jittery, but there was still quite a bit of it by the Japanese. Our people would go around with a truck and a sound machine and a captured Japanese to broadcast in Japanese the fact that the emperor had surrendered and that they could surrender with honor now and to please come in. This was usually met with ribaldry and lots of shots.

TUSLER: They thought it was a trick?

WARREN: They thought it was a trick.

TUSLER: It must have been very unnerving for you to be there in this transitory period.

WARREN: Yes, it was.

The island had been sprayed with DDT so there were no mosquitos. I'll never forget the emotional upset of one of the doctors in command of a medical unit. I had obtained a jeep and was wandering up and down the shore looking for a better place to put our men than the swampy place we were in. I ran across this doctor standing there at the edge of the swamp. Here were trucks coming in unloading a complete hospital unit in what essentially was mud and swamp. He said they wanted the ship. The surrender had occurred, and so the hospital ship wouldn't be used any more. So the orders were "Put it out on the beach." But he said, "You can see it won't last long."

There were microscopes, beds, surgical equipment, and everything. Before we left in three or four days, between the rains and the wind and no protection, the stuff had just gone to rack and ruin. It was a shame, too, because it had been gotten together as so many cities had done. The money had been raised locally and all this stuff had been purchased. A bunch of doctors had enlisted then, for the duration, to go with the hospital ship or a hospital unit. But that's the way it was. We were witness to the throwing away of just millions and millions of dollars' worth of gear. Well, they had to have the ships to take the boys home. The troops were ready to be discharged and they didn't want to pack all this stuff back. It's part of the destruction of war.

After we had been there ten days, a week anyway, General Thomas Farrell caught up with us, and Colonel Peer de Silva, our main intelligence officer, had all the officers get together. It was arranged that Major Friedell would go to Zamboanga to meet with the Fifth Amphibious Corps and I would stay with the Third. But, in the meantime, arrangements were to be made for me to go into Tokyo. Now, the reason for our having these attached assignments was that they weren't quite sure until just a day or two before this that we would not have to assault. And so Major Friedell was sent, just before the surrender arrangements, with half of our people to Zamboanga, because transportation suddenly appeared. That left me with the other half and most of the security officers and General Farrell. It was then agreed that Captain Nolan and I would go to Tokyo. General Farrell thought he could make arrangements for getting us to Nagasaki and Hiroshima.

Captain Nolan then went with the general and Colonel de Silva, and I waited over. I don't remember why now, but I think I was still worried about my enlisted men who were left and about the Geiger counters we had. I remember going with great difficulty in a broken-down jeep to where the enlisted men were and telling a couple of senior sergeants that they would catch up with us in Tokyo eventually. I said that I would try to get this arranged as quickly as possible. Of course, many people were trying to get to Tokyo and our importance wasn't very clear.

The next morning I took my duffel bag and went over to one of the airfields and finally found the plane to which I was assigned. It was completely empty and I could have taken my whole party in it. But there was no way to do this. Orders had to be cut and there was nobody around to do this. General Farrell was in Tokyo by now, so I decided I'd get aboard. I thought my men would follow the next day, and so we took off. This was one of the DC-4s that was due to be grounded, but which hadn't been grounded because the new bolts for its wings hadn't yet come. And I guess this was one of the reasons they didn't want to load it.

The plane had two pilots and an engineer on it. They decided after we had been gone for an hour or so that it would be nice to have me sit up in the copilot's seat. So I said that was fine and that I would like to learn a little bit about it. Anyway, it was better than sitting in the dark in tha back, because there were no seats and the hammocks were pretty badly torn. So I sat in the copilot's seat. After a while, the copilot said he was going to take a little sack time and would I mind if I sat there and sort of watched things along with the pilot.

Then the pilot and I struck up a conversation. He was a chemist and was going back in industry when he got through. He was well trained as a bomber pilot but he was now on transport duty, which was kind of dull, but it was all right. Things were very quiet. He sort of stretched and said, "Well, I guess I had better shave. Keep an eye on it, will you? All you have to do is watch this for altitude. It's on automatic pilot and just watch the needle of the compass." By this time I had had all this explained to me, anyway. But I didn't realize he was explaining this to me for a purpose--so I couldn't be chicken--and I just sat there and everybody disappeared for almost an hour. I sat while the plane flew itself with a little adjustment now and then. We hit one small downdraft and the pilot came back and said, "Well, that's all right. It wasn't a big one. There are no more clouds around. You won't have anymore."

There was the great big ocean, you know, and nothing else anywhere. So finally we came within a couple of hundred miles of Japan. By this time the crew all kind of recovered and came back. I relinquished the copilot's seat with a great deal of pleasure. But it was interesting. I have always wondered what I would do in case I had to land one of these things, a small one or a big one. This is the only thing that bothers me. The rest of it doesn't bother me very much. I never paid the money to be instructed by someone in this for some reason.

Well, we landed in Tokyo and then had a hard time getting transportation. I finally got on a jeep that was carrying cheese, of all things, from the airport into the hotel where I was to be bivouacked. This was about five o'clock in the afternoon, I guess, and I had one of the wildest drivers I have ever driven with. The roads were full of chuckholes. The Japanese had apparently been preparing to put in a pipeline, or a part of it. It was just wide enough for one car. Any time another car met us, we had to do considerable negotiating. If he waited in a wide place, fine. If he didn't, we had to find a wide place.

Along much of the road, we would come to a canal. There'd be a bridge just barely wide enough for a jeep. This is where I learned that movement around in Japan, if there had been any destruction of bridges, would have been very difficult. Our equipment, our weasels, weren't really equipped to cross these canals. They were maybe ten feet deep and maybe fifteen feet across. Perhaps we could have bridged them with a pontoon arrangement, but it would have been very, very bad.

Well, I was scared within an inch of my life four or five times on this trip. I just remember it with horror. One of the things that was particularly bad was that there would be a length of pipe on a pile of dirt beside the road. This would be aimed at us at a curve, just right, so that we could be impaled on it if we missed the turn. My driver said that he hadn't had any bad luck yet and he didn't expect he would, but I noticed he always fixed it so that the passenger was on the side where the pipe was!

TUSLER: Where were the other members of your party? Were they with you?

WARREN: No, I was all alone at this time; but General Farrell and Captain Nolan and Colonel de Silva were all in the Dai-ichi Hotel. I finally made it to the hotel, and Colonel de Silva got me a room. Then we had a long conference about how to get the rest of the party in, and what kind of arrangements would have to go down to Hiroshima. It took about three days, finally, for my party to catch up with me and for us, then, to get out in the field again. We had to be transported from the middle of Tokyo fifteen miles out to the Itsuki Airport where we were to take off.

The first trip south was in a DC-4 with a whole party of visitors who wanted to look, as well as General Farrell, Captain Nolan, Colonel de Silva, and myself. We went down there on a very bright and clear day, and flew over Hiroshima. In the process, one of the photographers wanted to lie down on the floor and stick his camera out the cargo door. Captain Nolan and I had to sit on his feet. We didn't like this because this was while the plane was making turns up on one wing a bit, and we were all looking straight down to the ground through the open hatch. We didn't like it, but it turned out that it was all right, actually. However, if the pilot had made any quick change we could have just nicely slid right out. None of this helped my appreciation of the solidarity of airplanes.

Well, we got back to the hotel and it was decided that we would take our party in three DC-3s. We did not have our own planes here, although we had made it from San Francisco to Guam in what was called the Green Hornet, which did belong to the wing of the air force that dropped the bomb. The Enola Gay was a part of this unit. I forgot to say that we stopped at Saipan for one day and saw the airfield where the bomb had been loaded on the plane. That was where I had authorized Professor Luis Alvarez to have a seven-foot cot especially flown over for him because he was too long to sleep on a standard cot. Being a civilian he demanded certain privileges, which he got. General Farrell had asked me whether I thought it was a good enough medical reason because it would have to be flown over special. Well, I saw the cot. And it was worth it, too. After all, Mr. Alvarez had a very delicate job to do. If he couldn't sleep, then the job might be jeopardized.

TUSLER: Was he the pilot?

WARREN: No, he assembled the bomb at the last minute. Then it was put in the plane and armed later by Admiral William Parsons, who was the man in charge of that part of the procedure. He was not an admiral then, he was a captain at that time. At Saipan, we also saw the first typhoon configuration, a funnel-shaped, black column, twisting in the air. It would disappear and then form again. Most of these we saw were high so that they didn't raise large quantities of water with them. None of them came on shore. But this was the beginning of the typhoon season; it was close.

Well, we went down to Hiroshima just to look and then came back. Final arrangements were then made for us to go in three planes. We all got together and went with General Farrell in two of the planes. The third one went to Nagasaki. Two of us went to Hiroshima. We landed at the airport all right. But it was full of bomb holes and very rough. Our pilot succeeded in stopping before we went into the water--there was only a short runway. When the plane stopped, the Japanese came out with a bus. It seemed to us that they had an unusually large collection of Japanese there, though there wasn't supposed to have been any notice of our coming. They had beer and all kinds of things ready for us. Apparently, the Russians had just left. They had commandeered United States gasoline, flown there the day before, been there overnight, and had been aware that we were coming. I don't know how they had this information, but they got off the field before we landed. The Japanese were very twittery, because the Russians had been pretty rough. All we wanted to do was to have arrangements for bivouacking and for our party on the other plane who were coming in shortly, and for transportation to the city for General Farrell, Captain Nolan and me to take a quick look.

TUSLER: What was the purpose of the Russians' visit? Were they doing the same thing you were?

WARREN: Well, they wanted to see what had happened, and were the reports real. Well, they were more than convinced.

They stayed at the Dai-ichi Hotel also. We had a separate mess so we weren't allowed to intermingle, although there was no evidence they wanted to. I certainly didn't want to talk to any of them. Finally, General Farrell, Colonel de Silva, and I got in a limousine-type bus and headed for the middle of Hiroshima along very muddy rutted streets. When we got there it stunk terribly, and there were flies everywhere. The flies were so bad that we had to close up the windows of the car to keep them out. You would see a man or a woman with what looked like a polka-dot shirt on, but when you got up close, there was just a mass of flies crawling over a formerly white shirt. There were faucets leaking everywhere. They hadn't had a chance to shut off the water. They were still losing it out of the reservoir.

We then had a meeting with the new mayor and the representatives from Kure in the chamber of commerce building which was still standing. It was full of cracks and the windows were gone. But the roof didn't leak too much, so we could have this meeting without getting rained or leaked on. We were told that the military commander had just died the day before. He'd died from acute bone marrow destruction. A new commader had come down from Kure to officially welcome us and provide services for us in any way. He, of course, had surrendered with the rest earlier. But he knew nothing about the local situation. He agreed that there had been maybe 30,000 or 40,000 troops in the town around the castle where there was a big military hospital. This was all ashes, now, and had been destroyed. First it was crushed and then it burned. There was no organization. We, of course, could go and come as we pleased. They would furnish what little transportation they could get in. They had arranged lodging for those of us who were going to stay there.

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TUSLER: You were just saying they had arranged to put you [up for your stay].

WARREN: The Japanese military had arranged to put our party on an island in the middle of the Bay of Hiroshima because this had not been destroyed. It had cooking and other facilities, and it was really a hotel, a very famous resort hotel, mentioned in Baedeker. So we all agreed this was satisfactory. By this time we had unloaded all our gear from the plane and had taken a look around enough so that General Thomas Farrell and Colonel Peer de Silva returned to Tokyo and left us there in the hands of the Japanese. Well, they had a bus that took us to a pier where we got on a steamer and went to the resort. And I think I described our first night or two there. So I don't have to worry about that.

Now I'd like to describe the windup and how we got out, because this was, to me, a very harrowing experience. Well, we got word through our security people that it was about time for us to go back. They wanted to get us out before the typhoon came along. They had weather indications that there was going to be a bad one in about a week. So we got all our stuff together and got back to Tokyo. Then I wanted to get hold of Major Friedell, who was in Hiroshima. I had finally gone to Nagasaki and Major Friedell had gone to Hiroshima after he got back from Zamboanga. I got a jeep and a plane and a crew to run it.

Admiral Tsuzuki and Major Motohashi and Captain Nolan and I decided that we would go to Hiroshima. We got up at four o'clock in the morning, and all motored out, on that same road that had water pipes sticking out to impale you, to the Atsugi Airport.* The first day we spent half a day trying to get a plane that would run. There was a sergeant who would inspect the plane. He would say, "That one won't get off very far." We wanted to take a jeep down and leave it for the next group in the military who were going there. They needed a jeep and we had one. We didn't want to take it back and we didn't want to leave it in Tokyo. We had to allow something like two hours for the trip down, an hour on the ground, and two hours back, which meant we had to get back in about five hours. It was getting to be the time of shorter days and they liked to close the field at five o'clock. Noon was the deadline to leave, but if we couldn't get off by noon, there was no sense in going.

Well, the first day we couldn't make it. The second day, when we arrived there, they had had a bad rain and somebody had pushed out the two planes that we had chosen by this time off the runway. One had a flat tire and the

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* Warren may be referring to the Tachikawa Airfield.--Ed.

other was mired. So they had to work until noon getting that fixed. Then they tested the engines and they said, well, they would have to fix a couple of things. So we said that was all right and that we'd be back tomorrow morning at six o'clock. You can imagine getting all the duffel, more batteries, and everything with our party all on jeeps and out of the hotel and to the landing strip.

The third day we got there, we got one plane off. We finally got our plane loaded with the jeep. About twenty Japanese just lifted it up and put it on through the cargo door. The other plane came back just before our last-minute departure, noon, with oil line trouble. But we decided we'd go anyway because I had to find Major Friedell or else we couldn't get away to go home. So we finally got off just in the nick of time. We were just able to get off the ground with the weight of that jeep and all the gas and stuff.

By this time it was a little cloudy. We flew down to about Osaka with a lot of turbulence and a lot of clouds, and we thought, "Well, if we have to land in Osaka, we better look at the field." We went down within a couple of hundred feet from the ground and we could see that the field was flooded halfway up the posts in the field. Landing there just wasn't feasible. So we decided to go on. Then we began to have trouble with the clouds. If we were able to stay under the clouds, which was good sense because of all these mountain peaks around, we would have to keep going lower and lower. Finally we got about an hour away from Hiroshima when we got into very dense clouds and rain. It seemed to me we were down so low that we could see the faces of the fishermen in boats.

All around us were these darn volcanic cones. We were down below their level because they were maybe 1,000 to 1,500 feet high. We'd been regaled while we were waiting at the airport by the stories of people who had had a jeep aboard who would try to land and would run into a mountain. The jeep would act just like a big piston and would come, whang, right up to the front, smashing everybody ahead of it. Our jeep was tied down with two rings in the floor at every corner, but even so, every once in a while we'd have to go and tighten the ropes because we'd be tossed around and the jeep was a little heavy.

We decided we better go "upstairs" anyway. About this time it was clear that we probably had to give up going to Hiroshima and go back to Tokyo. Hiroshima, of course, had no landing operations at all. It was just a blind landing; if it was socked in, we were through. So we decided to go back. My pilots were two fresh army air boys who had never flown in combat, who had taken on this assignment as a sort of dare because they wanted to see Hiroshima. That's all they cared about. There was the pilot, the copilot, an engineer, and a radio man--four of them. I had Admiral Tsuzuki, Major Motohashi, [Donald L.] Collins, Captain Nolan, one other boy and myself. Anyway, that was about the extent of the crew.

We went up as fast as the plane could climb, which was pretty difficult for us. It got up to its ceiling and couldn't climb any higher and we were still surrounded by clouds, we were tossing to beat the band, with lightning going up and down the wings and around our equipment on the dash. Well, the boys in their excitement had tried to keep the ship from turning over and getting badly damaged by all this turbulence and had forgotten to count the number of turns going up, so they didn't know if the compass was any good anymore. We finally leveled off and had a little conference. I was able to stand, holding on behind the two pilots.

They had my maps, by the way. There were no maps of this area at all. My maps were just ground maps and weren't any good for this kind of thing. We decided that the best thing we could do with the gas we had left would be to try just to make Tokyo, the Atsugi Airfield. We thought there was nothing else to do now, and that we'd ask the navigator where we were. Well, he couldn't hear a thing. There was no loran, which is the homing device and was supposed to be from Okinawa or from Guam. Neither station was audible, and we couldn't hear Tokyo. We didn't know where in the hell we were!

We had only Mae Wests, no parachutes, and we had this damn jeep. So we thought for a while, should we ditch the jeep or not. Then we began to realize that ditching this jeep in midair out the cargo door with all this tossing around was not child's play. In fact, we would be very ill-advised to do so because it might hit the tail or we might have a sudden change in the position of the airplane and it might destroy one of the wings or something else on the plane in going out. So we decided that we were stuck with the jeep. We wanted the jeep off because we were getting quite certain that we didn't have quite enough gas to get back to Tokyo, particularly since we didn't know whether we were headed out to sea or back in the right direction. Mount Fujiyama was in the way. So it was agreed that we would trust the instruments. About this time our navigator had hysterics and just sat on the floor, hopeless, saying he couldn't do anything. He just had a real fit of hysterics. This was at the time we had decided that there was nothing else to do.

We discussed throwing a flare out, but then we didn't know which way the wind was going. This was to tell us whether we were drifting or not. If we were drifting to the side it would throw us off miles. So again it was agreed that we would trust the instruments. We wouldn't put out a flare. We wouldn't think any more about turning the jeep loose. But I had four men sitting beside the jeep being sure the ropes were tight so it wouldn't get loose inside the plane. If it ever did we never could have handled it; it just would have gone through the side and that would be that. About this time it was decided that we would go in a true northerly direction for a certain time. We had just enough time and gas left. If that was the right place, as we thought, we would then turn to go up the Tokyo Bay and we would have just barely enough gas to hit the field, provided we could find it. And we weren't sure where Mount Fujiyama was.

TUSLER: Was it dark by now?

WARREN: It was black as ink, no stars, nothing. And the plane was just tossing up and down. The two Japanese sat on their net and put the blankets over their heads and gave up. They believed they were going to die and accepted it. The rest of us didn't feel much more cheerful. [laughter] But I had the responsibility for these fellows. I was determined to take every chance of getting home. So then we agreed that we better turn the lights off because this would save some gasoline, maybe two or three gallons, maybe just enough. So there we were sitting in the dark and the pilots looking out and watching the compasses and other intruments. I guess everybody prayed.

Anyway, after about an hour, all of a sudden, Tokyo station became audible. It was playing music. So we were out of the shadow and about where we should have been. We couldn't get the field though. By the time the music came on the navigator came to life again. This had provided something that he could use, you see. The pilots made the turn, got the plane lined up at about the right position, and the field responded. The field fellow said, "Whoah, we've been wondering what happened to you. We didn't hear that you landed or anything." And our pilot said, "We'd like to come right down. Where are you?" He said, "Well, I'm about to close. You're lucky. In about another ten minutes I would have been gone. I'll turn the landing lights on for you. You better hurry because there's a storm coming. You may not be able to land."

So then, with that, we had to remember that there was a power line in the way of our coming in low. We had to come in and then go down after passing over that. I reminded the pilot of this, and he said he was very much aware of it. Well, he made a dive and I was afraid when he got down that he was going to take the wings off with the heavy jeep aboard. But we made it all right. The good old DC-3 is a fine machine. We did see the wire. There was enough light from a searchlight so that we could see it. We missed it, hit the end of the field, and got about halfway down when our engines were out of gas. It was that close. Then it rained like hell!

There are a couple of little things I think I can tell you, but I have to see whether we are going to take it out of the manuscript. When we decided to make the turn and we finally heard Tokyo, all of a sudden, most of my people vomited. We had a paper box and we passed this around in the dark. I didn't vomit, so I did most of the passing. And then I decided that I just had to empty my bladder. There was just no way out because I had accumulated such pressure. We had a little funnel in the back of the machine which was on a rubber tube. This allowed emptying of the bladder with the urine going out in the air. Well, in the dark I made my way back there, but I forgot that the floor was not complete. There was a step down to the hall before getting to the tail. Well, in my distress and tension, in going back, I suddenly stepped out into the air. Finally, my foot hit, but then I had the most terrible thought, "Is my foot going to go through the hull?" I knew how thin it was and I was thrown about by the pitching of the ship. Well, I finally made it, but I'll never forget those few seconds when these things were happening.

We were on the field, and it was raining like mad and we couldn't do anything for quite a while. The pilots finally turned our lights on because they were on batteries. There were little piles of vomit throughout the plane because the cardboard box had had no bottom!

The pilots decided there wasn't anything they could do, so they just put their jackets around their heads, lay down on the floor, and went to sleep. They were exhausted and they were soaking wet. The back of their shirts were soaking wet as I could see from behind them.

TUSLER: They did a magnificent job to get you back.

WARREN: Oh, you bet you. If they hadn't done it precisely we wouldn't have come in; as it was we ran out of gas halfway down the field. Well, after the rain quit, we managed to get over to the station. Of course, nobody was there. So about four o'clock in the morning they opened up. There was a field telephone line to Tokyo. I finally got the motor pool, and they sent a truck out for us. We agreed we couldn't get back to Hiroshima. We wouldn't try it this day even though it began to look kind of clear. We had sort of "shot our wad," and Major Friedell would have to get back somehow on his own. Well, along about seven o'clock, we landed in Tokyo in the Dai-ichi Hotel. I met Colonel de Silva, and he said, "What's been holding you up? Major Friedell just got in."

He had gotten there by fording a couple of rivers and commandeering some train rides, and he had gotten back, but just barely. Well, he had gone to bed, so I didn't see him. I was busy getting my boys breakfast and getting them back to bed because they had been up all night. We had had about four nights in a row where we had gone to bed late and gotten up at four o'clock to get out to the field at six o'clock. Well, about eleven o'clock, Major Friedell got up. He said he had some radium that he had picked up at Hiroshima. Going by a pile of bones left from the incineration of the bodies he'd detected this material off the road. It was apparently from a woman who'd been treated with radium for cancer of the cervix, because it had the standard capsule for that. So I decided to give the radium back to the Tokyo medical school. Admiral Tsuzuki went with me, and we took the radium back. Then he said he would like to give me some swords. I had a little aide (who was about five feet two) in the jeep along with Admiral Tsuzuki. [Sergeant Brownell]

After we had delivered the radium we went to Admiral Tsuzuki's house over in the unburned part of Tokyo. Very foolishly, I didn't tell my security man where I was going. In Tokyo, the houses are faced by a fence with a little sliding door. You go into an entry way, take off your shoes, leave them there, and then go in the house. Then the sliding door is shut which makes a solid wall along the street. Aside from the fact that our jeep was out there we could have disappeared entirely. If we had been Japanese officers in America, the conquered people would not have allowed them to exist, I'm sure. No Californian of any stature would have let a Japanese conquerer come inside without doing everything he could to extinguish him. But the Japanese had surrendered without having to commit hara-kiri. This was hard for them to believe, but it was real.

Anyway, we went into the front room, and Mrs. Tsuzuki came out and was introduced and the son was introduced, but not the daughter. I had to ask to see the daughter. I heard her talking in the back and I knew he had a daughter. Then, seated on a bamboo settee, we proceeded to have tea from a low table in this little front room, which wasn't more than fifteen feet square. Across from me, there was Major Motohashi with a bundle of swords on the table.

Major Motohashi looked just like a typical Japanese caricature. He was short, squatty, very powerfully built, dark black hair, great big glasses with heavy lenses and thick frames. His hair was cut in a crewcut. We had talked a lot during the times when we were sitting waiting for the rain to quit in Hiroshima and Nagasaki. He turned out to be a broadsword fencing champion of Japan. We had had many discussions about this. He knew I had fenced some at

Berkeley. So, after the tea, he had a sword presentation ceremony. My aide was sitting on my right, barely tall enough to have his chin over the table. On my left was Admiral Tsuzuki. Major Motohashi was across the table from me in civilian clothes.

These swords were in their scabbards and when he took one up, a typical Samurai sword, he pulled it out of the scabbard and laid the scabbard down beside him. Then he presented the edge to me and said, "You see, it's a very fine blade. This edge is more than 300 years old and it has a wonderful balance, you see, just like that," as he hefted it. (Now, this was the kind of sword the Samurais had used to decapitate their victims.) Well, I could feel myself sweating, and my little aide was pale; but we didn't say anything. And mind you, the major was standing, too. So finally he reversed it and gave me the handle and then handed me the scabbard. He indicated that I was to put the sword in the scabbard, which I did and laid it on the left.

Then he took his cavalry sword up and said, "This is a very fine rare sword. It was the father of Admiral Tsuzuki in the Russo-Japanese War who had this sword."

He, of course, took it out of the scabbard and laid the scabbard down. Then he presented the blade to me and said, "You know this is a very beautiful edge and it is serated, which was the style at that time. Admiral Tsuzuki's father inherited it from his father. On behalf of Dr. Tsuzuki I have great pleasure in giving you this." And I said, "Well, I don't want a family heirloom. I just want you to give me some military swords that have no meaning." He said, "No, we have such admiration--" and so on. It was very long and flowery, and so there was nothing to do but to take it.

He had a couple of others, one for General Groves and one for General Farrell. And I got one for General Nichols too. These were the regular Samurai swords which have a crook. I was awfully anxious to get out of there with all this weaponry around. It was obvious that this wasn't good. I left a battery for Major Motohashi (he was going into cardiology, and he had an electrocardiogram machine but no battery), and we had taken the radium back; so we decided we were through. And with a lot of bowing and scraping, we left. We didn't lace up our boots; we just put them on, got in the jeep, and beat it. The little fellow who was driver stopped around the corner about a half-mile away and said, "My God, we were lucky to get out of that!"

TUSLER: Did you sense hostility in what they were doing?

WARREN: No, not a bit. If there had been the slightest hostility this would not have worked. But we had been together almost six weeks with these two Japanese officers in our party, and we liked each other. They really wanted to do something. This was all they had. There was nothing else they could give us as they were practically destitute.

TUSLER: That's wonderful.

WARREN: So then I had the job of getting out of there. Our officers wanted some more swords and our GIs wanted something. We were told that out on the field there would be rifles for each enlisted man and swords for each officer. Well, I had my quota of swords, so I had a hard time because everybody was snitching things. You didn't dare leave a sword around where somebody could take it. So I had to put them in the dunnage bag. This was difficult because they stuck out. There wasn't any way of making them really secure. But I had to take that chance, anyway. We kept the dunnage bag with us most of the time.

Along about four o'clock the same day we got word that our Green Hornet was going to pick us up out at another field, not at the Atsugi Airport but at another one. Major Friedell and all his group and all my group piled into jeeps and buses or carryalls and got out to the field. There were the guns. No arrangement had been made; they were just a pile beside the plane. So I said "The heck with it" and told the boys to go ahead and get themselves one gun each. They did and got back on the plane. The engines were already started when an officer came over just as fast as he could come in a jeep and said, "Put the guns back. You have no right to take those. They are for another party."

At about this time the pilot was beginning to gun the engine, so I waved and said I couldn't hear anything and we took off. Otherwise, the boys would have had nothing. I felt our boys had earned that much at least. By then, a lot of the boys in Japan had not been in the fighting itself.

We got to Guam about two o'clock in the morning and the weather was just terrible. We had an awful time--maybe the pilots did too, but in the dark our ship pitched a lot and our boys were almost all sick. We just had time for some coffee while they were gassing up the plane. We got back aboard and headed for Johnson Island, and then went on to Honolulu, where all our stuff went through customs.

Well, at Honolulu I found another barracks bag of mine. It had a whole case of cigarettes in it which I was going to use in bargaining, but which had never caught up with me until now on the way home. When I emptied it out, there was the most God-awful stink. A rat had gotten in there and died. As a result, nobody would take the cigarettes. I just left them there at the Red Cross and suggested that if they were aired out and left in the open somebody would take care of them. Gee, it was a terrible blow because I could have made a lot more friends among some of the Japanese interpreters. It helped a little if you could do something, as a friendly gift.

While there in Hawaii I think I had a nap for an hour. We got on board again and flew straight through from Hickam Field at Honolulu to Santa Fe, where General Groves met us. General Groves said, "Well, send your party down to Oak Ridge. You come with me to Los Alamos. We're having an E ceremony." I really hadn't been out of my clothes for three days at this point, but I said all right. There wasn't any choice. I got in his plane, and we went up to Albuquerque. We went to Santa Fe and then by car to Los Alamos. I had on the first winter issue of wool clothes, which didn't fit anywhere. My sleeves were six inches too short, as were the trousers. I had on field boots and I looked like hell, I'm sure. I had breakfast but didn't have a chance to get cleaned up. I shaved, I think, but that's all I could do at the time.

I went out to where the ceremonial platform was. Since we had half an hour or so, I laid down on the grass and went to sleep only to be awakened by a kick on the sole of my shoe by [Robert M.] Underhill who came along with Bob Sproul. I heard him say, "That's Warren. He's one of our alumni." And Sproul said, "Oh, so?" And he said, "Yes." So at this I woke up and stood up and shook hands with them. I hadn't seen either of them for many, many years. Then I went to the _E_ ceremony.

TUSLER: What was this ceremony?

WARREN: This was an _E_, a capital _E_ for excellent performance during the war, and it was kind of a medal arrangement for a company or a station or an institution like Los Alamos. Everybody was then able to wear a little insignia on the lapel which had a little _E_ on it.

General Groves then said, "You come back with me in my plane and tell me all about it." We then went to Andover Field where the _Enola Gay_ had originated, and where they did all the practice bombing in the desert. I think we had a couple of hours sleep. I remember I was able to get a shower and that's all, but they lost my barracks bag some way, so I couldn't change my underwear. I was able to get just a shower. I didn't have any shaving outfit.

We got near Nashville, and they decided to stay overnight. I'd been away from Oak Ridge and my family all this time. I knew if I stayed with them I probably wouldn't get any more sleep but would just want to talk all night. I had already told General Groves everything that he needed to know about what we found. So I said, "Why can't I go on to Oak Ridge by car? I can get a car and I can be there in two or three hours."

General Groves was quite put out, but he finally grudgingly agreed. I got the car with a driver and could sleep a little. But, anyway, I got home about nine o'clock that night. I had not actually been out of my clothes for five days, except for that one shower. And then I slept almost three days solid.

TUSLER: How long then was the whole expedition? How many weeks were involved?

WARREN: I think about six weeks with the week lost in Okinawa. There was the week getting there and the week getting back, about three weeks in the field, one week of which I spent in Hiroshima and two weeks in Nagasaki.

There we got our best information from the Japanese schoolteachers, with whom we would talk every morning. Then we would go out and look at the ruins all afternoon. Most of the children, of course, had been evacuated out in the country to get away from the ordinary bombing that had been going on. Of course, they had received LeMay's clock. That was a leaflet which had a clock on it warning people to get out of the city. Every time the air force would bomb a city like Tokyo, then they would move the clock ahead one hour, drop more leaflets, then bomb the next city. You see, they would stay with it for seventy-two hours or more until they had destroyed whatever they had intended to destroy in the city.

Where the palace and the educational institutions were in Tokyo, they left intact. This gave the Japanese the feeling that we were insurmountable. This was what it was intended to do. And it was also a warning to get their people out. Hiroshima and Nagasaki--Hiroshima particularly --had a lot of Christian Japanese living there. The officials began to wonder whether some deal had been made with the American Nisei to hold up the bombing of Hiroshima and Nagasaki because some of their relatives were there. The Japanese had begun to persecute and jail some of them. There was no such agreement, of course. The cities were just being preserved for an atom bombing later. And we didn't want to hit the big university towns either, the cultural parts. The air force pretty well restricted themselves to the destruction of the military parts. At Nagasaki, they got the Urakami Valley, which was almost all military. There were quite a few people down there, too, but here were mainly the big Mitsubishi plants and the big airplane factory at the north end. The rest of the town of Nagasaki, around the hill and across the bay, was mostly civilian.

TUSLER: What were the literal results of your expedition?

WARREN: We found, first, that there was some fallout that we could trace, but it was mostly of academic interest. It was of token interest, rather than of being any hazard to people. There was some neutron activation of radioactive materials in the immediate target area. These, also, you could identify, but that was all. We verified the results of the irradiation and the immediate causes of the deaths. It wasn't until many years later that the overpowering effect of tremendous doses of neutrons and gamma rays immediately under zero was identified as a brain injury, killing people almost immediately, at least within a few hours.

We had descriptions from the Japanese of the trains backing down into Nagasaki about ten o'clock in the morning, two hours or so after the detonation, and thousands of people packing themselves on the trains. Then the trains would stop ten or fifteen miles out from the city, where-ever there was a school or a flat. A lot of the more seriously wounded or burned would get off there. An awful lot of them would be found dead. They had been squeezed in the train all standing upright like sardines. These deaths I'm sure were due to a combination of shock and a high dose of gamma radiation. And then there were those who had lethal doses of a less amount, which had produced bloody diarrhea and the small intestine then fell apart. Four to six weeks later the bone marrow was destroyed and bleeding and the pallor were evident. It was about that time when we arrived. Some others were still alive and had pretty well recovered.

TUSLER: And that bone marrow condition proved to be lethal, too?

WARREN: Yes. About the time the navy and army doctors arrived, when MacArthur moved in after we had been there a couple of weeks, the bone marrow deaths disappeared. They'd all died by this time. There were a few with purpura who recovered, but the majority of the patients then were those who suffered burns. They were in a post-burned situation. They had been living with the farmers where there was food, you see, and some kind of a bed. And as soon as the first aid stations cleared out their patients with the bone marrow troubles, then the burned patients were brought in.

The American doctors who came in after we were there thought the burns were much more important as a casualty than the radiation. Well, of course, you have to realize that the radiation only went out a certain distance and the people beyond that distance got sublethal doses or none, depending upon where they were. And there were even people in caves or behind heavy buildings who got almost none, even though they were close. This is what's so confusing about the follow-up. Many of the "survivors" may even have been out of the city at the time. But they are counted as saying either consciously or unconsciously that they were in the location that was critical. And it might be that they had an amnesia. Many people do under situations like this. A couple of the Japanese doctors said that "at that time of day, I should have been in such and such a room in the clinic," but they found themselves out in the country twenty miles away about three o'clock in the afternoon. Presumably, they were there, but you can't be sure. That's the way with most of the follow-up information.

TUSLER: Were your findings written up in some published report or how were they presented then?

WARREN: Well, they were presented verbally. The only write-up is the Army Historical Unit's report of my office, and that is rather sketchy. Unfortunately when I got home I had two problems: one was the unwinding of the military operation and the other was the Bikini blast preparations. I was transferred very soon after I got back before I could do any writing up. I was transferred to the Joint Task Force by General Groves. At that time, too, there was a lot of discussion of whether we should give the Russians the description of how the bomb was made and so on.

I was assigned by General Groves to sit in on the hearings of [Secretary of State James] Byrnes and [Henry DeWolf] Smyth--he wrote the Smyth report--and [J. Robert] Oppenheimer. He wanted to give the Russians the poison pile, which I though was foolish. General Groves was terribly disturbed about this. This would not have worked at all. They would have been able to unpoison it without any trouble. I don't know why "Oppie" (Oppenheimer) thought this, but Oppie was a strange man, anyway.

I was very quickly overwhelmed with urgent, immediate duties. I never did get to write about the findings at Hiroshima and Nagasaki or the Bikini thing. When we got through the Bikini tests, we had the problem of setting up the civilian medical office that replaced my operation and then turning it over to Dr. Shields Warren when he was appointed as my successor. And, of course, all during this time I was negotiating with Dr. Sproul to become the dean here at UCLA. He urgently demanded that I come as soon as possible.

TUSLER: All these things piled up.

WARREN: These all piled up. Then I went to Washington too soon to write a report on the medical school; then I left there too soon to write a report of what I was doing there. So this is really the first time that we've gotten as far as this. It's too long a time though.

TUSLER: It was very shortly after your return that the Bikini operation took place.

WARREN: Yes, it was the following summer. We got back in November of 1945. I was assigned at the middle or the end of November to the Joint Task Force. I spent a great deal of time listening to the hearings that Secretary Byrnes was conducting. He and [James B.] Conant finally went to Russia to talk with Stalin and never got the opportunity to do more than ask the question, "Do you want to know about the atom bomb?" And Stalin said, "No." So the whole thing was a farce. Why he said that I don't know, except that he may have been advised by his people that [Bruno] Pontecorvo and some of the others had defected, and that they already had all the information they wanted. I see that our "friend," Dr. [Allan Nunn] May, was arrested by the East Germans for giving information about atom bombs to the Chinese recently. He was the fellow who was in Los Alamos with me. He's a Britisher. The British put him in jail finally. We didn't catch up with him in time. He spent some time out in Los Alamos.

TUSLER: Lansing Lamont talks about that.*

WARREN: Yes.

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* Day of Trinity.

TAPE NUMBER: XII, SIDE ONE

AUGUST 25, 1966

TUSLER: Dr. Warren, last time you finished talking about your Hiroshima and Nagasaki expedition. Today, shall we jump back again in time to conclude some remarks you wanted to make about the Oak Ridge plan?

WARREN: Yes. I think it would be interesting to review the medical and sociological problems that we had, the Corps of Engineers had, and the industrial firms had that took on various parts of the contracts to build and operate various parts of Oak Ridge. Oak Ridge, of course, was originally a large area of very low grade farming. The name came from some black oak trees that were clustered along a ridge called Oak Ridge. This name was part of the security effort to conceal the operation there and what importance the situation might have in respect to the number of people concerned and so on.

The topography lent itself very well to isolating three or four big operations in little valleys with high ridges separating them. That made it possible to put the town on several ridges and in a couple of valleys so that even the town itself couldn't be seen all at once by anybody. It was sort of spread out and isolated, using the principle that nobody should be told any more than he needed to do his job. This spread and isolation was very effective. The principle also meant, of course, that husbands could not tell their wives what they were doing. At first this seemed to be very difficult, but later it was accepted by both sides of the family. It wasn't until the end of the war and the announcemnt of the attack on Japan that the purpose of the project became know to the women and families and to a great many of the men. A majority of the men didn't know what they were working on.

This seizure of the land, in a sense, caused a dislocation of several hundred people who had churches and graveyards in the area. Some had lived there for several generations. But they were paid a reasonable amount for their farms and holdings, even a little more than the going rate. Then they were helped by the Corps of Engineers real estate office to find other farms in the area a hundred miles or so away. A good many of them moved into one location. I've forgotten the name of it. Probably Mrs. Warren will remember it. They moved there as a community or as one body.

I remember when we went there. Mrs. Warren and I finally had to move the family to Oak Ridge in late November of 1943. I have to remember that's twenty years ago, you know. The last contingent left at Oak Ridge had a big picnic. These people had property well out on the edge of the site so that they had no contact or any realization of what was going on in the parts where construction was under way for plants or for housing. But they had a big picnic, essentially chicken by the bushel. They had all their relatives and friends, and we went, too. They had singing and mountain music and dancing. It was quite a thing, quite different from anything we had ever experienced, and it was typical of the southern mountain people. They were mostly unionist during the Civil War and so they were different in their points of view from most of the Southerners in the Knoxville area.

There is a book titled The Tennessee Highlanders, I think. It is quite an interesting one. These people back in the hills lived in log cabins with dirt floors and a loft, and they slept in the loft. They climbed a ladder up the wall usually. They slept on corn husks and straw ticks. They have very little furniture and usually cook on an open fire which is built on a raised dirt platform, a combination of logs and mud. The back wall at the end of the cabin opposite the door is plastered. And there's a hole in the roof. This is their cooking, central heating, and everything else. They do have crude tables. The dogs, chickens, and pigs go in and out of the hut. They eat collards and soaked beans and raise their own tobacco. They had very poor soil, which has been badly handled, and plow downhill because it's easier. It's very hilly, of course.

Some of these people are back in the canyons, where it's very rough country. It's like the country in back of us here over by Ojai, straight up and down. The railroad has a very difficult time getting through these mountains, and so the people are isolated up these creeks. The rocks are so bad that you can't even get a sled or a cart up the creek bottom. One of the reasons for moonshining is that when the corn is fermented to whiskey it makes something they can carry out on their backs. They can carry a five-gallon jug or a couple of gallon jugs, you see, or they can strap them on a horse and come out. This is their cash crop for which they can buy sugar and a small amount of clothing and other necessities.

There's quite a bit of wildlife still in the area in spite of the fact that it's been hunted over ever since Revolutionary times. They get quail and rabbits, for the most part, but they shoot a deer now and then and an occasional bear. And of course, as you go further east, this merges into the [Great] Smoky Mountains National Park and the Cherokee Indian Reservation, which is over near Gatlinburg. Well, these people exist. They wore only overalls and a sweatshirt, or a jumper of some sort, and their ability to stand cold in the winter is fantastic. We were told by various people about this. It's described quite accurately, apparently, in this book on the highlanders of Tennessee. They can sleep with nothing on but a pair of overalls and a thin shirt, out on the open ground, with the hoarfrost developing overnight all around and with temperatures down around thirty. We would be frozen and couldn't do it. But they seemed to be able to.

Their education is pretty well limited to an elementary school, maybe three or four miles off, to which the children go. The distance doesn't seem to bother them much. But their schooling is limited. Obviously, it's difficult physically to get there, so there's a great deal of truancy and no truant officers. So a great many of the whites and colored can't read, but they are not mentally retarded, let us say. They are very sharp. Of course, to even exist in this area you have to be pretty sharp.

A good many people from the highlands came down to work at Oak Ridge. It's interesting that we had a colored cook and house cleaner who had to be trained, of course, in everything. Her first demand was to have an empty coffee can on the back of the stove so that she could spit her snuff into it. [laughter] This was kind of a shock, at first, but all the girls discussed it and were resigned to it. When she came in and said, "I won't do no kneeling," she meant she wouldn't scrub the floors. Their idea was to take a bucket and do it by hand instead of doing it with a mop. They'd never seen a mop or a vacuum cleaner.

These people were put in classes where they were shown how to operate dials. This was a simple thing; they would just turn two knobs or even just one knob and watch the dial and the needle. The needle had to be kept on the center or at a certain location. If it changed and they couldn't manipulate it properly, they would push a button which shut the operation down, or they would call the foreman. I guess there were some eight or nine thousand people who came in to do this. This was the first cash money they had.

I think I described a little bit the problems with the cafeteria. The first day, when we opened the cafeteria and we had maybe a hundred of these people and--later a thousand--fed in this cafeteria, we had to have a GI at the cafeteria line to show them how to pick up a tray and take a napkin (which they didn't know how to use) and then the silverware. Then they would choose what they wanted down the line. Of course, this was all foreign food to them; so they would eat only the chicken. They complained bitterly about the potatoes and things like that. Of course, the colored people wanted chitlins. It took us about a month to figure out what "chitlins" were. Finally the cafeteria manager ordered a barrel of the entrails of chicken from the Chicago chicken cleaning place. It just stunk like the devil when it was opened; but by this time they had a colored person there, too, to supervise it. This was just deep-fried. The stench going downwind was fantastic, but they thought it was wonderful. And after that we had peace.

To go back to the first day: when they got up and left the cafeteria, they put everything on the floor, because at home, you see, the chickens and the pigs and the dogs would have cleaned it all up. When they finished the chicken bones, they acted as they did in the time of Henry VIII; they would throw them to the dog. And, of course, it took a couple of weeks to get them to be able to go through the cafeteria line and make their choices and put everything back on the tray so that the busboys could come and pick it up. I think I described about the colored people having Coca-Cola, potato chips, and a chocolate bar, or something like that, for breakfast. The children had this, too. This was a very bad diet and we had to send out some of our people to explain that this was not good and that they should have milk and so on. I think I explained the problem with the milk pasteurization, didn't I?

TUSLER: I forget; what was it?

WARREN: Well, of course, we were planning for about 70,000 people on this site within the year after we opened. From zero to 70,000 is quite a jump. The requirements for food, pure water, sewage disposal, pasteurized milk, and all of these things were quite a problem. We had a public health officer who was a young major and quite green at this kind of thing. But we sent him around to look at the pasteurizing.

He came back horrified. There was none, essentially; they only warmed up the milk. Milk was collected by an old antiquated truck which circulated among the farmers. The farmers milked and put the milk in five-gallon milk cans and set them out at the road at the mailbox. The truck came by any time during the day and picked them up. They had sat there in the sun. And, of course, the farmers weren't particularly clean. They didn't wash the bag or the tits or sterilize their buckets or do anything. Of course, the first milk that was delivered wasn't even properly capped and the bacterial count was fantastic.

We got some GIs in who had worked in dairies and sent them around to train the farmers. Then we negotiated with the distributor and finally loaned them enough money to buy a good pasteurizing outfit. It was understood he would be the central pool for all the milk that was to come in there. The prices, also, were negotiated, and the price that he would pay the farmer was negotiated. So there wasn't any holdup and money grabbing out of it. This took about six months, but finally we were able to get milk delivered that was safe and had a good bacterial count. If we could get the bacterial count down to 20,000 per cubic centimeter, we thought we were doing very well.

And it was the same with the Coca-Cola. The Coca-Cola syrup was brought in. That came all right in the carboy that was fairly clean, I guess, and sterile; but they had a big mixing vat full of water into which they dumped the syrup. This was open at the top, and flies and bees and yellow jackets and spiders and all kinds of debris were collected in it. So we made them cover that. Then we financed the purchase of bottle-washing equipment and used some hot water to clean and partially sterilize the bottles and the equipment used to make the dilutions. But you were apt to find, in the first deliveries of the Coca-Cola, all kinds of insects and things.

TUSLER: Cooked right in?

WARREN: Not cooked; they didn't cook it. You see, they just added the syrup to the tap water, essentially, and we weren't sure we wouldn't find trout and polliwogs.

TUSLER: Was there any sickness as a result of this?

WARREN: No. We caught it in time.

TUSLER: Now what exactly was your relationship to this? I think of you as being in charge of the safety aspects of the program.

WARREN: We were in charge of all of the safety and all of the health.

TUSLER: The whole thing.

WARREN: We were in charge of the whole medical resources of the community. We had to supervise the meat and all of the things that were used by the people. After a while it became obvious that we had to get involved in some of the social organization, too. I was successful in getting a couple of psychiatrists, Dr. Eric Clarke and Dr. [Carl] Whitaker, and then later some transferred out of the armed forces; so we could deal not only with the psychiatric upsets, of which there were a few, but also with the social problems. Social workers would go out to these housing areas (you have to recall that we had several kinds of housing levels). We had built great big dormitories. Finally, we had cluster housing for 5,000 people, women and men separately.

There was a big swimming pool, expanded from a pond and a spring right in the middle of this housing. And I was bound to get a swimming pool by July 1 of that first year so that by the Fourth of July, when we were to have about 1,000 come in and settle in these dorms, we'd have a place to swim and have some recreation. You see, there were just a woods all around. And the streets weren't paved, but only gravel. We were lucky to get water, sewage, and light, you see. So we finally got the swimming pool--that is the pond--lined with gravel at the edge, because the wind would kick up mud. Then the problem of chlorinating it became a tough one because putting chlorine in didn't seem to work; it would just disappear. So finally they got a canoe from somewhere and towed big barrels of Clorox with holes in them. But, unfortunately, you could go twenty feet behind the canoe and pick up a sample and there'd be no chlorine. It took us some time to figure out that it was the clay in the water that was absorbing the chlorine. Well, it was also precipitating or grabbing, you might say, the bacteria. Finally, our health officer and I reached an agreement that if the bacterial count got down to 20,000 bacilli per cubic centimeter, which was the pasteurized milk acceptable level, then it was acceptable for swimming. But this is horrifying to anyone that's sterile minded, [laughter] as the ordinary swimming pools would be and other swimming places where the water did not contain things which absorbed the chlorine.

TUSLER: But there weren't any problems with that?

WARREN: But there weren't any problems, and we had no infections from this. We were worried about streptococci, typhoid, and things of this sort that might be spread by the swimming pool, because people were coming in by the hundreds. And you could see that we had nothing but a cursory physical examination. They were just asked, "Have you had typhoid or--" Well, that didn't help much, you know. They were apparently susceptible to sore throats.

TUSLER: Where were these people coming from?

WARREN: Everywhere, from all over the nation. The Corps of Engineers had a huge procurement campaign, not through the army, but through the contractors: General Electric, du Pont, and Union Carbide. Mr. [Edwin L.] Jones had a big construction group. The construction contractors for the housing and for the plants had as many as 20,000 workers on the site at a time, because this construction was all on rush. They would complete four or five houses a day when they got going. They'd dig the foundation. The cement mixer was right behind them to pour cement; the carpenters were right after them and put in a floor. The plumber would put the sewer connections in and ditches were dug.

About that time the big trucks would come by and deposit the marble gravel. They found a big marble quarry right on the site. This was ground up and made a very fine aggregate for the roads. That red clay, when it rained (which it did every third day on the average all summer), became ankle deep in mud within an hour. Of course, when you went to visit somebody, you wore your galoshes and you took them off on the porch and you went in barefooted. Well, it was common that if you would go to work with your car, when you came out at four o'clock if it had just rained like mad, the car would be mired down. So you'd have to put chains on in the mud. The next morning it was kind of dry, and you'd take the chains off. Well, that gradually improved, you see, as they got more and more streets covered with the gravel.

The last thing that happened was that a big gang would come around with a truckful of doors and they'd put your house door on. The doors were different colors, which was a nice way of identifying these houses. You'd see the truck just moving away and a moving van would back in. Very often it was so heavy that it would get mired down through the gravel. Then they'd have to pull the van out. But if your house or your aparment wasn't ready, then you had to hole up in anything that was available around. Clinton was about fifteen miles away, and the people were living in modified chicken houses, just anything that would have a roof on it and where you could put your wife and kids for a temporary period.

TUSLER: And how did people react to this? What was their spirit?

WARREN: Well, their spirit was good. They were all excited. It was pioneering and secret. This helps, you know. And they put up with all kinds of inconveniences with transportation and food. We had an awful lot of trailers, which were just beginning to be manufactured at a good rate. I'm sure that we increased manufacturing and better design. Some of our engineers would go around and talk with the trailer people about improving the design. Then we had prefab houses which were assembled on the spot. They came in by truck. Also, we took down a lot of army barracks that were abandoned for some reason and brought some from as far as Indiana by truck. Individual houses were just knocked down and dragged down to our place and put up on foundations. This went on all around. Bulldozers were echoing all over the place all the time for two years, and there was lots of dust, of course. But this furious activity was infectious, so everybody really got going and didn't worry about why. And, of course, during the initial instructions they were all indoctrinated with "What you hear here, what you see here, leave it here." There were a lot of slogans like that around.

TUSLER: Were you bothered at all by the outside world attempting to pry?

WARREN: Not a bit. There were a few inquiries made by people, but the local inhabitants would shut them up and say, "We don't know what's going on down there, it's just none of our business." It was very interesting, how, without being told at all, they would take care of the security. You see, these people were getting kind of a rough deal, but there was almost no complaining--just two or three episodes.

And it was difficult to get there, you see. You had to get a car, and cars were short. The only extra transportation was a few taxis in Knoxville. And you had a very difficult time getting to Clinton from Knoxville. It was twenty or thirty miles into the woods; the roads weren't too good and they were jammed with our own traffic. So there was hardly any way for anybody to get there. The three railroads that went in there hauled freight exclusively and no passengers. All passengers were debouched from the railroad at Knoxville. You could come in by two or three gates, but these had guards on them. Of course you had to have a pass, and sometimes permission. You had to have a sponsor. But the gates had nothing much to do with strangers.

TUSLER: The newspapers didn't pry?

WARREN: The newspapers didn't know about it. But then later in the war, one radio commentator thought he was smart. He said that he understood there were four or five thousand people in a place called Oak Ridge near Clinton. Well, there was a security officer in his office within an hour. [laughter] And without telling him anything, it was pointed out to him that since it was so difficult to get information, didn't he think perhaps there was a reason why it should be quiet and that it was his patriotic duty not to mention the fact?

TUSLER: And he quieted right down.

WARREN: So he never spoke about it again. But this was very late, I guess, almost the last year of the war, because this was critical; this was the time when we didn't want anything known about it at all.

TUSLER: I think that's quite extraordinary that you didn't have more of that with all of the movement of trains and the drawing of people in there.

WARREN: Well, of course, the trains were full of people that were going to induction centers. Trains were half military already, or three-quarters. Well, there were a few, you might call, hotels. There was one place--gee, I've just forgotten the name; it's not the Rest House--where important people could come and stay for a couple of days in a kind of an apartment arrangement. There was a cafeteria there so that they could eat. But if you didn't have a specific assignment, there was just nothing you could do. The recreation hall wasn't full of anything that was of any value to a visitor. There were just people sitting around drinking beer and playing a few card games and maybe singing a few songs or listening to the radio. Towards the last some of the scientists got together and produced an orchestra that had quite a flair for a few months. It's still going, too, for that matter; but it got together later. Waldo Cohen was, I think, its spark plug and organizer.

TUSLER: Was he one of the scientists?

WARREN: Yes, he was one of the scientists in X-10. Later, he, along with Paul C. Aebersold, developed the manufacture and distribution of radioisotopes for experimental work and medical use immediately after the war. They had a big extraction operation already in existence, and it was quite easy to convert it to commercial use. Of course, they had the set standard for the use, which is something I'll take up later.

Well, then we had about a year after this big mob of people settled there. We had 71,000 living on the property and about 10,000 commuting every day. We had an epidemic of polio in the periphery. Of course, we were scared to death that if we let it loose we were just sitting ducks for its dissemination. If we had only known what the vehicle was! At this time we didn't know whether it was a fly or what. I made a special trip up to Buffalo, which was an endemic area. Of course, we had had a lot of it in Rochester. But we came to the conclusion that the fly in open sewage was the vehicle.

So we got some of the early DDT and just plastered the whole area, particularly around the cafeterias. Now there's one thing about construction. As soon as you begin to open a lot of ground, flies seem to multiply some way. Organic material, I suppose, is disturbed, and maybe worms and other things furnish food for their multiplication. So, just overnight when the cafeteria was hardly open, with the first scent of cooking, the flies swarmed all over the building. Of course, we had screens on, but you had practically to wipe away the flies in order to get in. So the DDT was used right away and that stopped them. We had no flies after that. And it was very lucky for us that we had the DDT.

Well, to finish the polio problem, we had a lot of people in from the Buffalo and Rochester area, particularly those that were working for Eastman Kodak. The local people were beginning to find out from friends at home that there was more polio outside than here in their home grounds. There was no sense in going back; they were better in Oak Ridge, since we hadn't yet had any polio in the area. There were about forty cases, as I recall, in one of the little villages about ten miles out. But we had only three suspicious cases. One was a little girl who had a slight case. She had a fever and we got her in right away. We were looking for this, you see. She got a little increase in protein in the spinal fluid, and a few cells, but that's all. She had a fever just a few days. And the other two just had colds, I guess, because they showed nothing and recovered right away. That's all we had. Well, we kept our fingers crossed for about a year on this and watched every sniffle, practically, in the schools. If anything was reported we sent somebody out to look right off, or get them in. This is one advantage to having military control.

The town itself was operated by a nonprofit corporation called Roane-Anderson, because we were across two county lines. This was a good disguise. The Roane-Anderson

Corporation operated all of the village operations. They built and sublet the stores. At first they tried to get at least one of each kind of store and then later they tried to get some more. But a lot of people, when approached, would say, "Well, how many people are we going to have to serve?" And they couldn't tell them. "But you'll be all right." "Well, what are you doing?" "Well, we can't tell you." So they'd back out.

They were kind of fly-by-night entrepreneurs who came at first. But soon a couple of stores showed that they were very prosperous, even though they could not disclose to an inquirer how much they were making, how much they sold, and so on. It was quite obvious, just looking at it: the shelves were full and they were crowded with people.

After about a year or so it was not too difficult to get storekeepers of one sort or another. Also, it was necessary to disguise their purchases, because if they got a carload of can goods or something too often, this would disclose to somebody in the canning industry that here was a big bunch of people. So the orders were split and a lot of monkey business was manipulated by the engineers and by the Roane-Anderson people, finally.

Roane-Anderson appointed a mayor, theoretically. They also got a city council. This dealt with problems when there were arguments over the gardens. City government was, of course, unnecessary, but they hired some policemen and had a patrol car or two. The place had some of the earmarks of a city. Of course, part of it consisted of the cleanliness of the bus station, because the buses came in just like big trains. They would come at certain places, stop, and let people off to come to work. Of course, we never saw the people that were deposited at the plants. They came and left by buses which didn't mix with the buses from other places. The tendency was to cluster the people, except some of the scientists and the military, in the environs near the plant and over the hill, so they couldn't see the plant, so their families couldn't tell where they were going and what they were doing. Of course, the family couldn't visit them. There were guards all around the approach gates. You wore a pass on your lapel or shirt. Some of the pictures on these passes were pretty fantastic. We still have one of Viola's. You'd think she had escaped from something. Mine wasn't much better. And the children didn't look like themselves at all.

I think I mentioned the fact that the engineers had constructed the sewage disposal of the plants upstream from the water intake for the water supply. But they said (after I complained about this), "Well, if the effluent isn't good enough so that the water is good, then we have failed; but we guarantee it." This turned out all right, and they were successful in this. And after all, the Clinch River from which we drew our water supply had sewage dumped into it from Clinton and all the people upstream. You couldn't drink it anyway. It had to be purified. So we had great fields for filtration and digestion of the sewage and filtration of the water.

The only complaint with the water was that there was so much iron in it that very shortly we began to have trouble with the plumbing, particularly in the houses. This was war issue plumbing. It was Britannia metal, very badly cast, thin material. Faucets would leak and toilets would leak; and this caused Roane-Anderson quite a bit of trouble to keep the plumbing maintained all the time. It was hard to get plumbers because the plumbers were working on the war effort. So there had to be an agreement that the deferment of these people and the use of these people for maintenance and so on was just as important as their working in the plant.

Meat was a very serious problem because we had meat ration points. We couldn't disclose how many people we had, so they eventually bought about 70,000 cattle, I think, in Louisiana, and drove them up back roads and finally got them to an isolated part of Oak Ridge where they slaughtered them. Of course, we had to have veterinarians and inspectors for this to be sure none of the cattle had undulant fever or tuberculosis and other things that would affect the meat.

We had a hard time getting butchers. But when the first butcher came, there was a big line of women waiting. Word had gotten around that a butcher shop was going to open that day. The meat had been delivered to the butcher shop and quarters of beef lay with quarters of sheep on the floor. The butcher, of course, came in with muddy feet and he walked right over this meat. My health officer came along just after that and saw the muddy footprints over these carcasses and he said, "You shouldn't do that." And the fellow said, "Well, I wasn't interested in this job anyway. I think everything's crazy, and I'm not going to stay; you do it." So he took off his apron, put it over the head of my health officer and walked off! Well, there were about a hundred angry women. So I heard about it and I called him in and said, "You've got to use more discretion." We had quite a little heart-to-heart talk about things, and I told him he had to close his eyes to certain things in order to get a job done and to help rather than to be just official. (It was like the swimming pool which came up a little later).

Finally, the next day they got a couple of butchers in and cut the meat up, and the girls got their meat. Otherwise, they had to get in the car (and there was rationing of gasoline units), and four or five or them would go together to Clinton or Knoxville. Well, so many people were doing this that they used up the meat in Knoxville and Clinton, too. The local people would get in and buy their meat at six and seven o'clock in the morning. When the Oak Ridgers came, there was nothing for them except hog jowl and soup bones and stuff. Well, it was quite a problem to get the food in.

TUSLER: It really became quite a self-sustaining community, didn't it?

WARREN: Yes, it had to be.

TUSLER: Everything was done on the premises.

WARREN: Yes, the idea was that the army would transfer as much as it could to civilian operation. That's why the town was not an army town. We went around in uniform, but there was no saluting and no drill at all. The general said that we had no time to drill, that we had a job to do and to get at it. The saluting was very prefunctory. Whenever a new officer came, he saluted right and left, and it took him about a day to figure out that it wasn't done very much.

TUSLER: You began to speak, a little while back, about some of the social problems.

WARREN: Well, the social problems became severe in two or three areas. In the first place, the women, when the cooking and the housework was done and the children were off to school, would sit around bored. There were a few radios, not very many. We had moved a piano down there, and this became a very useful instrument, particularly in the evenings. So Viola and Mrs. [Kenneth D.] Nichols, who was the commanding officer's wife, had the job of figuring out activities for the women. And Viola can tell you how they organized a women's club and all kinds of reading groups and singing groups and things of that sort. Then the churches began to come in, and she can describe to you how each church was assigned one hour and how the women would bring their hymnbooks and their flowers and then would take them out, and the next group would put theirs in.

Well, one problem, of course, was in the trailer camps and dormitories, particularly in the trailer camps and in the small housing for the workers. Many of these families were common-law marriages, and there were lots of arguments and spats. We had no real murders in that group. We had murders among the colored, who were quite nonchalant about stabbing each other with perfect freedom. There were very few colored families. The colored were mostly single people, younger people, and the colored women were in dormitories behind barbed wire. They had to have a very high fence because the colored men--or the women--would climb the fence.

We also had incipient divorces and so on, so that the social workers began to have quite a load of patients that were brought in to see the psychiatrists. Of course, psychiatry was not a very acceptable brand of medicine at that time. We had had our hospital and an outpatient clinic built by this time and had a large wing full of psychiatrists and social workers. Seventy thousand people is a lot of people, particularly people who were not acquainted with each other before. The "peck" system had to operate in these small communities where the housing was. But, if the client was a man, and it looked as if he was having trouble adjusting to his job, the personnel office of the plant would send him to the personnel counseling office. This was entered through an outside door separate from the clinic, but it opened into the clinic. They went to the receptionist there, where there were no signs or anything except Personnel Counseling on the outside door. There was a convenient parking lot there for his car. He would be ushered into the social worker who'd ask a few questions, and then he would see the psychiatrist. The clinic was labeled psychiatry, but the patient didn't have the stigma of going to the psychiatrist. By this time, he had told his troubles and he had been started. And this turned out to be very successful. I think we prevented as many as eight or nine thousand separations.

This was very important. In the first place, there was the trouble of procuring these people. They might have come from several thousand miles away. And, too, there was the cost of clearance. There had to be some kind of investigation of the man's or woman's background before they came in--of where they had worked and of what kind of people they were. We had to know if they were in trouble, or if they had bad companions. Were they crooks, drug addicts, homosexuals, or things like that? We were not so worried about those particular items, per se, but by the fact that they would be vulnerable to pressure which might make them likely to say things that they shouldn't if they were blackmailed.

We also had difficulty in getting civilian doctors and dentists, because we didn't want to take the boys out of the armed service; we did have to have a skeleton group of the more highly trained ones. It wasn't until the second year that we could get some civilian doctors and dentists. We got them deferred from the draft, or they were over age, or they had some physical difficulty which prevented them from joining the military. One of [our] troubles, particularly in the plant operations, was to get men who were not alcoholics. We took some alcoholics and, I think, we were pretty successful with them; but we had to eliminate about four, which really was a small number in the whole operation.

We set up an insurance program because this was not to be free medicine, and everybody paid in. Dr. Friedell and I came out here and talked with the California Physicians' Service, which was just starting here under the auspices of the county medical society. We got a man from Ann Arbor [Dr. Nathan Sinai], who had been responsible for publishing a lot of studies on medical insurance, to help us set up our insurance. We were quite forward-looking and early in this, because we had everybody on a payroll deduction, which, of course, we could enforce. But this payroll deduction was rather inexpensive. It was $5.00 a month per man and $7.00 per man and family. Then we had a dental program which started out at $5.00 a month, but the teeth were so bad that we had to raise the price. I think we finally got it up to $10.00.

We had our own dental laboratory where they could make any kind of dentures, crowns, and so on. And this was organized by a Lieutenant Peter P. Dale from Rochester, who came out of the Rochester dental program. He was a very good administrator. I had to go to the procurement office in Nashville to get the assignment of four or five dentists from the armed forces Dental Corps and from the surgeon general's office. And I had to get the deferments through that office, also. I learned a lot about dentistry there, too.

We set up our dental program very much after a scheme

I saw used in Nashville by one of the older dentists. He had had fights about this with his confreres, but he finally had been able to convince them that this was all right. He had twelve dental chairs in his suite and only one other dentist with him. The patient would come in and be x-rayed. Then the teeth were cleaned. This was all done by dental technicians. In the cleaning of the teeth and from the X rays they could identify the cavities. When the patient had gotten this far the dentist would go to look and verify the fact that there was a cavity there. He'd give the dental technician a code number, and the technician prepared the cavity for that type of crown or whatnot. The impression was made after the dentist had approved the work. The casting was made, and the patient would come back in a few days and it would be put in. The dentist would go in and put in a few touches to be sure that it was all good and so on.

This was really dentistry on a mass scale. It was very satisfactory. I looked at some of it, too, and I got Pete Dale to go over and look. So we tried this at Oak Ridge. There were some objections, at first, but it finally began to work pretty smoothly. We fixed thousands of people's teeth there and just about broke even financially. But we had to have a big dental clinic, a two-story building a couple of hundred feet square.

TUSLER: Was it your responsiblity to oversee all these different aspects?

WARREN: Yes, this was part of our program. It was part of the health care. Our job included public health, food, other care, and the general comforts of these people--anything that was necessary to keep them satisfied with the job.

TUSLER: You also were responsible for the safety aspects of the plants.

WARREN: Yes, the safety was another responsibility. We had a different crew for that. You see, the same problem existed at Hanford and Los Alamos. Then we had to keep an eye on the contractors who were refining ore, not only for the safety but for the health of their people, because we didn't want anything to happen that would give a bad name to any stage of the process anywhere. So we upgraded their medical programs everywhere. Then we would call on these plant doctors. We would tell them just enough so that they knew they were handling the refinement of uranium. We would tell them about the X^1 and X^2 (that was the strong gamma emitter that came out in the discards) and why we were interested in their people using masks, showering, keeping their bodies and clothes clean, and things like that. If there was a suspected contamination, then the doctors would do urine tests and blood counts. By this time the combined efforts of the Chicago and Rochester laboratories had devised urine tests, phosphatase and blood cell counts that would detect the very early rather innocuous effects from uranium. The damage would heal, if we found it, by ceasing exposure. It was a very fortunate thing.

Well, I think I mentioned the fact that there were four processes given in the report of the committee to General Leslie Groves. (As I said earlier, the committee was composed of Drs. Conant, Bush, Lawrence, Urey, Murphree from Standard Oil, and Arthur Compton from the University of Chicago, who was called "Mr. Holly.") They agreed that the urgency was so great and the real possibility that none of these methods would work that they should program all of them. This turned out to be a very useful thing. The reactors finally did produce enough plutonium, all right. The giant cyclotron-mass spectrograph method of Dr. Lawrence, which was operated by Kodak, dealt in molecular amounts. This made the accumulation of great amounts pretty difficult. This had been known, and they had used a fantastic amount of steel--the equivalent of a battleship--in the magnets. They got along far enough so that they were able to start Dr. Urey's barrier filtration procedure which wouldn't start up to that time. The plutonium was made by a reactor on uranium, but the other processes were supposed to separate the less common uranium from the more common variety. The less common variety was the one that would "fish" and therefore detonate under the right conditions.

The navy, under Dr. Philip H. Abelson, who is now the director of the Carnegie Foundation, had a steam distillation system which required thousands and thousands of feet of big pipe. There was a little pipe in the center where steam was carried under terrific pressure. This, again, used a hexafluoride. The idea was that with distillation and migration upward, the lighter molecules would go a little faster than the heavier ones, so there'd be a slow separation as these gases travelled up the column. They stacked these pipes in an area about as big as a city block, just as close as they could make them. They stole the big generator plant. It was a steam generating plant the city of Chicago had on order and was about to have delivered, but the Manhattan Engineer District procured it out from under them and put it up in the woods. Coal was easily brought in and they generated the steam for Dr. Abelson's program, which was called S-50. That got underway just in time to help Dr. Urey's program add another step. When the Y-12 Kodak program got started, Dr. Abelson was able to dump in some enriched material. At a later stage to get it over another hump, due to some peculiar physical chemistry that nobody had expected, material was taken from Dr. Lawrence's program to Dr. Urey's. As soon as Dr. Urey's plant got into operation (as I told you, this was about a mile long and had to be supervised by going from one end to the other on a bicycle because it was too difficult to walk), it began to produce enough uranium so that they could begin to have bomb material.

Did I tell you about the coming of the railroad? Each railroad representative at the beginning of the second year came around to visit the colonel and complain. They'd been bringing in thousands of tons of building materials and other things; and they thought the army must be making something, but they had had no business for taking out the products. Well, at that time, the product was in micrograms, hardly visible, which was being taken out to Los Alamos in a little vial contained in a briefcase chained to a courier's wrist. So the Oak Ridge admins-trators had to tell them, "Well, we're sorry." But they couldn't be told what was being done, so they had to be satisfied to continue as it was. When it all came out they would be pleased that it had worked as well as we thought.

We had problems when we were putting together the plants that would provide the fluorine for the uranium hexafluoride. This was a gas at about 110 degrees. It could be handled as a powder or as a solid and manipulated; but when they wanted to move it, they would just heat it up and it would produce a gas. That's why it could be used in the barrier process. The gas was pumped against many baffles of very, very thin nickel sheets which had intermolecular pores. As it went through the maze the lighter stuff went through the sheets and the heavier stuff would continue to go by. They had thousands of these baffles with big fans all sealed up. There were troubles with bearings because this stuff was quite corosive. Everything had to be absolutely clean because if there were a speck of carbon in the valve and if somebody turned the fluorine valve, there would be enough heat produced so that the gas would catch fire. It would be just like a welding torch and burn right back to the vessel which supplied it. So Dr. Hodge did a lot of experiments with rats and mice and dogs to determine what the toxic dose of fluorine was. Of course he also had the hazard of the elemental fluorine burning in his laboratory. But they got along fine with the animal experiments.

In order to clean the pipe, the solvents were put in a big vat about two feet longer than the twenty-foot-long pipe. This was special pipe. I think it was plated on the inside with nickel or something similar. But, anyway, it was special pipe. These pipes were hoisted in bundles and submerged in the solvent and then cleaned with soap and water and gasoline. The last dip had to have a special solvent which took all of the carbon and every other kind of debris out. We thought it might be very toxic. So we had to do a "quick and dirty" toxicity run on that. This was what Rochester was set up for, you see--to do these kinds of things. It was decided that it wasn't very toxic after all and that the vapors around the pit, if it were done out in the open, would not be hazardous. But if men had to down in the empty pit before the solvent was dried out they should wear masks. That information had just been received and accepted the day they started the operation. This is the way it was done all the time. We would get the information, issue an order, and that's all the word they'd need for the operation or to start a new procedure.

It was like the carbon tetrachloride. We didn't know very much about it, but we knew it was toxic. I went down to the chemical warfare experimental headquarters at Gravelly Point, Virginia, to see Colonel "Dusty" [Cornelius] Rhoads. He wanted to know why I wanted to know. I said I couldn't tell him, but that I wanted to know all about their findings on carbon tetrachloride poisoning treatment, because when it was poured on a hot plate it formed phosgene, a chemical warfare gas. And we didn't want that to happen around our place. Well, we had two accidents with that: one occurred on Saturday during Eastman Kodak's preparations of it; the other I described earlier.

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WARREN: I was telling you about the fact that the Eastman Kodak Y-12 process used uranium hexafluoride in the process of separating the two uranium isotopes in the big mass spectrograph operation. We began to be worried about phosgene, because when carbon tetrachloride is heated, it becomes phosgene very quickly. In fact, it's dangerous to try to put a fire out in a closed area with carbon tet. You could get phosgene poisoning and die. It's a very bad war gas.

So I went to Gravelly Point, [Virginia] to the chemical warfare people, and they gave me a lot of information. They indicated that we could perhaps detect people who were exposed to small amounts of phosgene by electrocardiograph records. We might expect to find heart irregularities. With higher doses, of course, we'd expect to get fatal heart damage. And there were liver injuries and other things that were of less importance. They gave me some testing equipment, too, so that if it couldn't be detected by odor--it has a sickish, sweetish odor--it could be tested for and some idea of the amount in the air could be measured. But they had no experience with ventilating factors or other properties. All their work was done in closed operations. It had been tested since the First World War. They were pretty confident that they could handle phosgene production without any serious problems.

Well, we were prepared. And our first and only episode at Oak Ridge occurred one Saturday afternoon, when things were closed down. One of the scientists conducted a little special operation with carbon tet. When he was through, he dumped it into the stack in such a way that it got mixed with very hot gases. He didn't realize this. About thirty or forty pounds of carbon tet went up the stack. That amount therefore produced maybe four or five pounds of phosgene in the process. Well, the hot gases from the stack of this building--it was about four stories in height--hit the air inversion and leveled off. As it crossed the edge of the building, there was an updraft on the sunny side, but as it crossed on the cool side, there was a downdraft.

This downdraft brought the phosgene through an open window into a lavatory where a colored lady was sitting. She began to smell a funny odor. Since she was finished in there anyway she got out. About this time the detectors noticed the carbon tet around the building, and the alarm went off. The prescribed routine was to gather all the personnel and get them all out, then to ask where they had been and how much exposure they had had. About this time the colored lady, who was a cleaner and a mopper-upper, began to get wobbly. So they rushed her up to the hospital. We did some electrocardiograms. Dr. Friedell and I were notified and went down there. But, by this time, she began to get over her nausea and began to feel pretty well. The electrocardiogram changes were there; but they were very minor, so we crossed our fingers, thanked our lucky stars, and discharged her with no probable follow-up problem. We saw her every day for about a week, and she recovered completely.

A little later at Berkeley--I think I did explain this to you--a chemist [Stanley Reuben] who was working on the chlorination of uranium by carbon tet had a vial of it out on his desk and was shaking it and looking at it when the phone rang. He had broken his arm, which was in a cast--I did tell you, didn't I?

TUSLER: Yes.

WARREN: He died. He got about four or five cc's of the carbon tet right in his face and had inhaled it. This really caused trouble. This was phosgene itself. He had had a lethal dose and had extreme electrocardiographic changes. He died leaving a wife and two small children. It was a serious blow to the effort there, too.

TUSLER: Does death follow almost immediately after exposure?

WARREN: Two days. He was given oxygen--I've forgotten now--a lot of other things. Dr. James Sterner, the Kodak industrial physician, was there, fortunately. The student health hospital--Cowell Hospital--was right across the street from the chemistry building, and he was rushed over there, but it was too late to do anything about it. You couldn't neutralize the stuff. I have a faint recollection that we tried some of the metal chelating agents which were just then coming along as a way of reducing some of the cellular damage from various toxic agents. I know that our Rochester group was trying them in the mouse and rat feeding experiments with uranium. But the chelating agents really combined with metals rather than the chlorine in the phosgene. It's the wrong chemical charge.

TUSLER: Well, that's a very good record, only two such cases out of the entire operation.

WARREN: Yes, out of the whole works.

TUSLER: It seems quite fantastic to me.

WARREN: Well, we had a good system of standards and policing. Being military, we could enforce them. And since the contracts were mostly cost plus, the engineers could insist in most of the cases. There was no identifiable fee concerned so the process couldn't be traced. Well, du Pont, particularly, first raised the question of safety, because they didn't want to be called the "merchants of death," you see. Kodak would have complied, anyway, without this enforcement. Since they didn't make uranium powder to any extent they weren't involved as "merchants of death," but they just did this research as their contribution to the war.

We had no other serious episodes of any sort and no epidemics. We had what was called the "crud." Every time anybody would go on a trip they would get a diarrhea and come home with that, but fortunately it didn't spread. This was because we took meticulous pains to keep the cafeteria clean all the time. This diarrhea was the source of most of the absenteeism, if the diarrheas were bad, or it would be an excuse not to work--one or the other. So particular attention was paid to that illness.

We had one accident, an electrical shock death in the Y-12, the Kodak program. It was during the installation of equipment, which really could not be charged to the operation. It occurred through a miscue by the team that was installing and testing the electrical controls of the big mass spectrographs. It involved one of the GI boys who was part of the team. You see, if the contractors couldn't find someone to work, the engineers would procure him from the army. They would just look through the cards and put in an order for this code number, for one boy or several boys. This is the way they got a lot of chemists.

The Philadelphia operation had some trouble. They needed a chemist or a chemical technician in the line that was operating in front of the row of pipes I spoke of earlier.

Many of these pipes had little petcocks which enabled you to bleed off a sample. Then this sample was tested for the ratio of the two isotopes of uranium. This was difficult and tricky because of the 1200 degrees Fahrenheit steam temperature, at about 1,000 pounds per square inch of pressure. Fortunately, nothing ever let go as far as the steam was concerned. But once in a while the gases would corrode the exit joint of this little pipe where it was drilled into the big pipe, and that would blow out. We had insisted on treadle showers at both ends of the row, so that if the boy was exposed, he only had to go twenty feet--about five big steps--and jump on the treadle and put his face up towards the shower. We also had drinking fountains that could wash the eyes out if it was necessary. You get a bath in today's drinking fountain, but these were made a little bigger to throw a stream vertically so that you could lean over, step on the valve, and the stream of water would hit your eyeballs and wash them if you forced open the lid.

TUSLER: Did these devices have to be used?

WARREN: Not very often. Our people and the contractor's people drilled all the operators of these operations. We installed these treadle showers and pull-chain showers everywhere there was the slightest possiblity of exposure to acid of various chemicals.

Now there was an accident at the Philadelphia Naval Yard (where Dr. Abelson had set up his pilot program), where they were fluorinating the uranium in big steel vessels. These were six feet in diameter and six or seven feet tall. One night they forgot that with the reduction in temperature the gas would become solid. As a result, the pressure stayed low as they fed the gas into the vessel to stop the process over night. Since the gas became a solid and shrunk, they put more in than they should have. And then the next morning, when they began to heat the vessel up, the solid turned to gas and the pressure rose fantastically high and blew the vessel apart.

There were about fifteen men in the room, and they got a big dose of the hexafluoride, both by inhalation and by skin burn. Some of them acutally got it on their faces. So I flew down there. This was where Dr. George Lyon first came into the picture, because he had come back from the European theater as a man who knew a little bit about toxic chemicals. He was a captain in the Medical Corps of the navy and was assigned to the Philadelphia operation. This accident occurred about seven o'clock in the morning, and I got there about two o'clock in the afternoon. We met and went around to see these patients. I was horrified to see about ten men with opaque corneas. Of course, we left orders to look at the urine and blood counts and other things.

There wasn't much we could do at that time. We didn't know about chelating agents, but they wouldn't have done much good, anyway. The uranium had been inhaled, and the hexafluoride had spread all over the skin of the face. Well, the faces were red, but they had washed them off and it looked as if there were going to be no problem there. But the corneas looked just like brown manila paper. The next day we got an ophthalmologist in. He looked them over and he said, "Well, I wouldn't worry. In about ten days I'll peel that outer layer off, and it will leave no scar." And this is what happened.

TUSLER: And their eyes weren't damaged?

WARREN: Their eyes weren't damaged one bit, and there were only two, I think, that had moderately severe injuries to the kidneys from the absorbed uranium. Uranium damaged the kidney as it was excreted. I don't think we had any bad results, eventually. I think within a year they were all clear. I don't remember ever again hearing anything about them.

TUSLER: But there were no deaths as a result of this accident?

WARREN: No, no deaths. But there could have been deaths from the power of the explosion. A piece of steel could have killed somebody.

TUSLER: Don't you think it's remarkable that there weren't any?

WARREN: Yes, very remarkable. Then we had some trouble at the Brush Beryllium Company in Chicago. Beryllium is a rare metal, of course, and beryllium oxide turned out to be a very excellent material for high temperature. It really makes a ceramic-like material that can be machined and so on. The ore was in pretty good concentration. I think it was shipped in from Brazil or somewhere. I'm a little sketchy about this. Anyway, there were a couple of brothers who had a little plant. The engineers took over its output and tried to beef up the output. Almost nothing was known about the toxicity of beryllium oxide at this time. We were very much interested in what might happen.

We didn't hear about it until Bob Stone saw some of the patients that had worked in the factory. In fact, one of the brothers had inhaled quite a bit of the dust. Beryllium has the unhappy faculty of causing a peculiar sclerosis of the lung, which is progressive and ends with shortness of breath and, finally, the inability to walk around. There were four or five deaths from this, in this operation. They would not clean it up the way Dr. Stone's people suggested, so I don't feel we were responsible. It wasn't until some of the people in the houses downwind from the plant began to have trouble and a couple of them died that an autopsy showed this result. Then Dr.

Stone in Chicago and Dr. Hodge in Rochester began to do some experiments on it. It was quite clear that this was the inciting agent. It's almost a tumor-like overgrowth of the lung parenchyma. It was confused with a carcinoid tumor, which is one of some rarity; but it had the same peculiar overgrowth of lung epithelium and a sclerosing fibrosis. It's quite different from silicosis.

We had a little bit of that in Los Alamos before we became sophisticated in this area, because they were machining beryllium oxide in Los Alamos. There were two or three men in the machine shop who got into trouble. One of them, who is still living in Pasadena, had quite a rocky road for maybe three or four years. He could hardly walk up stairs. I saw him here as a patient after we came here. But he's married now and earning a living. He's gotten over it. He was paid quite a healthy compensation and had good medical care. Now this is no exchange for health, but, nevertheless, there was an effort made.

We had a very good compensation insurance program. The insurance companies were called in by the engineers. They were told that they couldn't be told what the operation was, but that they were to stand behind anything that might happen. They would get a fee for this and the money would be paid for by the Manhattan Engineer District. The company would be reimbursed. So, while they were a little unhappy, particularly not knowing what they bought, and not being allowed to go around and see anything, they covered everything. All we had to do was to certify that it was true that the man was hurt. Our own insurance people were the chief negotiators on any of these cases. This covered the contractors, too, for special materials. The negotiation was made, through the contractor's insurance people, and the injured people were paid off.

The only other thing happened after the war. I probably had better describe that when we talk about Bikini. But it can literaly be said that we had almost no incidents that could be called industrial accidents with about a million people involved all over the United States.

TUSLER: That's a fantastic record.

WARREN: Well, in the first place, you see, we had authority. It just shows it can be done if you have the authority and you do the research to get the proper information and then put in the regulations to protect the people. I feel the same way about civil defense and atom warfare. If we have a properly trained group we could save a great deal of the population from the fallout. You can't do much about people directly in the crater, but you can do an awful lot to protect the population.

It's no different from the situation that occurred during the Middle Ages. As you know, two-thirds of the population of Europe was killed by the bubonic plague. Bubonic plague has been endemic here in California for fifty years. We've had only a couple of little epidemics. One occurred when I was a medical student. At that time a friend of the family, a young doctor, died because he wanted to stay with his patients and keep the infection from spreading. He got bitten by the same diseased fleas that were in the house. The plague eventually killed the two patients, but he took care of them.

That was kind of a useless sacrifice in many ways in the light of today's knowledge. We are the only nation to send missions safely into India and China where there were plague epidemics to find out how the disease is spread. It was found that the rat carried infected fleas. The fleas bit the rat and infected it with bubonic plague. The rat died and the infected fleas then spread to humans. The fleas can spread to other humans and so on. The causative organism is *Pasteurella pestis*. These bacteria also can be inhaled. When a patient has plague pneumonia the droplets get out in the air. If you pass close by and the patient coughs, you can inhale the bacilli in the droplets in the air. You can protect the public against this by controlling the rats and/or by immunization.

Well, we were worried about all kinds of things. One concern was malaria. Some of our civilian workers would be returnees from endemic areas for malaria. They may have had malaria. When they were hired, they might have concealed this history. If there were any doubt, we always ran blood smears on every ex-serviceman. We found only one in the whole time. He was dosed heavily with quinine; the malarial parasites disappeared and he has had no trouble. We had killed the mosquitos with the DDT, and of course all marshes were drained so that there were no places of any large size that could breed mosquitos. Fortunately, we had no rats. Dogs and cats were permitted, with all their problems. I think we did pretty well.

I didn't have much of a problem with Hanford. This was due mostly to the health and safety program organized by the Chicago team and Dr. Stone's group. Du Pont ran it. They employed a doctor [William Daggett Norwood], who was a very sophisticated person and who built a hospital. It was called the Kadlec Hospital after one of the former directors of this part of the operation in the early days. He set up the safety regulations among the contracting builders. This was when we had the problem with the meningitis epidemic which I described. They had "change houses" and all the techniques that they developed in the practice runs with the small reactor at Oak Ridge and Chicago. They put them in on a big scale at Hanford. It's interesting that just about the time Oak Ridge was built and proven in operation, they built Hanford and put in full-scale safety and health operations there. While there were hundreds operating the programs in Oak Ridge, there were thousands operating them at Hanford.

The town of Hanford was also about twenty miles from the reactors. The reactors were out on the big extensive desert, which was along a big curve in the Columbia River. Hanford and Pasco were right down on the river. The Hanford town was a little better laid out than Oak Ridge. The town was rectangular. They didn't have much trouble with the town operations because most of the people in the operation were a little better educated. There were lots of service stores, and so on, but not in the proportion they were in Oak Ridge. We had trouble in getting dentists and doctors, and I made several trips to Seattle with Dr. [William] Daggett Norwood to find them. We talked with the procurement officers there and got some young dentists deferred and transferred as civilians. And we transferred to Hanford one of our very able dentists, Dr. [Harry] Pitluck and his family from Oak Ridge. He had had experience in organizing the clinic and the dental operation. They liked the desert and stayed there. They were city-raised from New York. They enjoyed the isolation at Oak Ridge and particularly enjoyed the desert, and the kind of isolation at Hanford was not a bother.

TUSLER: You were in a supervisory position over all three plants, actually?

WARREN: Yes. From the medical standpoint.

TUSLER: Yes, but you lived and spent most of your time at Oak Ridge.

WARREN: I moved my family to Oak Ridge for safety because there was fear that somebody might find out I was on a secret project and they could look for the children or threaten them. So the best way was to move the family. We had to lease our house and this was a terrible problem. My last renter moved out in the middle of winter. Fortunately, I was in the area; so I went there and I thought there was enough oil to keep it heated while I was trying to rent it again. And, darn it, I forgot that when they took the curtains off the windows the heat loss was so great that the oil was used up in two days. When I came back on the third day, all the plumbing was frozen. The toilets upstairs were lifted out of the floor by the ice, and the washbowls were lifted up on their pedestals. The meter was broken. I had to get the hospital plumber to reestablish the plumbing. It cost about $1,200, money I didn't have, so I put it on the market and sold it; but I sold it for very little more than I paid for it. This is interesting because we put the money in E bonds to help the Oak Ridge drive, and this put them over the top. It was about $10,000. So security immediately investigated me. "Was I paid?" That's on my income tax return. So almost every year Mrs. Warren and I have to answer the same question, "Where did we get the money?" We have all kinds of letters showing the sale of the property. Then, of course, we used it out here to buy our house. They were very careful on all the security business.

TUSLER: You were a prime target.

WARREN: I was suspect. I could not be vulnerable in any way, you see. They even asked our neighbors, when we got ready to move to Oak Ridge, "What kind of a person was Mrs. Warren. Did she play bridge? Was she a gossip?"--this sort of thing. The schoolteachers were asked what kind of people we were. Fortunately, we had had no fights with anybody in the parent-teacher organization. [laughter]

TUSLER: You passed.

WARREN: Well, you can see that the whole project was vulnerable to things, like this man [Harry] Gold who was a machinist. Through his connection with the Rosenbergs [Julius and Ethel], they prevailed upon him to give them some information. He had the critical job, unfortunately, of bomb assembly. So he knew about the implosion, the forceful apposition of two uranium hemispheres to form a critical mass. And the design of the powder, the baritol, which was used for the implosion around the periphery, was critical. Now it's not so critical because there are many ways of doing it. But at that time it was quite important, and it had not been given out. Of course, that saved the Russians all the effort of putting two and two together. Then, of course, there was the Pontecorvo defection and the information given out by Brother [Allan] May, who worked in Los Alamos and knew quite a bit about these things. Yet Stalin didn't appreciate what he had, or he didn't want to admit it or something, when [Secretary] Byrnes and Mr. Conant went over to negotiate that.

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SEPTEMBER 1, 1966

TUSLER: Dr. Warren, we have a distinguished visitor in our presence. I wonder if you'd introduce him on the tape.

WARREN: Yes, I'd like to have you meet former Colonel Stanley Stewart, whom we all called "Slim," because obviously he is slim [laughter] in contrast to some of the other higher officers. During the war he was assigned here in Los Angeles to be General Leslie Groves's troubleshooter and the procurement officer for the Los Alamos program. He had many peculiar assignments, you might say, for General Groves because materials were hard to get, men were hard to get, and personalities were difficult. I think all of us felt that Slim could do almost anything. As a matter of fact, we can talk later about how he got the Camp Santa Ana temporary barracks buildings for the atomic energy contract here. This became the first part of the medical school here on campus. Without his ability to wangle outside, and Mr. [E. Vernon] Barker's ability to wangle inside the university, we would have been a year, maybe two years, later in starting.

TUSLER: So his experience at Los Alamos was a help.

WARREN: He was very helpful in that. When were you first aware of General Groves's activities, Slim? Remember, we were talking about this the other day.

STEWART: I'd say it was about the first part of February 1943. I was in the construction division, and the construction program was kind of on the wane.

WARREN: This was the Corps of Engineers?

STEWART: It was the Corps of Engineers and the Office of the Chief Engineer in Washington, D.C.. As the construction program waned, officers were being reassigned to other duties. Every once in a while, Colonel [Donald E.] Antes, who I was working with, would come to me and say, "General Groves wants an officer of certain qualifications." Then we'd sit down and figure out what officer in the construction division--they might be anywhere, all over the United States, actually--would fit these requirements. For instance, you remember Colonel [Earl H.] Marsden?

WARREN: Yes.

STEWART: He came in with that business--the Alcan Highway. General Groves wanted an officer. By that time Colonel Marsden was about through with his job, so he switched over. The same thing occurred with my brother. Then one day Colonel Antes came in and asked me if I would like to go to Los Angeles. I said, "Oh, yes. It's pretty nice out there. It's near my brother." And he said, "Well, he wants somebody that doesn't know anything about procurement." I said, "Well, that's me. I don't know anything." [laughter] And then he said, "You go in and see Mrs. O'Leary and set up an appointment."

I was then interviewed by General Groves. He said that some sort of a contract with the University of California was coming up and that it was high-priority business. I was supposed to come out here and help the university with it. I guess you'd say it was an intensive procurement program. He didn't say too much about it. And he asked me if I had any nerve. And I told him I thought I had. I don't know why he asked me that question. And then he said that Dr. [J. Robert] Oppenheimer would be in his office in a day or two and that he wanted me to meet Dr. Oppenheimer to see if I was acceptable to him. So later on, then, I went in and they gave me a call when Dr. Oppenheimer was ready to see me. So I went in to talk with him.

Oppie, as he was called, was quite intense. He appeared to me to be apprehensive of the University of California and, in fact, I guess he felt, or I had the feeling, that he was quite anxious about this project and didn't want any administrative delays and whatnot. But he was quite apprehensive of the University of California. I guess anybody who has been with the university knows that normal procurement takes quite a lot of time and a lot of red tape and things like that which he wanted to eliminate. General Groves had told me before the interview with Oppie that I was to assure him that any of the red tape and whatnot that he feared, in so far as military procurement was concerned, were to be alleviated. He said I would have the authority to "label" his "requirements" and that if Dr. Oppenheimer wanted the moon, why, we were to get it for him the next day. [laughter]

TUSLER: Probably, he never asked for that.

WARREN: No, but he asked for a lot of things that were almost that difficult.

STEWART: I guess I was acceptable to Oppie, because soon after that, why, General Groves told me to grab a plane and go out to Berkeley and see Oppie out there. It was my first ride on a commercial airplane (the Pennsylvania Airlines), from Washington and Pittsburgh in one night. It was a DC-3, and it was rough.

WARREN: It makes me seasick just to think of it.

STEWART: It was rocking all night. I guess that was about the weekend sometime. I got to Berkeley and met Mr. Robert Underhill. In regard to Mr. Underhill, General Groves had said, "Now when you go out on this project, you'll have to do business with one of the most difficult businessmen in the country." He was referring to Mr. Underhill. But I never had any trouble with him.

TUSLER: Who was Mr. Underhill?

STEWART: That's Robert M. Underhill who was then the secretary-treasurer of the Board of Regents and was later, I guess, the vice-president.

WARREN: Yes, but he was the negotiator between the University of California and the military throughout this project. You have to realize that the university was doing the atomic energy project as its war effort. The regents felt definitely this was a war effort, particularly Regent John Neylan and President Sproul and Mr. Underhill. Regent Neylan was chairman of a small committee of three. I've forgotten for the moment who the other two members were. This was, you see, during the war, so Admiral [Chester] Nimitz was not a member of the board at that time. Mr. Neylan took the point of view that whatever the government wanted to do, the university should do it. And being a lawyer he felt that the contractual obligations for taking on any part of the program were sound, or he saw that they were. Then it was up to Bob Underhill to see that they were and to protect the university's interests. You have to understand that this Berkeley thing started out with Ernest Lawrence and his cyclotron. And then it included the involvement of a lot of chemists and physicists in various parts of the program, including the medical component that stems from the Chicago Met Lab operation under Dr. Robert Stone. The setting up of a secret city in New Mexico out of state was just fantastic, a thing without any precedent.

Now let's go back to the point where General Groves had just come off from building the Pentagon and had returned to the Corps of Engineers office, just before this, hadn't he? Then President Roosevelt had OK'd his appointment to the Manhattan program. The Manhattan Engineer District was the operating agency and was backed by the Manhattan Engineer Project, or MEP. It was MED and MEP. Manhattan was taken as the name just because they had their first offices in Manhattan. There was a local engineer there who did a lot of things, too. The whole scheme of organization of the Corps of Engineers was set up with the local project engineers, the district engineers, and by other methods of organization to do a job. This was the way dams were built. Colonel James Marshall, who preceded General Groves by maybe a month or two, had been in charge of this project. He had just finished the Alcan Highway, the Alaska Highway. Wasn't Colonel Marsden in on that?

STEWART: No, no. [Colonel E. E.] Kirkpatrick was in on that.

WARREN: Colonel Kirkpatrick, yes. Now one of the reasons that the Manhattan Engineer District program went so well is that these men that were brought in were top administrators and producers. Since General Groves finally became the chief of the Manhattan Project, he got all these old hands, you might say, together. They knew how to work together, and everything was very smooth. And as Slim said, the general had unlimited priority on everything from President Roosevelt. President Roosevelt, by the way, was spending the money out of his emergency office funds; it was called OEM, the Office of Emergency Management. And Congress just gave him a blank check for this.

TUSLER: Why was this? Because it was such top secret business?

WARREN: Well, he ran the war really out of his pocket a good deal of the time, out of the Office of Emergency Management, particularly this project.

STEWART: The Manhattan Project started when Albert Einstein had his theory of atomic energy. He and some other scientists felt that an atomic bomb was possible with tremendous release of energy. And they sent somebody into Washington to see about this.

WARREN: Yes, it was Leo Szilard and Albert Einstein.

STEWART: They tried to see, I guess, the secretary of war or the president or somebody. But, anyway, they ended up with--I think the first official person they saw was General Groves. I guess President Roosevelt was impressed with what these scientists had to say. On the basis of that he set up the Manhattan Project.

WARREN: He appointed a series of committees. They varied from year to year, but it was called the S-1 Committee. I did quite a review of this and I have all the notes from this that I made for the army historical section. They didn't use this stuff in my report, so I think I can get that back and turn it into the record.

It took me six months because there was no official sequence laid down anywhere, and I had to ferret it out of the Government Operations Manual showing the organization of the government and the various committees. Then I had to do a sort of undercover investigation. I spent a month in Washington five years ago during the summer just doing this, because it was all secret and nobody told anybody else about anything. Henry Stimson was the secretary of war at that time. And then General Somervell came into the situation.

STEWART: He was head of the services of supply. They provided the wherewithal for the combat troops. I don't know where or when the Manhattan District took over from the Office of Scientific Research and Development [OSRD], or when Einstein and his people came into the situation.

WARREN: Dr. Harold Urey was working in Columbia, Ernest Lawrence in Berkeley, and Arthur Compton in Chicago. Leo Szilard was kind of a free agent around. I think he was at Columbia a good deal of the time. Anyway, they met in Washington at an Academy of Sciences meeting. While they were there, Niels Bohr called up to say that Dr. Lise Meitner's experiments with fission were true. So they all went home and verified it within a week or so, because they were working in this general area. Then they decided that this was quite important. Leo Szilard got an idea and prevailed upon Dr. Einstein to go with him to Washington after they wrote a letter to the president. This was turned over to Dr. Vannevar Bush. Dr. James Conant was advisor to Dr. Bush at that time in the OSRD. Dr. Bush was running the Office of Scientific Research and Development, which was a creature of the National Academy of Sciences. The National Academy of Sciences has statutory origin. By law, it is the research advisory committee to the president.

This is kind of involved; but in this period of about six months, the president got more and more interested in what the committee was telling him. The committee would meet almost every month. The progress was reported and all the different ways of separating the heavy and light uranium isotopes. It was finally decided by the committee to urge the president to do something official, because everybody was afraid that the Germans were going ahead and would have solved it in their well-known systematic manner, very quickly. As it turned out, the Germans got in a row and there were three ventures: one by the post office, one by the secret police, and one by the air force. We ought to spend a whole day on the origins. If I can get my stuff back, or if I can find it, I've got it all pretty well laid out, and Professor [Samuel] Glasstone has written a pretty good article, a book on this whole thing.

TUSLER: The orgins of it?

WARREN: The origins.

STEWART: Well, anyway, I might inject that the scientists that developed these ideas came to the point where they felt that the manufacturing of one of these bombs was possible. And I guess they sold President Roosevelt on that. In effect he gave the job to General Groves to go ahead and make the bomb and not to worry about the expenses. That's how we got into it, to expedite the production.

TUSLER: So the program actually hadn't been in effect for very long before you were approached for this particular position.

STEWART: Los Alamos was unique in that it was the place where they were supposed to actually make the bomb. There were things being made at other places, but the bombs were made at Los Alamos. There was some apprehension of catastrophic explosions. And that was why they wanted an isolated community--from that point of view--as well as security.

WARREN: They chose a very difficult place to get to. [laughter] It was kind of a Conan Doyle's lost world up on a mesa with a very narrow country road leading to it.

TUSLER: Nothing was there at all?

STEWART: No, what really had affected the actual selection was that there was a boys' school there. You know, it was one of these rustic things where they camp out lots and have horses. And it seemed that Oppie went to that school at one time, maybe during one summer or other.

TUSLER: He knew about it.

STEWART: He knew about it, and that's what I think steered us there.

WARREN: Did you go around with General Groves and Oppie when they reviewed the site before they decided to take it?

STEWART: No, the first time I was there was as a result of this trip when I was interviewed by General Groves and Oppie and then went to Berkeley. I was supposed to stop off at the site on the way back. I think it was about the middle of March, the thirteenth or fourteenth of March 1943. There wasn't anything there but a big old log cabin. What do you call it, the lodge?

WARREN: It became the lodge.

STEWART: There were other shacks around the log cabin, and it was kind of "spitting" snow at the time.

WARREN: Yes, it was at 6,000 feet elevation, with beautiful yellow pines and mountain meadows.

TUSLER: So it was your job to oversee all the procurement for the whole thing? Was it from the military point of view or from the social point of view or everything?

STEWART: No, I don't think it was that dramatic. Actually, I was primarily with Los Alamos. The scientists were supposed to figure out what they wanted. It was up to me, through the university at the time, to get what they wanted at the time that they wanted it.

WARREN: You didn't have anything to do with the construction or the operation of Los Alamos, did you? You backed it up by getting all the supplies and equipment.

STEWART: Yes, plus other things that had to do with contracts. When you had the type of contracts where you must get along with labor, you work out a table of employees, salary ranges, and employment policy. We were supposed to use the University of California policies. We used their policy on procurement and their policy on personnel. I remember one time in the office in Los Angeles I asked Mr. Robert Underhill, Mr. James Corley, and Mr. George Taylor, "What's your policy on procurement?" They were personnel managers and they looked at each other and didn't say anything and then they said, "Well, it's in the book." Then I said, "What book?" [laughter] Well, they got one of these old catalogs. There was a short paragraph in it that didn't tell you a damn thing. [laughter]

WARREN: So it all had to be done by rote.

STEWART: Yes. You might say the military were relying on the university as, say, a going organization that had been in business for a long time. They supposedly had established policies on procurement, personnel, and on all that, plus insurance.

TUSLER: But actually they didn't have those established?

STEWART: No, they had nothing.

TUSLER: Well, that left you sort of a wide open field, didn't it?

STEWART: Well, it did except when it came to the auditors.

WARREN: These are government auditors.

STEWART: They kind of frowned on this and that. Mr. Underhill got around it. He felt that if this project was wanted by the government, and if in accomplishing the project it required unusual things to be done, why, it was OK with him if I approved of something ahead of time. Well, being the construction officer's representative meant that the university would be reimbursed regardless of what might have developed later on. So, in effect, to a great extent, I was more or less the business manager for the University of California and for Oppie.

TUSLER: For the whole works.

STEWART: Yes.

TUSLER: How much did you know about the project when they approached you?

STEWART: I didn't know anything about it.

TUSLER: They didn't inform you of the objective?

STEWART: According to the policies of that time, General Groves seemed to think it right to tell the individual only what was considered necessary for him to do a particular job. But I had been in this construction business for quite some time. We knew--or at least I did--that if you could get triple-rate priorities for say a piece of metal and take it out of the ordinance supply stream scheduled to go to make B-29s or something else, why, you know it was important. But they kept you so busy that you didn't have time to sit down and figure out why it was important. So you just went ahead and did it.

WARREN: Before you were done, how large an office staff did you have? I remember going down there, and you must have had twenty-five or thirty people working on keeping books and ordering.

STEWART: Well, when I had gone out there, I was told to help the university set up this procurement office which was supposed to be a real expediting and liberating arrangement. We were supposed to operate under certain security regulations. One was that in Los Angeles it was supposed to be strictly the University of California. We weren't supposed to reveal any connection with the Manhattan District. That was the overall project. And particularly, we weren't supposed to reveal our connection with the project in New Mexico. And so I worked it up with [David] Wilt that we'd have the main procurement office in Los Angeles, and that we'd have a branch office in Chicago and one in New York. It would all be connected with a teletype. (A teletype makes it that much quicker). The New York office and the Chicago office were not to communicate directly with the project at Los Alamos. If they had any questions on procurement, they'd come to Los Angeles. Then we in turn would answer them. We had a warehouse in Chicago and one in Los Angeles. All of the stuff we ordered was in the name of the University of California. It came to this warehouse and we repacked it and took the labels off. We were told to cover up the name of the University of California and ship it to Mr. D. P. Mitchell, Box 1553 (I think it was), Santa Fe, New Mexico.

TUSLER: Was he a fictitious person?

STEWART: No, he was a physics professor from Columbia University. He was head of the procurement at Los Alamos.

TUSLSER: I see.

WARREN: But he had an office in Santa Fe.

STEWART: Yes, he had that little one.

WARREN: It was really just a cubbyhole with teletypes in it. This, you see, interlocked the Chicago scientific operations and the New York scientific operations with Los Alamos through the Los Angeles area. Then Los Angeles was also in close contact with Berkeley. So that without it being apparent at all, you could get any kind of information back and forth, over a secret wire.

TUSLER: Where were you, yourself, quartered then? Were you here in Los Angeles and Berkeley, or were you over in Los Alamos?

STEWART: I was in Los Angeles. In fact, I stayed at the Biltmore Hotel. The arrangements desired by General Groves (which didn't quite work out that way) were that I was supposed to spend the week--Monday through Friday, say--in Los Angeles or in one of these other procurement offices. Then I was supposed to go to the project every weekend--beat it back and forth to iron out any particular problems that you could do by talking with the people out there--then come back again on Monday and start off on another hectic week.

WARREN: You can see by that statement that General Groves got twenty-fours a day, seven days a week, out of his people.

TUSLER: Yes, you're correct. He must have been a good leader to do that. What kind of transportation difficulties were involved, or was this a serious problem?

STEWART: What do you mean by transportation?

TUSLER: Well, getting the supplies to Los Alamos.

STEWART: What happened was that the Santa Fe Railroad ran past Lamey, which was on a little spur. We used to use the railroad to some extent as far as first shipments were concerned. But mainly, because of the remoteness and whatnot, we found that by using trucks from Los Angeles we did better. We used an ample freight line. Later on, we'd load up a trailer and take it up to a little area down below the project. They'd park it near there and our people would unload it, and then haul it by the trailer to the project. It got so we were doing the same thing in Chicago. Well, when we got started on the thing, you couldn't haul the trailer from Chicago to Denver to Los Angeles without having to transfer it out of one trailer to put it in another one. By working on the transportation people, we finally got them to agree that we could fill a trailer in Chicago and haul it all the way to Los Alamos. We'd have to change tractors, but that's one of the things that you run into.

WARREN: It's interesting, too, that this transfer point below the mesa at Los Alamos was just a wide spot in the road with a couple of shacks around. I can imagine that to the truck drivers bringing the stuff in and just leaving the trailer out there in the wilds with big buttresses of mountains all around them, nobody much there and no factory, it must have seemed very peculiar. But part of the trouble was that the road, at first, was just a dust track up the shelf on the side of the mesa.

STEWART: Yes, it was just an old dirt road.

WARREN: It took almost a year, didn't it, to get a good road up there to get two-way traffic. It was almost another year before they had it all surfaced.

STEWART: Yes, that's one thing that got Admiral [William Sterling "Deac"] Parsons and General Groves there, later. Admiral Parsons was out there to help out on the bomb procurement part. When he arrived he made a big fuss and insisted that they put in a good paved road from off the main highway up to the project. But General Groves kind of went for stark simplicity, and he didn't go for a lot of what he thought, in some cases, was unnecessary luxury.

WARREN: Well, it was purely an improvised arrangement to get the job done with the least cost, because he was very acutely aware of the fact that the Manhattan Project was taking stuff away from the armed forces out in the war theater.

STEWART: And it was also thought, too, that once they delivered the bomb that these projects would be disbanded or that the war would be over and whatnot. Nobody realized that there would still be a Los Alamos out there as it is today.

WARREN: That's why he didn't want to build hospitals and a lot of other things.

STEWART: Yes, you got involved with that one. [laughter]

TUSLER: When did you two actually become aware of each other's existence?

STEWART: I guess it was at Los Alamos.

WARREN: Yes. Well, I just knew vaguely that he had the Los Angeles "in" you see. But we didn't have any problems that he had to deal with, so it was not until we got pretty near the bomb testing era that we met. Then you had to make some of the arrangements--or did Parsons do that?--with the navy so that the battleship Indianapolis went to Mare Island to be fixed up so it could carry the two bombs to Tinian.

STEWART: Yes, I think Admiral Parsons did that; well, with little sidelights. We were fixing up the battleship McKinley for the bomb tests later on. And they readied the LST [landing ship tank] with which they lowered the underwater bombs with underwater shot mounts in the middle of it, down here at Terminal Island. Of course, those scientists down there wanted a lot of things. They got upset with the governmental red tape and so forth. And they wanted to send a lot of messages back and forth to Los Alamos. So they had me down there with them to discuss whether or not to put in a teletype machine. Of course, the navy with reluctance would go along with the teletype machine if they could be advised to what they could charge the cost. They said anybody sending messages over the machine would have to conform to the navy message form, and so forth and so on. Of course, the scientists didn't like that and they just looked at me. So I told this captain or lieutenant commander down there, "Look, if it's all right with you, why not let the University of California put a teletype machine in here. It would just be for a couple of months. Just let the people send over it whatever they want to. I'll pay for it." "Well," he said, "if you can do that, that's all right." So they got out of it. They seemed to be happy to solve the problem that way. So they let us put in a teletype machine.

WARREN: This was all backcharged to the joint account.

STEWART: It was charged to the university contract.

WARREN: And the money was paid out of Joint Task Force One account at that stage wasn't it, or was it still the Manhattan Project?

STEWART: I think it was the Manhattan Project.

WARREN: This was a year afterwards.

STEWART: Yes, that was the Manhattan, because the university paid for that.

WARREN: Yes, I see.

STEWART: But that's another one of those things that, normally, Mr. Underhill wouldn't go along with, but since I approved it ahead of time, Mr. Underhill would be reimbursed and so he had no objection.

WARREN: Yes, that was a magic word, that they would be "reimbursed!" [laughter]

TUSLER: Of course, it didn't always happen.

WARREN: Yes, it did.

TUSLER: It did?

WARREN: Yes, that's why Mr. Underhill was a tough bargainer.

STEWART: As long as I was there, the university never had any exceptions by the General Accounting Office to anything that was reimbursed on the contract. After I left, they got into some problems.

TUSLER: Now, what sorts of materials were you primarily concerned with? This wasn't food or expendables like that which you were dealing with, or were they? Or was it everything?

STEWART: It wasn't food because the people at Los Alamos, you see, had the military organization there operating on the base. People had their families there and were living in those apartments and could buy their food from the commissary. We didn't get involved in the food business; but it was everything else--anything you can imagine as far as materials like paper clips. Well, one time they wanted, I think, thirteen ounces of indium or something.

Indium is a rare metal. I was dealing with the Manhattan District office in New York. General Groves plainly told everybody around that whenever I asked for something they had only one thing to do, and that was to turn handsprings to get it for me. Well, they went to him a couple of times and they learned that he meant it. [laughter] They told me in regard to this requirement for indium that it would upset the whole metal market because that was about all that was available on the market at that time.

WARREN: So this would give away maybe something important.

TUSLER: Did you get it?

STEWART: Yes, we got it; I got it down there, and then they didn't use it. [laughter]

WARREN: This always produced a little tension and bitterness down there, when everybody had strained all their efforts to get something and they'd say, "Oh, didn't you know? We decided not to do it." But there was relatively little of that, actually, wasn't there?

STEWART: Yes, the first time I got involved with Robert Buettner, I think, they wanted a lot of X-ray film.

WARREN: Buettner was my executive officer.

STEWART: We flew it down from Oak Ridge. We had to get permission, I guess, to go in and arrange that it be sent down there with air freight. I was down there about a month later, and here these cartons were with "Air Freight" labels on them and they had never been opened. Then, later on, we arranged with the Eastman Company to send film back to Eastman headquarters where they reclaimed the silver nitrate off the film. We got some money out of that; I don't know, some outlandish figure of $10,000 worth of film or something like that, maybe more than that. Maybe we got $20,000 out of it in silver nitrate.

WARREN: I think that came about because at the time, when the order went in, everybody had agreed that they were going to do chest films on all employees not only for tuberculosis, but for the question of industrial hazard. The orders were sent out for the film, and they were cleared and had been obtained. Then we had another look and decided that the orders had not gone out. But the film was already there, but it wasn't really necessary.

STEWART: Well, I didn't know why they didn't use it, but that just shows what happens sometimes. You turned handsprings to fly things down there and maybe get special flights to rush it down there and they then decided not to use it.

WARREN: Tell them about MATS flights. I've forgotten what the M stands for.

STEWART: Military Air Transport Service; this was MATS.

WARREN: Yes, this was set up to run officials from Washington to anywhere, practically. First it was across the continent. Then, as we moved into the Pacific, it began to be there, too.

STEWART: I guess the military just felt that they had to have their own air transport so they could get a little better service than to rely on commercial airlines. So they set up MATS. It ended up that they took a lot of the civilian pilots and made officers out of them and pilots. They flew these planes all over the country and all over the world, both passengers and freight.

WARREN: It was at this time we had very crowded transportation, particularly by air but also by the trains. You had to have a priority, particularly on the planes; and you could be bumped, which was one of the problems in trying to get somewhere.

STEWART: Yes, that was another one of those things in which the importance of the work that you were doing wasn't understood. Of course, the navy didn't realize at the time that I had the authority to write my own travel orders and that I also could establish a priority just by my signature that would get me on an airplane. I forget what priority it was--there were some passengers that had a higher priority than what I could get--but I could generally get in where I wanted to and within a reasonable time. A lot of the officers in the Manhattan Project had the same authority.

WARREN: At this time all the commercial airlines were DC-3s that would go about an hour and a half or an hour and they they'd have to gas up. This meant about every two hundred miles. So that, in a trip across the country--

STEWART: --it would take you all night.

WARREN: Yes, it took about twenty-six hours if you didn't get bumped anywhere. So it was an endurance test. Then, toward the end of the war, the Manhattan Project had a sleeper plane, which was a three-decker. They had a canvas stretched between stanchions in the plane, and you slept close to the floor or in the middle or up near the ceiling, usually wrapped up in your overcoat. The only thing you took off was your shoes.

TUSLER: And you really slept this way?

WARREN: Yes, well, if you were going to get any sleep you had to.

STEWART: You were usually so tired that you would sleep, anyway.

WARREN: Yes, you would leave, as I recall, at six o'clock from the Washington airport. You'd arrive in Albuquerque about five o'clock the next morning. And that was as near to a through flight as anything that existed. They stopped at a little town outside of Kansas City.

TUSLER: Was Albuquerque as close as you could fly to Los Alamos? Could you get in?

STEWART: No, they had an airport at Santa Fe, but most people landed at Albuquerque because you could fly TWA, which only landed at Albuquerque.

TUSLER: Who was it that you got your orders from at Los Alamos? Was it Dr. Oppenheimer?

STEWART: Well, mainly because I was primarily interested in procurement, they were from Dana Mitchell, who was in charge of procurement.

TUSLER: I see.

STEWART: Or he determined the requirements, I guess you'd call them.

WARREN: Well, he would only bother you when there were problems in procurement. Most of the stuff went through your office as a matter of routine and there was no big sweat.

STEWART: Yes.

WARREN: Did you have to worry about the procurement of the pipe for the water system? Or did they have to pipe it up from the river?

STEWART: No, all that construction work out there at the project was handled by the local people there. By local people I mean like, you know, Captain [J.] Stevenson and Colonel [Whitney] Ashbridge.

WARREN: Yes, Colonel Ashbridge. And he was the local engineer.

STEWART: Yes.

WARREN: Was he the district engineer?

STEWART: No, he was the second camp commander. Colonel [John M.] Harman was the first one, and he didn't last very long. He was kind of an old fuddy-duddy.

TUSLER: How much actual dealing did you have to do with Dr. Oppenheimer, then? Did you get to know him?

STEWART: I got to know him quite well. In fact, when I went out to Berkeley the first time, I had dinner with him and his wife. He had a nice place. He told me he was quite concerned. For instance, he wanted me to talk to Emilio Segrè, who was an Italian refugee. He said that Dr. Segrè was kind of apprehensive about pulling up stakes from Berkeley and going up to this "concentration camp," you might say, in New Mexico. This hesitancy was due to his background. He had given up everything in Italy when he had fled as a refugee ahead of the Fascists. So he was pretty apprehensive about going to Los Alamos. I don't know whether I was very effective in persuading him, but anyway he did go to Los Alamos. One of the first problems they had was to get those groups of scientists from all across the country assembled at Los Alamos, where they could put all their brains together to come up with the bomb. There was a group at Berkeley, a group at Purdue, a group at Ohio State, a group at Chicago, and a group in Columbia.

WARREN: At Rochester, New York, too.

STEWART: Yes, and they moved these scientists and equipment--lock, stock, and barrel--to Los Alamos. It was done, you might say, the first of spring of 1943.

WARREN: It included the Harvard cyclotron group.

STEWART: Yes, there was a group from Harvard.

TUSLER: Did your procurement problem become easier as the numbers went up?

STEWART: No, it got more difficult all the time. They'd come up with the darndest things. Of course, this was the same kind of situation that came with one of the atomic bomb tests out at Crossroads. They had suddenly decided they would make some bunkers out there and whatnot, out of concrete. Somebody realized that if they made the aggregate out of iron ore, it would have a greater sealing effect; so nothing would do but that they had to have two carloads of iron ore from one of those big iron mines up in Wisconsin or somewhere. Within three or fours days, in San Francisco, we put it on a boat that was all ready to leave. They had had to come to me, and I arranged to have these two cars of iron ore put on the City of San Francisco train. They had to make the boat in time, you see.

WARREN: Well, also they used a tremendous number of rubber gloves for the dry boxes in Los Alamos. That's a way of looking through lead glass and other shields and manipulating your arms inside a box, while protecting your skin from contamination by a rubber glove. Rubber gloves, of course, were of very high priority and scarce. They were needed all around. And I guess we took half the supply at one time or another.

TUSLER: In the whole United States?

WARREN: Yes, of the whole manufacturing output.

TUSLER: How did you go about locating such things as rubber gloves?

STEWART: It's not as difficult as you think. The Yellow Pages are good. Or there's the Thomas' Register [of American Manufacturers] and it's got a pretty good index of the manufacturers in this country. Also, a lot of this was by word of mouth. If you ask somebody and he doesn't have it, he'll refer you to somebody else. It takes a hell of a lot of phoning, too.

TUSLER: You must have gotten very expert at finding your way around.

WARREN: He could find anything. [laughter]

TUSLER: What are some of the other peculiar things you had to cope with: problem materials, paper clips, rubber gloves, carloads of iron ore?

STEWART: There was something in connection with moving these groups to Los Alamos. There was one fellow; I think he came down from Stanford. He was a big, husky, dark-complected man. It was back when we were working on the University of California policy in regards to these people. And they had no general policy. You know what I mean, each case was treated as an individual case to decide whether or not and how well they liked him, and what they would pay him. These scientists do the damnedest things. He packed all his household goods, including his car, and loaded them right in the freight car. I mean it was all shipped to Los Alamos. [laughter] I had quite a discussion with Oppie about that. Oppie decided that if he could put the item in the kitchen and cook off of it, or something like that, why then it would be considered a household effect. If he couldn't do that he'd have to pay for it himself. [laughter]

WARREN: Was he married and did he have a family?

STEWART: Yes.

TUSLER: How long were you in charge of the operations there?

STEWART: Well, I got there in March of 1943, and I stayed there until August of 1948. But, actually, the main part of the thing was over in 1945, as far as delivering the bomb and the war effort were concerned. They had some tests to determine the effects of bombs. And they had some other developments that they wanted to test out.

WARREN: Did you have to make the arrangements for the transportation of the bomb from Los Alamos to San Francisco when Jim Nolan and somebody else went along? Dr. Jim Nolan--one of my doctors, who was the chief medical officer for Los Alamos--and the security officer, it seems to me, went along.

STEWART: I think the security people handled that. They wanted to keep me out of it to some extent, and I didn't get involved in that.

WARREN: Do you remember the name of the security officer at Los Alamos? Colonel [William B.] Parsons was the chief at Oak Ridge, but Colonel de Silva came in later.

STEWART: Oh, yes, it's funny how things go. This Roger Warner, that I was telling you about, was kind of the head engineer to develop component parts for the bomb under Admiral Parsons. When they were getting ready to go out to Bikini, he came to me and told me that he was apprehensive about de Silva, because de Silva was going to be in command of the military personnel out there. They had a lot of scientists and whatnot and young fellows that had been drafted into the army who were reassigned to Los Alamos and allowed to continue to do their scientific work as scientists rather than as soldiers. And they had them in what they called a military detachment area. They had a commanding officer and whatnot. Of course, he tried to subject them to some sort of military discipline, which they didn't like. Then Warner came to me one day and asked if I'd be interested in going out there and being in charge of the military detachment, because they were apprehensive of Colonel de Silva. They didn't want him to go out there. I told them, "I don't know; I don't think so. Looking at it with an overall view, I'll give you my point of view the way General Groves would look at it. I think that when you guys are out there, there's a lot of things you are going to want--this and that--and getting things out here to you is going to be important, more important than leading that little old detachment out there. I don't think he'd let me go. But you can ask him if you want to." He said, "No, there's no need of asking, if you don't think he'll let you go." So they didn't ask him.

WARREN: Were you involved in sending the seven foot cot for Dr. Luis Alvarez at Tinian, because he was too long to fit the regular issue and needed a longer cot?

STEWART: No, I hadn't heard that. You see, everybody was somewhat channelized.

WARREN: Yes.

STEWART: And if things went out of your channel, you weren't aware of things and the details pertaining to them.

WARREN: Dr. Alvarez had the final assembly of the bomb at Tinian, you see. He is over six feet and needed a longer than normal cot. I had great sympathy for this. A normal cot just didn't fit at all. You extended over either at the feet or at the head end. So General Groves called me in one day down at the Washington office and he said, "Will you look into this monkey business? We've got to request a shipment of an extra-sized army cot to Tinian for this fellow Alvarez." And I said, "Well, I'm sympathetic because I know just what his trouble is. If you're going to expect him to put the bomb together and get any rest, you'd better get him the cot." So he did.

TUSLER: This was part of your concern.

WARREN: Yes.

TUSLER: As a medical man?

WARREN: Yes, as a medical man, dealing with the comfort and the safety of the man to allow the operation he was going to carry out.

TUSLER: Is Tinian a town?

WARREN: That's an island out in the middle of the Pacific. It was one of those that we finally took from Japan. It had a huge airfield. Guam, Tinian, and Saipan were all clustered together, but several hundred miles apart, actually. The airfields were the takeoff places for the bombing of Japan.

TUSLER: I thought you were speaking about the bomb that was detonated outside of Los Alamos.

WARREN: Alamogordo, it was called. It wasn't Alamogordo, really. It's only a very small part of the old bomb-testing range called Alamogordo. It's really near Socorro and not at White Sands. White Sands was over the mountain range beyond the Socorro mountain range. The town of Pope down there was only a railroad siding. But that's where a lot of the stuff was brought into the test site by railroad. And that was twenty miles, or so, from the actual test site, I think.

TUSLER: Then what happened? The rest was all lugged in by truck, I suppose.

WARREN: Yes, by truck. I think the Manhattan Project was responsible for a great deal of the development of the trucking industry, wasn't it? They had a lot of special trucks.

STEWART: Yes, they got a lot of special trucks and a lot of special arrangements; for instance, the through trailer from Chicago to Los Alamos. After we did that, then the industry found out that they could do it. And now they have these piggybacks on railroad flatcars. They would load the trailer on the flatcars and take it all the way across the country. But it's reloading it and getting it on a transshipment that's a problem.

WARREN: You have to realize at the time the highways were pretty lousy, too. They were gravel roads to a great extent, full of chuckholes. We didn't have a nice freeway as we have now, twenty-odd years later.

TUSLER: It really was that different twenty years ago?

WARREN: Yes.

STEWART: We had all kinds of other things. For instance--talk about stuff that they didn't use-- What was that big container they were going to set off the--

WARREN: "Jumbo," it was called.

STEWART: They were going to set off the test bomb inside this big steel container. It was designed so that it would absorb the initial shock. If the nuclear stuff didn't go off, the container would keep it inside in order not to lose it. Well, I had to make special arrangements with Babcock and Wilcox, and so forth and so on, with all those engineers at Los Alamos, to make this thing which was thirteen feet in outside diameter. It was about a foot thick and it was made of steel. It was kind of castle-shaped, with round openings, that were welded together like orange peel sets. And I had to get a special car. There was only one in the country. I had to set up a special train with a transportation route. We figured out a route to haul it down to New Mexico.

WARREN: From where?

STEWART: I sent one of my officers down with it, and he had it covered with a piece of canvas and so forth. After they got down to Los Alamos they noticed that on one side the canvas was cut. It had come close to something. They had figured that the width and the tolerance was more than that.

WARREN: Where was it made?

STEWART: It was made in Barberton, Ohio, at Babcock and Wilcox Company. They had to ship it, I guess, to Youngstown to do some milling on it with a machine. They had it down there and set it up. Then they did some more figuring and decided that if the thing went off, why, the heat of vaporization of all the steel would throw off their meters and so forth, because they're calibrated for a certain range. They couldn't get accurate measurements; so they decided not to use it. [laughter]

TUSLER: That was another thing that fell by the wayside.

WARREN: Yes, and what did you say, it took about three months to make it?

STEWART: Yes.

WARREN: And it was produced at a terrific rush.

STEWART: Then they had to build a trailer to haul it from the railroad out to where they were going to set it up.

WARREN: They hauled it over on this sandy desert road, really just a track and dusty.

STEWART: Sometime later, there was an ad in one of the papers that showed this big trailer. They had Goodyear tires on it, and I think it was Goodyear that put the ad in.

WARREN: It had multiple wheels didn't it?

STEWART: Yes, all kinds of them.

WARREN: It's kind of the precursor of some of the present multiple-wheel trailers that are used for heavy hauling.

STEWART: I think the thing weighed about 250 tons, and I think we got some big building moving outfit from Cleveland to design the trailer because they made vehicles that moved buildings, you know. They got so that they could take a big building and move it across the street or turn it ninety degrees, and whatnot.

TUSLER: Then was it used after that?

STEWART: They decided that since the thing was set up down there they ought to use and test it. They set the bomb in there without the nuclear parts in it. The design of the steel container was such that the bomb was supposed to be suspended in the geometric center of the vessel. Some people went to set up the thing.

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WARREN: We were talking about this jumbo container, steel vault or vessel, that was mounted up in place on a foundation; and the question was to test it.

STEWART: Well, the vessel was kind of like a castle. It was set upright, and since it was down there they decided to test it. Instead of suspending the bomb without the nuclear parts in the center of the vessel, the people who were doing the testing just set the bomb inside on the bottom. When they set the bomb off, it just blew apart. The test wasn't any good at all because it had been positioned in the wrong place.

WARREN: Wasn't this due to the fact that the fellows who made the original design had already gone?

STEWART: No, you remember [Robert W.] Henderson. He was still there, but he wasn't involved in that.

WARREN: The people carrying out the test didn't know what the procedure was to be.

TUSLER: It sounds to me as if you became scientifically knowledgeable out of this job, or did you have a background in this sort of thing before you took over?

STEWART: No, I have a bachelor's degree in mechanical engineering. Maybe I have a natural trend towards being interested in things that are scientific, or I have the ability to grasp what scientists talk about. I can see what they're trying to do. I may not quite understand all they are trying to do.

WARREN: You had to understand enough of it to be able to OK it. [laughter] Now, one other thing about "Jumbo" was that their testing of it was done before the first bomb test went off. This was in October, six months before the first non-nuclear tower bomb test. I don't know which bomb configuration they used without the nuclear materials.

STEWART: I think they used "Fat Man."

WARREN: The Fat Man, yes.

TUSLER: What was the Fat Man?

WARREN: The Fat Man was the implosion one.

STEWART: The "Little Boy" was the rifle. It was the gun.

WARREN: With the implosion, they put the baritol in a series of "sandwiches," you might say, triangles so that they fitted around the nuclear material. When the baritol went off it forcibly brought the nuclear material together. I don't know whether it was in two hemispheres, or just what. With the gun type, they shot one hemisphere into the other one, and at that time, the detonation would occur. Actually, they had not tested both of them. They had only tested one of them on the desert; so one was kind of chancy. They thought the gun one was sure to go off, so I think they tested the Fat Boy on the desert. And then, you see, they sent one of each to Tinian, and Dr. Luis Alvarez had the job of putting them together. Bob Bacher climbed the hundred-foot tower and put the bomb assembly together in the desert. He's now at Caltech, as you may know. This was quite a nervy thing to do because if he slipped in the dark he could fall off. It was done in the dark the night before.

TUSLER: Why did it have to be done in the dark?

WARREN: Well, it was at the last minute. Everything was done at the last minute. As soon as they got it ready, why, it was done.

TUSLER: That's the way the timing went?

WARREN: That's the way the timing came out. Before the test they had already sent Jim Nolan, the security officer, and the bomb to the Indianapolis; and they were on their way to Tinian. So if it worked, fine; if it didn't work, we were all sunk; if it was a fizzle, we were all sunk.

TUSLER: Which type of bomb was used in the actual bombings at Hiroshima and Nagasaki?

WARREN: I think the Fat Boy was used at Hiroshima, and Little Boy or gun was used at Nagasaki, wasn't it? You know, we're still hampered by security. We learned a lot of things, but we tried to forget them right then. As soon as decisions were made you tried to forget, so that if anything happened to get you in a bad spot, you would not be able to remember enough to disclose anything. This is a terrible handicap, you know. You have it in your subconscious, and I suppose since we remember so much of it that if we had been given the crucial test who knows what would happen? One of the big problems was that one of our people might get kidnapped and be given truth serum, or one of those drugs, where just before becoming unconscious the person is very susceptible to questions. Your inhibiting forces are all gone. This doesn't work as well as it is supposed to; but, anyway, this was the great fear. This is why everybody that was in a sensitive position was moved to one of the secret city locations if they were going to work on these things.

TUSLER: How long were you involved with the project before you became aware of what the objective was? Did it take quite a few months?

STEWART: Yes, I'll say it did, because I had learned a long time ago not to be too inquisitive. I had to tone down some of my people who were being inquisitive. I used to say, "You'll get yourself in trouble. It's better not to ask. What you don't know isn't going to hurt you, and it's better not to learn it." I think it was six or eight months before I realized the importance of the project.

TUSLER: Then after that you had to be extra careful in keeping your mouth shut.

STEWART: Yes, yes. You see, actually, we made the bomb parts out here under the University of California contract and they weren't doing too well. That's what I had to build up my staff for out here. In order to help them at Los Alamos, why, the university people here were a little bit reluctant. For instance, I talked to David Wilt about his staff, you know.

WARREN: David Wilt was the local procurement officer for the university, from the campus.

STEWART: He'd set up an office and he thought he had a fine office, you know. And I said, "Well, it's not big enough. You want about twice as much space and get twice as many people here because you're not going to be able to work fast enough." He didn't seem to appreciate that. So I built up a separate procurement staff of my own, using government purchase orders and government contracts. We were able to do a little bit better than the university because they didn't want to hire engineers. But you had to be knowledgeable in engineering in order to explain what you wanted from these machine shops and so forth. We could get engineers, and the army had several officers with engineering backgrounds. So we set up a little office which grew quite a bit, I guess. It developed that what we had out here wasn't big enough or fast enough. They, in turn, set up another procurement office in Detroit under Colonel [Robert W.] Lockridge, who worked directly for Rear Admiral [William

"Deacon"] Parsons at Los Alamos. They had some big contracts with A. O. Smith and some others there.

WARREN: Well, you didn't actually fabricate the uranium or the plutonium out here in Los Angeles.

STEWART: No, that was done in Los Alamos.

WARREN: But you got the other parts done. You made the casing.

STEWART: We made the forms, or the molding, you might say, that later on Bruce Sades used out at China Lake, to cast that baritol. And they used it later at Los Alamos. We had to make objects in these molds out of material whose specific gravity was close to that of the baritol. They wanted a model done. It was kind of a concrete block, a cheap concrete block. They had to fool around with fitting them together at Los Alamos. We made those here.

WARREN: Mr. Harold Fidler was kind of a local manager out of Berkeley, wasn't he? He had an office there.

STEWART: Yes, he was connected with the cyclotron. They kept Mr. Fidler at the Berkeley office and out of the Los Alamos thing.

WARREN: I remember, in speaking of China Lake, that you made the arrangements so that I could send the boys out to China Lake to test baritol on posts to try to get some kind of a blast figure on rats that would tell what the blast waves might do. If it hadn't been for Slim we wouldn't have been able to make these tests before going to Bikini. You have to appreciate the fact that very little was known about blast. There had been quite a lot of theoretical work done by--who was the boy at Princeton? We were going to have him here on the faculty after the war, then he got cancer and died. He was the theoretical mathematician who worked on the shock wave. I learned first from him about the reflections that might be possible.

Jim Nolan, Dr. Louis Hempelmann, and I tried to test rats by attaching their tails with battery clips to wires strung between posts. We had all kinds of crazy results. We suspected the effects we saw were due to reflections. Hempelmann and Nolan did the experiments in one of the canyons there at Los Alamos with some baritol that they could get from the group there. We did this with the rats before the test, and then we did some more when they exploded 100 tons of baritol on a tower as a preliminary to get some idea of what the baritol alone would do. This didn't work very well. We found rats killed at quite a long distance out. So we had no real idea what the blast would do until we went to Bikini, certainly not before the Japanese detonations.

But out at China Lake we found that where the detonation was initiated, for example, in a big keg of baritol put up on a post, that would determine the configuration of the blast wave pattern. In other words, if there were four detonation sites on a big disk of baritol, you'd have four foci of origin of these blast waves, which were like a cloverleaf. We found this out by raking the sand very smooth underneath the site of the explosion out to the posts where we had hung the rats. You could see the sand was disturbed out from the focal points; but where the cloverleafs came together, the blast was hardly measurable. That's why rats that were in that particular location didn't die and others a couple of feet to the side would die. By this time we had been able to get a lot of information from the British, who made studies of the V-2 explosions. They were puzzled by the same thing, because there might be two hotel windows facing the blast. One window would be shattered and people killed and the other window would hardly lose the glass. These blast reflections became quite important, later, in planning for civil defense and for protecting people with objects in the path of the blast waves.

TUSLER: When was this experimentation? Was this before the explosion at Alamogordo?

WARREN: The experiment at China Lake was between times, after the surrender and before the staging out for Bikini.

TUSLER: Before Bikini.

WARREN: We tried cages for rats. Even in wire cages with the wires spaced just enough to keep the rats from escaping, the wire would act as a reflecting device and reduce the internal pressure in the cage maybe 50 percent or more. Without that size mesh we discovered that the rats would die. They would drown in some kind of fluid that was freed in the lung by the blast. You could see the rib markings on the lung by blood that was lost into those areas. And there was a little work done by Zimmerman, a Britisher, who tried to design protective clothing for the military against these high explosives during the war. He didn't have a lot of evidence as to what actually killed the soldiers or the civilians.

I went to the medical officer in the surgeon general's office and finally got to see Dr. [George R.] Callender, who had been in Ordinance and was working with goats and other animals trying to decide what a blast would do, but there was really not much known. It wasn't until Dr. Benedict Cassen, here at the project, spent quite a few years working with a blast tube and mice that we began to understand what actually happened. You'll hear the physicists say, "Well, we knew all this in theory," but when it came to actually applying this information to people in locations, you just couldn't do it. At the time the security was such that it was very difficult for us to get any information. And Oppie, of course, didn't like our putting up experiments out in the desert because they were always afraid--and

Colonel Mitchell was, too--that we might step on some wires or something and ruin the bomb test. This was something that we had to be very aware of, because they had their instruments around, at great distances, with wires just laid out on the desert.

TUSLER: And that could have triggered things?

WARREN: Well, who knows! Anything could happen. Everything was fail-safe as much as they could make it but, remember, this was the first trial.

TUSLER: You didn't really know.

WARREN: No one really knew.

STEWART: That brings to mind another incident that is kind of rambly. Before the test in New Mexico, somebody suddenly decided that they needed a certain kind of coaxial cable that was only made by a little plant outside of London. We were set up at that time to handle stuff coming from foreign countries by sending a wire to General Groves's office. His G-2 people would operate through intelligence circles and they'd contact somebody over there. It happened that they got a couple of reels of this cable and arranged to fly it back here with high priority. The scientists called me about Wednesday and they said they had to have it on Sunday. Well, we got it to them in time and they laid it out there on the ground. Then some clown ran over it with a bull-dozer and chewed it all up.

TUSLER: And that was the end of it?

STEWART: Well, I think they patched it up.

WARREN: Well, there were hundreds of people around you see. The test site out on the desert had a couple of shacks. The rest was all tents. There was an enclosed water tank sitting on stilts near the site. That served as a shack where the weather man sat.

STEWART: Somebody said that, at about that time, they saw a lot of these high-powered scientists digging a trench in the sand by hand down there. I guess they were putting down a new cable or something.

WARREN: Yes, well, there was not time to get a plow, and the bulldozers were all doing something else. It was quite an organization problem which Colonel Dana Mitchell and some of the others handled very well, considering. These men had come fresh out of the laboratory and were put down on this big desert. They had to set everything up. The magnitude of many things, distances particularly, was overwhelming.

STEWART: I would say it is amazing. They had some high-powered committee meeting down there one day with Dr. James Conant and General Groves and others at Los Alamos. They called me in to make a couple of statements, but I didn't know what it was all about until later. Anyway, a lot of the scientists were upset with Colonel Mitchell because he was trying to make them justify why they wanted certain things.

They felt that this was kind of a deterrent to their thinking process or something or other. They wanted him removed and they also had some problems, they thought, in connection with getting some rare items. They thought that if somebody like Colonel Mitchell was set up in an office in New York, he could operate independently and help them more. General Groves called me to Washington one day and asked me about it. He said this committee had decided to take Mitchell out of the Los Alamos project, and he asked me what I thought of it.

I said, "Well, if you want my opinion, I think it's wrong. Mitchell, I think, understands the problem better than anybody. He may give those people a little hard time, but he's generally right. That's one point of view, but another point of view is if you set him up in New York and give him all kinds of authority to operate independently, why, you'll just be agreeing to the fact that all during this whole project all we've been doing has failed. You'd be admitting something that I don't think is true. I'd leave him down there.

WARREN: Did Dr. Kenneth T. Bainbridge come in about that time to help at Alamogordo?

STEWART: I believe he did.

TUSLER: What was Mitchell's point of view? Was he just trying to conserve money and avoid waste?

STEWART: No, Mitchell was primarily concerned about time. He'd been involved in procurement in the Columbia University project and he knew what was difficult to get. He was mainly concerned with time. If something was asked for that he knew was going to take quite a while to get, he'd try to talk them into getting something that was more readily available. That's, I think, how he operated.

TUSLER: He was just more practical?

STEWART: Yes, he wasn't concerned about money too much. I'd have had a heck of a time without him down there.

WARREN: Yes, because you would have had to have somebody that you needed to train.

STEWART: And you had to have somebody that was a scientist in order to talk to scientists. When it came down to scientific things, they wouldn't talk to laymen. They would talk to another scientist who could understand what they were talking about.

TUSLER: And he was a scientist?

STEWART: Yes.

TUSLER: And he was the one with whom you worked directly?

STEWART: Yes.

TUSLER: Were you present at the explosion?

STEWART: At New Mexico?

TUSLER: Yes.

STEWART: No, I tried to get down there, but General Groves wouldn't let me go. I was up at Los Alamos.

TUSLER: But of course you were very involved in it, in getting the supplies out to the location.

WARREN: Well, there were all kinds of problems because Los Alamos had no culinary setup that was expandable. I think they had about two cooks for a couple of hundred people. You know, everything had to be brought in. This was right out flat in the desert. Nobody was permitted down there that didn't have a real assignment. They trucked in some newspaper people and people like Ernest Lawrence and others. They had left Los Alamos about midnight and got down in the area in a couple of buses and then were assigned seats on the Iron Hills--isn't that what they were called?

STEWART: Yes, about twenty miles away.

WARREN: Twenty miles away, and you can read Lawrence's statement that he was terribly mad about the fact that they weren't going to see anything. But after the test went off, they were more than satisfied. When the cloud got up and began to look as if the fallout were going to fall on them because they were only twenty miles away, they were very glad to get in the buses and go home. [laughter]

TUSLER: Was it strictly for safety and security reasons that they were kept out and away like that?

WARREN: Yes, nobody knew what would happen. There was quite a bit of discussion about where Colonel Mitchell and Oppie and Dr. Enrico Fermi should be. Dr. Fermi had an assignment to carry out. He had a specially devised tractor with a big sheet of metal on the bottom. Dr. Hempelmann, Dr. Nolan, and I had several discussions about whether it was safe and when and at what point he could be permitted to go in with this protected tractor. He was to shoot a bucket out into the crater and get a sample of the dirt because they were so anxious to get some idea of how efficient the fission was, how much of the bomb was unexpanded. He was all set to do that, but he wanted, also, to be in the bunker. They all wanted to look. The rest of us were all at nine miles. The bunker was something like three to three and a half miles from the site. And, of course, there were three miles of wire for a lot of the instruments.

TUSLER: Three miles!

WARREN: Yes, you see, the wire that was laid out on the desert had to go to the instruments that were in the bunker.

TUSLER: The bunker was where you were?

WARREN: No, this was the closest observation point. This was a big, concrete cube with a door on the far side. Then a huge amount of dirt was put up over it. It was sloped in such a way that the blast wave wouldn't tear it apart. Fortunately, it was far enough away. The base camp was nine miles away where Conant and Bush and Groves and Farrell and Dr. Richard Tolman were. That was where I was. Dr. Richard Tolman was my only friend the day I sent in my report on the fallout. At least I thought he was the only one that was kind about it, when I caused them so much trouble by demanding that there be some safety procedures set up. Nobody had thought about what would happen after time zero. He died about five or six years later.

Well, now, what else can we bleed you dry on? You got out when?

STEWART: I got out from the Manhattan Project in August of 1948.

WARREN: You were still here right after the war when we came here. You were very helpful in setting up our contract and getting us launched. We took some of his staff to work in Mr. Buettner's office. He had come with me and became the business manager for the project; we called it the Atomic Energy Project, contract 1012. Of course, Slim paid the university out of the contract for moving the buildings from Camp Santa Ana to put them up here on the university and helped us get equipment. A lot of excess war materials were available, and Slim was able to find them. We got desks and typewriters and chairs and all kinds of things of this sort.

TUSLER: The university bought these materials from the army?

WARREN: Through the contract, yes; it was from one pocket into another.

TUSLER: I see, and this was really the beginning of the medical school then.

WARREN: Yes, because the first members who worked on the research were chosen because they had worked on the Manhatten Project during the war, and so they were set up in offices. Dr. John Lawrence was one of them.

TAPE NUMBER: XIV, SIDE TWO

SEPTEMBER 15, 1966

TUSLER: Dr. Warren, today you are going to talk about the actual explosion at Alamogordo, is that correct?

WARREN: That's right. But just before we started, I was talking about a "fizzle." A fizzle would mean that the bomb would only explode because of the high explosive contents which were in the bomb to compact the metal. There were two basic theories. One was that they used a gadget like a rifle which shot one half of the sphere of uranium against the other half. In this case the amount of explosive material was relatively small, and this was called the "Little Boy." And then there was the "Fat Boy," which was the implosion design where the baritol was distributed in sort of pie-shaped masses around the uranium and forced the uranium into the center where the other half of the mass was. This was a design that Harry Gold gave to the Russians through the Rosenbergs.

It wasn't until after the war that they got a fizzle set up and set off in order to study what would happen; how much risk there was of fission occurring; and how badly distributed the bomb materials would be. Now the bomb material is the "bone-seeker," and the alpha emitters which it contains naturally are kind of destructive even though the intensity of the radiation is pretty low. But, nevertheless, it's not a good thing to have a lot of the rare bomb metal distributed around in gas and powder, or at least in volatilized and powder form.

Well, one of the big problems that kept nagging my group was the fact that if the first bomb test was a fizzle we would have a tremendous trauma and a psychological disintegration, really, of a great many of the scientists who had been working so hard on this bomb. And, of course, we all knew that General [Leslie] Groves was going to make the gamble all the way through and send the bombs to the launching site which was all fabricated and ready for use on Japan. The minute they were ready they would be on their way. Everything was done that way; you'd do something today, and it was put in effect tomorrow or in five minutes. It was fortunate that so many things--almost everything--worked. There was extreme care taken with every step. Everybody was very aware of the consequences of failure so nothing was left to chance. Every detail was checked as far as it could be before it was done. This policy pervaded the whole operation as you can judge from the things I have said about Oak Ridge and Hanford and other places. There was a general spirit of doing the job honestly, thoroughly, and correctly because there might not ever be a chance to do it over. And if you failed in your part, nobody knew what that might do in creating failure in the whole thing. It was all so dovetailed. I think General Groves had a group of master dovetailers, you might say, in this whole operation. The men he chose out of the engineers and the men that he dealt with in the companies, the big organizations, were all of very high calibre.

TUSLER: You feel that this was one of General Groves's particular qualities that [stood out].

WARREN: Of course, he had the policy that everybody including himself was expendable. And he would say, "Well, if you are on the firing line you would be expendable, and you're on the firing line here just as much." So this is one of the things that our office had to watch, the possible decay of somebody.

We always looked at the couriers because these fellows were sent back and forth from Oak Ridge and Los Alamos and occasionally other places with very highly classified material, secret material, in a briefcase strapped to their wrist with a chain and a lock. And they slept on their briefcase. In fact, most of them never went to bed. They just slept in the chair or in the airplane or somewhere because they wasted no moment between getting off the transportation, delivering their package, getting whatever they had to take back, and getting on the transportation again. So we had a regular setup at Oak Ridge in which one of our officers, occasionally myself, would meet the planes and the trains in Knoxville and ride in with these men and talk to them about how they felt and get a look at them. As soon as they got their material delivered, we would put them in the hospital and give them a good hot bath and massage. Remember, meat points were very short; but we would feed them steak and anything they wanted in the way of food and then sedate them, and give them twenty-four hours of good sleep, waking them only for meals.

TUSLER: Because they were so exhausted?

WARREN: They were just exhausted. If we were fortunate in getting somebody on Friday and we could talk the courier service into waiting until Monday, we then had a real good chance for forty-eight hours, you see. We would give them only a light sedative on Sunday night, enough to keep them under, so they really got a good sleep. And, my, these fellows were just rejuvenated. I'm sure we saved a lot of them. These were very valuable people because they knew exactly how to go somewhere without attracting notice and how to get there. They would have been a bad loss.

TUSLER: How much did they know of what they were being involved in?

WARREN: Nothing; they knew nothing. It was a job, but their job which they carried out.

Now, to come back to Alamogordo, in May of 1945 we had a test shot, a dry run of the whole operation. A hundred tons of baritol were put on the tower, about a hundred feet high. Well, it was at the same place as the experimental tower. It was a little bit off the site of the real test. Then all of the equipment was spread out in the desert, all of the electrical connections made to the bunkers and the camp. About this time I began to have an interest in the weather and where the contamination was going to go. I could get almost no information. Everybody was too busy with getting the bomb fabricated to worry about what happened afterwards. In fact, we'd get brushed off, and I had to insist that our people do something about this. Dr. James Nolan and Dr. Louis Hempelmann joined me. Dr. Nolan was the chief medical officer at Los Alamos, and Dr. Hempelmann was, you might say, the industrial physician. He worried about all of the hazards in the manufacturing and testing operation at Los Alamos. He had an assistant, Dr. Harry [D.] Whipple, who was later to become quite a famous man in this field, too.

They finally were able to get the ear of Joseph O. Hirschfelder, who was a flame physicist--that is, he worried about the development of a flame, as the bomb, of course, would produce a flame, a hot center, if the fission occurred. He had done a great deal of theoretical as well as practical experimentation on flames, so this is why he was there. Well, his work had been pretty well finished up. He had some instrumentation, of course, in this testing, but he and Paul Aebersold, who was a very young man at this time, just out of graduate school, also a physicist, trained in Berkeley, sort of became our consultants.

I used to go out there to the site, and we would sit after dinner and have long arguments clear past midnight wondering what actually was going to happen. We finally got them to agree that there might be as much as a ton of radium or a million grams. A gram of radium put out a curie. Now, before the war, hospitals and doctors treating cancer thought they were in marvelous shape if they had a quarter of a gram or maybe a few milligram needles. I had ten milligram needles. So I had almost one microgram, and this cost quite a lot of money and was quite dangerous to handle. And when you thought of a ton and a million grams, my God! Excuse me for saying that in the record, but that's really the truth, you know.

TUSLER: Unbelievable, yes.

WARREN: We would not have thought much about this as a feasible thing or as a realistic thing, if we had not been dealing with large scale operations, tremendous amounts of radiation from the reactors and other things. So I was particularly impressed by the fact that this might be true. Then we also wanted to know as much as possible about the blast and blast effects and blast waves. We could understand that there would be a lot of heat, but this probably would be absorbed by the atmosphere and wouldn't be a problem very far out; but we didn't know.

Just before the experimental test in May, Nolan and Hempelmann did a few experiments in one of the canyons with some extra baritol. That's a form of dynamite, you might say. It's got a shorter explosion pulse than dynamite. But it was put on a stand in the canyon. Then rats were hung up by using battery clips and stretching a wire across between some trees. They got variable results in killing these rats at different distances, to pretty high charges. So we decided that when they did the 100 ton shot we'd better put some rats up in the field and really check and not go by theory, because who knows.

In the meantime, I looked up everything I could find out about blast. I went to the surgeon general's experimental group. Dr. George Callender was one of the few men who had done any experiments in this field.

Prior to him, a Dr. [W. J.] Miller, a physicist, had done some experimentation with blast; but the instrumentation was lacking. They tended to work close and they had very heavy gadgets that depended upon the transition of the diaphragm by the blast wave. Obviously, these weren't suitable for our kind of work.

In asking around, there were two or three projects which we saw going up later in which they would have a piece of wood or metal with a hole in it, five or six inches in diameter, and a graded series of smaller holes. Between two sheets of this wood or metal they would put very thin sheets of paper or aluminum foil of different thicknesses and then these would be placed out at various distances. Well, I looked up as much as I could find about this method. Of course, the paper was subject to humidity changes, and so it was not very reliable. When I talked to some of the men who were putting them up, they said, "Yes, we know, but we have nothing else but these two methods." We didn't have stream gauges to any extent at that time, though I think there were a few homemade ones put up, and then there were our rats.

Now, the problem was that we'd have to put the rats up about midnight, because the detonation was going off at dawn, about six o'clock or five-thirty. Would they hang there all night? We got some very strong battery clips and clipped them by the tail. Of course, this made them upside down, and some of them could crawl back up their tail and sit on the wire. So they weren't exposed and, of course, we didn't know whether they were going to get it front or back or just what. But, anyway, we put them out at distances of 1,000 feet, 2,000 feet, 3,000 feet, and one mile. We, of course, got in the hair of the task force. Oppie was very critical of our wandering around in the dark; we might upset some of the cables, which was true, but we took men with us who were supposed to know where these were. Dr. Hempelmann and I succeeded in getting these rats strung up in the dark.

The next morning we were sitting and waiting. I was stationed in the command hut at the base camp and I had a one-channel portable radio. Dr. Paul Aebersold and Dr. Hirschfelder were on the periphery about thirty or forty miles out at the crossroads near Carrizozo, and we were trying to see whether our radio would work. Of course, we found that there were a lot of places where there was a radio silence; you couldn't hear a thing. This is quite common out on the desert. There are holes in the atmosphere for radio waves. Apparently, magnetic fields are influenced by local ore deposits or something, maybe a hill in the way, and you're out of luck.

I had looked up ammunition dump explosions. But the only helpful thing that I found--I got this out of the Library of Congress--was the explosion of Krakatoa in 1883. I read this from cover to cover, and it was quite clear that here was a real big detonation that went 150,000 feet into the air. Well, gee, I thought we wouldn't have anything like that. The dust went around the earth for about thirteen days, and it spread. Krakatoa is near the equator.

TUSLER: Was it volcanic?

WARREN: It was a big volcano that exploded and kept on erupting for about a week. It threw a fantastic cubage of gaseous and particle materials into the air. This could be seen for 1,000 miles, practically, because it was so high. You see, that's almost the limit of a balloon ascension. We had no idea what the meteorology was in that situation.

Well, I stood there nine miles from the detonation site. I had a man over on the other side of Mockingbird Gap, which was towards White Sands. He was about sixty miles away. His job was to watch for any cloud. I had, by this time, come to the conclusion that we might have a cloud that could be seen to drift. This man was to wait there until ten o'clock in the morning--that was four hours--and if he saw nothing, then to come home.

He was too far away to be heard on the radio. Well, just to finish up his story: he stayed there and the cloud went right over him all right, but he couldn't distinguish it from any other cloud because there was no color differentiation or anything. It was just like looking for a needle in a haystack as far as he was concerned.

Dr. Hempelmann and I stood there and watched this thing go up. Of course, everybody else got their immediate observations and then went back to Los Alamos or elsewhere. But Hempelmann and I stuck around. We went out and got our rats. There were a lot of funny things that had happened. The top of the grass would be cut off as if you had used a mowing machine. The grass in a hollow would have three or four inches of stem, and then it would grade down to nothing at the edge of the hollow. This would be out maybe 1,000 feet. This was kind of impressive, you know. Well, our 1,000-foot, 2,000-foot rats had opaque corneas. The ones at 1,000 feet were all dead; of the ones at 2,000 feet, there were a couple still alive. We brought them back to base camp because I wanted still to watch the clouds. The autopsy revealed that the rats had hemorrhages in the lungs and in the rib cage just as the previous rats had had in the canyon. This was puzzling. Some animals we never found. Apparently the blast just carried them away--tore them loose. Well, I stood there and watched that cloud for over four hours, almost to noon, and I could see it as a balloon in the air.

TUSLER: Where were you at this time?

WARREN: I was back at the base camp, nine miles from the test. I had left somebody to keep an eye on it while I was getting the rats.

TUSLER: Were you there at the base camp at the time of the explosion?

WARREN: Oh, yes. There was quite a big light, and you could hear a little rumble. It was very impressive, even at nine miles--100 tons, this was pretty big. But for the big test we were talking about kilotons. You see, that's 1,000 times as large. If it was that impressive from 100 tons, oh, boy! And this was even better than what they had been predicting. So there this cloud was; it went up about 15,000 feet, which was 5,000 feet above the Sierra Oscuro Cliffs. You see, there was kind of a palisades there on the east side of the desert, where the Carrizozo Mountains just went straight up. The cloud was another mile above that, and it went merrily along in a thirty mile-an-hour wind. Four times thirty [miles] is 120 and six times thirty is 180 miles. I looked at the map and there was Roswell and other places.

WARREN: Right in the path. So I began to inquire. The Los Alamos boys had a meteorologist, Jack [M.] Hubbard, who had been trained in the Normandy invasion with a group of others to predict the weather, using the latest procedures, for the day of the invasion. These men had been indoctrinated with all the latest theories and gadgets. Up to this time meteorology was pretty cut and dried. There was supposed to be winds always blowing from the west to the east, and these winds were plotted out in straight lines. It was a lovely, simple system. The Weather Bureau was stuck with it and wasn't too happy because they weren't predicting things very well.

The airplane industry used DC-3s. They would go 200 miles and come down for gas, and they didn't go above 5,000 feet. So 10,000 feet was pretty high, and they had no oxygen. The interest in meteorology was just a brand-new thing. I can remember with horror all those trips back and forth in DC-3s which jumped up and down all the time. And I helped all the pilots without any overtime pay. Well, I had some close shaves, too. There was no way they could go around a thunderstorm; and if you got in one, why, you were in one. Once in a while, a plane would be disintegrated. Of course, we weren't too happy about this. Also, a lot of pilots were being trained, and they'd go into the mountain wall outside of Denver, lost in the clouds. So flying in that area wasn't too good.

Well, I made arrangements to take a flight in a trainer plane over this area. I got Dr. Hempelmann to go with me. He was as much afraid of flying as I was. This plane had a plastic bubble in the front, and you sat right out in the open. This was an observer's plane--a spotter plane--a light two-engine job. Well, we flew north and south and east and west and just looked all over that area for 150 to 200 miles. It was quite clear that there were a lot of people living in the desert that weren't on the map. There'd be kind of tracks, and you'd see a green spot where they had a well or a spring, and there was either a dugout or a stone or a log or adobe hut. Maybe there'd be a wagon and a primitive corral. But there were people there, and we suddenly discovered Indian reservations there with lots of people. And then there were dude ranches that somebody hadn't thought to mention. We had to keep out of the east of this area because there were just too many people, several thousand people. Also, there was Roswell down there and Carlsbad.

We came home and had a conference on this--Dr. Nolan, Dr. Hempelmann and I--and we decided that we just had to recommend to the general that the detonation had to be put off until the weather was toward the northeast, not the north, or the east, but the northeast. So then he got hold of Mr. Hubbard and said, "What about it?" About this time, Colonel [B. J.] Holzman was attached from the air force as a meteorologist. He was a professional. We were talking heresy as far as he was concerned, and he said finally that he wouldn't take any responsibility for any firm predictions. He would be glad to sit in and listen and be helpful, but he wasn't helpful. So that left it up to me.

I had to do this pretty much alone because all my men were distributed around the country on jobs where they were indispensable. Occasionally, Dr. Friedell could get loose. I used him to check my mathematics, because he was a good mathematician with a very keen mind. I used him for my "crying wall," you might say. I tried my ideas out on him and if he thought they were good, fine; if he didn't then I'd look for the problems. Well, Hempelmann and Nolan were this way, too. And it was fortunate that Dr. Nolan was not only a good doctor and a good gynecologist, but he was visual-minded. He could visualize what happens in the air around, you know, talk about a blast wave. Very few people can think of this as a wave front which moves physically, and with the speed of sound, when involved with this kind of detonation. Or we thought it did; we knew from some of the work that was being done by the Princeton group that waves reflect and there is the stem effect, which is an enhancement. The reflected wave and the advancing wave coincide and you have magnifications and you can have skips.

By this time I had gotten quite a bit of information from London in reports of the London people who had studied blast (the V-2 rockets were beginning to be very bad); and they'd report that of two people sitting in hotel windows that were side by side, one might get killed, his window shattered, and the other one suffer no injury, hardly losing window glass. And they might be ten feet apart. Things like telephone poles would create shadows, and if somebody happened to stand behind a pole they were saved. But then there'd be people around a corner who got killed. There were all kinds of wierd things.

We didn't know what happened in the water, though. By this time, I had gotten a couple of cans filled with water, put a mouse swimming in the top, and shot a .22 bullet through the can to see what would happen. I could kill the mouse without touching him because of the waves of compression that came around him in the water.

I knew we were possibly going to get an underwater blast sometime, maybe not in Japan; but, anyway, this was one of the things we had to look at. But I dropped [the water study] since I was assured that we weren't going to do that with the first detonations in Japan, anyway.

Hubbard began to think about this in terms that were useful to us. It was quite clear the the cloud from the first tower shot with powder had gone as a discreet free balloon, in an air current that was about 40,000 to 60,000 feet high. That was the place where the inversion was and where the big speed of airflow was. This phenomenon was later called the "jet stream," a very common wind pattern. But airplanes couldn't get up that high at that time; 30,000 feet was about as high as they could go, and these were only military planes. So, you see, we were at 6,000 feet, and the cloud was probably a mile up, above the Oscuro. The Oscuro was 3,000 or 4,000 feet high, so we had somewhere between 10,000 and 15,000 feet where our cloud was likely to be. Evidently there was an inversion there so that the cloud could be carried along as a free balloon. This pattern was unconventional. Hubbard therefore began to plot the levels, wind speeds, and directions; and we began having sessions every day when I was out there. Hempelmann continued them. We finally were convinced that this information was going to be useful to us. One couldn't get much information above 40,000 feet because this was as high as the weather balloons went. But he was getting weather reports from all over the western part of the country on the teletype and a little bit from the East. He then tried to plot the big movements of air.

It was now about two weeks from the day of "Trinity." I sat down one night and had a long talk, got the last plane out of Albuquerque, and got into Washington about noon or late afternoon the next day and I told Dr. Friedell I was going home to write. So I worked for about twenty-four hours on a letter to General Groves and created what I considered to be a fallout pattern (Hirschfelder had helped me on this). We knew nothing about the distribution of particles in the air. Van't Hoff's law was used to measure and identify the rate of fall of particles; so we used that. But, anyway, you could diagram the fact that the cloud went up; I used ordinary graph paper to do it. We thought it would level off at maybe 40,000 to 60,000 feet. Well, 60,000 feet was beyond our reach for any measurements, but 40,000 feet was not.

I described the countryside and the difficulties with getting it contaminated in any place but the northeast.

I recommended to General Groves that they take care to set it off when the wind was in that direction. I asked for a couple of hundred troops, jeeps, and trucks, because General Groves had told me that he would have the power of marshal law--he had talked with the governor--and that I would operate under that at that time. So I said to myself that if I needed to evacuate people, I would have to have armed troops to go in and take them out. Suppose grandma was cooking dinner and she says, "The heck with you boys." These were independent people and had been living that way. They frequently had a rifle behind the door and wouldn't take any nonsense.

I also began to lay out a plan for distributing the people around in case we were wiped out at headquarters. Dr. Friedell was to sit in Santa Fe and be in touch by radio. Then I had Aebersold go up and down at the site in an area where Dr. Hempelmann and I had gone out with stakes and red flags and staked out the best path that we wanted the fallout to follow. I guess we went about three or maybe five miles with this. They weren't very close, but at least this began to be commented about around the place. The boys thought we were a little crazy. But this is the way we wanted it. If it went in this direction, then the fallout wouldn't hit anybody that we could find by air.

TUSLER: What you're talking about now was all delineated in this letter to General Groves?

WARREN: Yes, right.

TUSLER: You had to do that because you weren't getting sufficient attention on this matter from Los Alamos itself?

WARREN: Oh, they weren't paying any attention to it.

TUSLER: No attention to it whatsoever?

WARREN: No, they were interested only up to time zero and when the bomb went off--what happened then. I was the only one with Hempelmann and Nolan to do any worrying about afterwards.

TUSLER: That seems extraordinary; you'd think that would have been one of the first things that would have occurred to the authorities there at Los Alamos.

WARREN: No, they were all physicists, you see, and working on a gadget. It was really my responsibility because it concerned people, and I had the people as my problem.

TUSLER: What was General Groves's response to this then?

WARREN: Well, I went into Washington with the letter, which was top secret, of course. I kept a copy in my files, which really wasn't kosher; but I did. I saw it not too long ago when I was looking up this army historical data. Somebody had stolen the diagrams out of it." It was interesting, but I could remember them enough so I could make them over. They are very simple.

I turned it in that morning and sat out in the anteroom. General Groves came out pretty soon and said, "Well, you sure play hob with everything."

And I said, "Well, this is what I think is going to be true, and we ought to do something to prepare for it."

So he said, "Well, I've asked Conant and Bush and Tolman and others to help." (These were his scientific advisory committee.) He said, "I've called them in for tomorrow morning and you be here!"

So then I went on trying to figure out with Dr. Friedell by phone how many people we would need, because obviously we would have to rob other bases to get these military people. But I finally did get enough six-plys. These were four-wheel-drive trucks; you could get maybe a dozen people in them. I got about equivalent to a company and a half. We couldn't take any of the guards away from the site, so these had to be brought in new. They weren't bivouacked in the actual headquarters camp. I don't know where they put them, but they were ready that night.

TUSLER: You mean the night before the detonation?

WARREN: Yes, they came in. The officer reported and I gave him his distribution.

TUSLER: Was General Groves sympathetic to this whole aspect of the thing? No problem there?

WARREN: Yes, this is one of the interesting things about him in contrast to General Farrell. General Farrell was a former Engineer Corps officer and was the chief of engineering for the state of New York. General Groves wanted him--he had worked with him before--so he procured him. General Farrell was willing, of course, to go back in uniform. But he came in only about three months before the test, and so it took him quite a long time to understand it. Two or three days before the final test, we were sitting at headquarters, and Hubbard and Hempelmann and I and Hirschfelder were sitting there looking at some of Hubbard's weather data. We then took a piece of paper and put a point, which was our site, and then we put arrows out for the direction of the wind. The direction of the wind two days before the test was in every direction. If you stacked it all up on one point at different levels, it went everywhere. Farrell happened to look over our shoulders and said, "Oh, it's hopeless. You can't do anything about that." And we said, "Hubbard thinks that two days from now the whole wind pattern will collapse and there will be a big trough and no wind for a while and then it will go off to the northeast." Well, General Farrell says, "Anybody knows that you can't predict the weather that well."

And, of course, Colonel [B. J.] Holzman came and took a look and said, "Nuts"; and he never attended any of our sessions after that. But Professor Mitchell and a few of the other task force people would come in, and it seemed to make sense to them, too; so we got their cooperation on it. And they did extend the test one day, in order to meet this schedule.

TUSLER: Specifically because of the weather?

WARREN: Specifically because of the weather, and I sure appreciated it, because they were all keyed up. You can just imagine. They said, "We don't want to wait, we don't want to wait; we're ready."

TUSLER: How much authority did you have over this, Dr. Warren? I mean, if the weather had been impossible on the day that the test was scheduled for, could you have stopped it?

WARREN: I could have stopped it probably, but I could have been overruled by General Groves. The circumstances and the timing were such that maybe they were going ahead, anyway, because they would have sacrificed people. This was a war, and if there were a few hurt [it didn't matter]. There was a good chance I was wrong. I was just a doctor, you know, dabbling at things that I shouldn't know anything about. But Dr. Hirschfelder was a respected physicist, and it never came to that. Colonel B. J. Holzman wasn't willing to say, "It's wrong." You see, he said, "I don't know"--which was honest and correct from his standpoint. He couldn't take the responsibility; but a civilian could and I could. Because if I were willing to take the responsibility, it was all right by him, and I felt that I should.

There was another group I ought to mention. That was the group from the Signal Corps who had those big search-lights. There were four groups posted to box the compass. But they had to do it in terms of the local geography so that they weren't quite north, south, east, and west; they were northeast and southwest a little bit, which was fortunate, in a way. Anyway, they were out seven miles. They saw the detonation, the big light, and everything. Then the cloud went up and it hadn't gotten very far, so they decided to cook breakfast. They had saved some meat points and had bought steaks for everybody. I had a monitor with each one of them.

All of a sudden the monitor said, "We're contaminated." There were the steaks frying over the fire in a frying pan. The monitor put the Geiger counter on it, and it was contaminated. He said, "We've got to evacuate." So they dumped the steaks out and buried them and beat it. They never did get measurements from the cloud because the cloud, by this time, was about twenty miles across. So, before it began to drift off, it was over them. You see, this was about an hour to an hour and a half after the detonation. The cloud had time to go up, and it stood there, really, four hours. The heavy stuff fell out, and so they got some of this heavy stuff. So there was no doubt about it. One of the problems of getting the monitors located was to be sure they could get on a road that would get them out. They never did get a chance to measure the height. By triangulation, using their searchlights, they could see the image in the mirror and they could center it. Then they could read the angle. They also knew the distance from zero, and it was easy to triangulate. But, when it was right over them, they were stuck and then they had to leave. So the plan was a fizzle. Those boys were madder than spit, you know, because they didn't believe that this was going to be anything much, anyway. Seven miles, my Lord, that's an awful distance out! But it was one of those amusing things.

It turned out that my own measurements of the height are the only measurements ever made. What I did was to use the old boy scout trick, just for my own amusement. I was sitting there, nervous as a cat on a hot griddle, watching and waiting and wondering. The cloud was taking an ungodly long time to go up and settle, and the wind had collapsed just as Hubbard had said. We had had rain about midnight. Everything was damp. The clouds were over, but all of a sudden the sky cleared just like that, at about seven o'clock or six-thirty. And there it was! So I found a place on the top of the door jamb in the shack, and then went back and got a meterstick, and squatted down and sighted along it. Then I measured the distance from the meter stick to the door jamb and the height of the door jamb and the height of the meterstick. I triangulated by simple grammar school methods, and I came up with 70,000 feet at the top. This was awfully high. Very few people--later, when I talked about it--would agree that this was so. But they had no evidence to the contrary.

TUSLER: Do you believe that that actually was correct?

WARREN: Yes. I've gone back and thought it all over again and laid out on graph paper what I did, and it was perfectly right; there was nothing wrong with it. I knew the distance was nine miles to the center of it.

Well, anyway, I had prepared for a fizzle on this thing by getting Dr. [Eric K.] Clarke, who was our psychiatrist at Oak Ridge, on notice that he might get a phone call from me to come immediately. I had reserved two planes so that I was sure to have one to strip Oak Ridge of all of the psychiatrists (they had four people). Fortunately, we didn't have to have them come. But the tension around the test was just fantastic, as you can imagine. After everybody had gotten their equipment in--it was about midnight when they came back--everybody was supposed to sleep. Well, I went around to the cafeteria, and most of them were sitting in the cafeteria drinking coffee and just more jittery than hell.

I got a couple of hours of sleep and then got up a couple of hours before the test and went around to see what people were doing--Conant, Bush, Groves and Farrell, and Vicky [Victor] Weisskopf from Rochester. Vicky had brought some welder's glass and had handed this out. It was a very intelligent thing. I had never thought about the possibility of the light being too great at this distance. So I immediately passed the word around, "Don't look at it; turn your back to it." There was a ditch there which had some dry leaves and some hay in it, so we suggested that everybody lie down in the ditch and look over the top. This would protect us from the blast and things. Oppie was in the bunker with Mitchell. That was at three miles distance where a lot of the control equipment was.

Anyway, they all collected at the ditch. They were embarrassed, you know, to lie down; so I lay down, myself, so there would be no question, then Dr. Hempelmann and Nolan. Then it went off. And, at first, of course, there was a feeling of great heat as if you had just opened a great big furnace door, and then it was shut. There was a funny squeezing sensation to the ears, in the mastoids, that I have noticed several times since and never was able to identify as anything real. Then this fireball developed. After the heat had hit our faces we were well enough constrained to turn our backs. Then Dr. Weisskopf looked through his welder's glasses (they were just big sheets of glass). And he said, "The fireball is worth looking at." It was very bright, so those who had glasses turned around and looked. Then the brilliance of the surroundings began to diminish, so all of us turned around and looked. It was still very bright for quite a while, quite a while being five seconds; it seemed like an awful long time. Here was this great big, boiling, incandescent mass beginning to go up. Daylight began to come and there was dim light all over the desert. You could begin to see the Sierra Oscuro. A lot of clouds were around. The stars faded. Then the column became quite dark and kept going up and going up; it must have taken three-quarters of an hour to go up and stablilize. But you could see rocks and stuff come down. There was enough light by that time so that you could see these things. And they thought, "Well, there's the tower and there are the other parts of things going down." So it got up there and it seemed to hesitate for a while and then it actually, what I would call, ruptured--what must have been a big inversion. This was at about 60,000 feet, I think. And then it went up and just kind of stood there, something like that picture over there, [pointing] not quite as clear.

Well, everybody was jubilant, of course. Conant and Bush and this other gentleman threw their arms around each other and patted themselves on the back. You would have thought that it wouldn't have taken much to have them kiss each other. You know it was such a triumph.

TUSLER: I'm surprised they didn't.

WARREN: They were very much embarrassed, and this quieted them down very quickly. Then they were very dignified. It was just a matter of course; everything was fine.

TUSLER: How did you, yourself, feel at that point?

WARREN: Well, I didn't have time to feel because now I was worried about what was going to happen.

TUSLER: Their part of it was done.

WARREN: Their part of it was done.

TUSLER: Now you had to worry.

WARREN: Well, everybody had breakfast, including me, except I would go out to the door and look because I wanted to see what the heck was going to happen. If it went east I was sunk. If it went northeast it was going to be all right. But I had time in that hour to eat breakfast and kind of think a bit and check on where people were. Aebersold wanted to know if he should go now, because his job was to go down the roadway that was parallel to the site; it went north and south. And we said no, because we all agreed that it was too early yet. They didn't let him go until eleven o'clock. He didn't get all the way. He was stopped by the radiation, so he came back in the car. He had the car all closed up so dust couldn't get inside. So he came back.

At about that time Dr. Fermi had a tank specially reinforced by steel so that the radiation would be cut down that would come up through the bottom from the ground or come in from around. He had a cannon on it with a scoop on the end of a cable. He went as far as he could go with the Geiger counter. We had Dr. Hempelmann to talk to him very seriously about not getting overexposed. As I recall, he would not wear a film badge; but he took along a meter, and in he went. We heard the noise of the gun and he came back later with the statement that he'd gotten a little bit but not very much. He never said how much or how long he was in there, but he got maybe a couple of handsful of stuff out of the edge. He didn't get any green glass though; he wasn't that close. But he got a lot of contaminated stuff. So he immediately got in the car and went up to Los Alamos to run the tests on it to see what the efficiency was. This was the big point: How efficient was it? There were all kinds of guesses, but the guesses were pretty close, equivalent to 10,000 tons of dynamite or baritol. You see, 100 tons versus 10,000 tons gives you a kind of a measure of how much bigger this one was.

There was one thing that I ought to mention. That is that Admiral Parsons (who was then a captain) had undertaken to fly from Albuquerque with an observation plane over the site. There were some lights strung out which would identify on the ground in the dark where zero was. His approach was that he was to pass over zero about the time that the actual bomb release would occur. Then he would be at a safe distance afterwards and have some idea of what the effect on the airplane would be. Well, he got up there. I was on the same radio channel, listening. Well, it was on the loudspeaker in the office where I sat. General Groves would come in every once in a while to hear all these things. Here was the admiral up there and he says, "I can't see the site because of the clouds, and the turbulence is bad." (A thunderstorm had just been there three or four hours before.) Finally, it got to be within a couple of minutes of time and he said, "I think for the safety of the crew and everything, the mission should be abandoned because we can't see anything. There is no use risking the plane for a dead duck." So he went away and was over the landing field in Albuquerque when the detonation took place and really got no sight of anything with the clouds in the way. But I felt always, later, particularly at Bikini, that Admiral Parsons knew that I had heard what he said, and that there was panic in his voice. I think he actually chickened out and didn't like me because I was there listening. Well, General Groves listened, too, but he didn't have anything to do with Groves, you see, later. But he was my immediate superior at Bikini for general operations contamination, bomb control, and things like that.

TUSLER: Admiral Parsons was?

WARREN: Admiral Parsons was--under Admiral [William H.P.] Blandy. All my techincal operations there, were under him--but really under Dr. [Ralph A.] Sawyer, who was the civilian scientist in control of all the gadgetry and measuring devices. But I was equal to him [Parsons] in relation to Admiral Blandy and above him when it came to radiological safety. So we didn't get along well. He fought bitterly all my attempts to disseminate information about the detonation and the creation of the civil defense programs, all the time for the next five or six years. I'm quite sure that this must have been the basis of it, because there was too much of a personal clash between us. He took every opportunity to make fun of me by calling me "Doctor" when he should have called me "Colonel." When I would come aboard a ship and hesitate a moment remembering which end of the ship I should salute--where the flag was--he would sort of sneer and make some comments. It wasn't nice. I could understand kidding; that was just fine. But this other was something else again.

TUSLER: How long after the detonation did you stop worrying?

WARREN: Well, I didn't for fifteen years.

TUSLER: I mean about the particular effects of that particular detonation.

WARREN: Well, about two o'clock in the afternoon Hempelmann went out in a car and Hirschfelder went out in a car and they went on the Carrizozo-Socorro road, both ways, and surveyed the town of Bingham, which was a big metropolis of one store and a windmill and a tank and a small motel. That was contaminated very, very slightly. And then Dr. Hempelmann went on north on some dirt roads until he got up to the Chupadera Mesa. That afternoon, late, he found some suggestions of contamination. He then went back the next day and found, a little further, some pretty good hot spots, which always bothered me afterwards. But that was the limit of what he could find. There was nothing toward the east. Well, along about ten o'clock it was possible to see a layer about 10,000 feet high that went west, over towards the--I've forgotten the name; in Spanish it's the Mountain of the Thieves. For a little while, it looked as if it was going to go southwest, which was towards the Indian reservations along the Rio Grande. Most of it, however, the high stuff, all went northeast, and this was fine. There was nothing out there except a very few cattle and an occasional ranch, but nothing very much. Even these ranches weren't in the direct lineup.

We got down and really surveyed the area. We were fortunate in having a good deal of the fallout fall along the line of the stakes that we had put down. They weren't quite in the center, but this caused quite a bit of comment, you can imagine. We saw the green glass and the "dish" in the desert. It was about three feet or so in diameter, it looked like from a distance. It was too hot for us to go on to it, of course.

So then I came back to Los Alamos and asked Dr. Hempelmann and some of the others if they wouldn't try to get into the country over toward Gallinas Peak and just take a look, because we had had a fellow 180 miles north. He had left at noon and the cloud hadn't arrived over there yet. You see, we had no idea of how fast these things were going to go. It's very frustrating for a fellow just to sit out in the desert in a car waiting, and looking at the meter, and nothing happens. Half a day goes by.

TUSLER: Why did he leave? He figured it wasn't coming in his direction?

WARREN: He felt it wasn't coming, and he was out of radio contact. He was in a big silence area. He tried ten or fifteen miles in several directions as far as he could go by tracks on this open desert. The roads weren't fenced or anything. He couldn't raise us. And we had told him to leave at about noon, not knowing. So we had no idea what happened beyond. I never got back to it until after the war when I sent a party out from here. I had Bob Fennicks from the AEC (who was against going in again because the lawyers and everybody were against doing anything). The military said, "Aw, you're nuts. There was nothing in Japan." Well, there was; it was all of academic interest, but we found it. I went out there just after Nagasaki and Hiroshima had been bombed to kind of clean up and see. I was going to go by myself on foot, starting back at Hempelmann's canyon--and then going on foot with a Geiger counter to see whether I could get up on top of the mesa and see what happened.

Right about then I was called up by General Groves and told that I was going to Japan. He hated to do this to me, and I said, "Well, after all, I think I ought to go." And he said, "Yes, I'd like to go myself, but I can't." So we agreed on who would go and how we would strip the instruments out of plants in order to have enough instrumentation. I went back to Los Alamos and didn't get home till later. I had a chance to call my wife. Of course, she knew something was up, that I was going somewhere. I was taking my summer uniforms so I must be going to a place that had been told about over the radio. I said, "I can't make any comments." She said that she'd been successful in getting the laundry.

Had she told you about getting the laundry and that the laundry lost the uniforms when she first went down? Well, anyway, she got it all in my barracks bag, and Dr. Friedell brought it in the next morning. I took Nolan because Hempelmann was a civilian and I couldn't very well take him to Japan, although he wanted to go. I took Harry Whipple and Nolan, some GI boys from Rochester, and all of our military group that were doing the industrial surveillance, except Captain [John L.] Ferry, who had arthritis. He was very important in keeping the operation going in the plants because they hadn't shut down yet. They weren't sure they were not going to have to use them again. We had only one bomb to spare. This was the one that was used later at Bikini at the first shot. They needed to have some more spares because nobody knew about Russia.

TAPE NUMBER: XV, SIDE ONE

SEPTEMBER 22, 1966

TUSLER: Today, Dr. Warren, you're going to describe your activities with the Joint Task Force One at Bikini.

WARREN: That's right. In the late fall of 1945, the president and the military establishment and the scientists who had been generally engaged in war programs as well as those that were engaged on the atomic bomb production in the Manhattan Engineer District program were of the opinion that there was need for a great test, a large-scale test of the weapon as a military device. This also was approved by Congress and had the general support of the population. It's interesting that the idea of having such a test had such popular enthusiasm, because so many people were finished with the war--wanted to get home, reestablish their lives, and make money. Inflation had hit and there was a great shortage of everything. Everybody wanted to have the things they hadn't had--mostly a new car, new tires, new household goods, and new housing. All civilian progress was way behind. They needed to repair roads and build public structures. The building of hospitals and schools had all been delayed during the war years. But in spite of all this and the great need for this activity, the Joint Task Force One was organized; Vice Admiral W.H.P. Blandy was made its commander-in-chief. I will turn over to you an extra copy of a book, the official pictorial record, called Operation CROSSROADS, which gives the organization and a brief description of the large number of groupings and experiments, with some layout of the target.

TUSLER: Who put this out?

WARREN: It came out of Joint Task Force One. The photographs, of course, are taken from various journals and press associations, International News Service, and things of that sort. William H. Wise and Company actually did the printing in 1946, but the editor was the chief of the Office of the Historian who was appointed early. This was one thing about the military; they had the habit of having a historical record as much as possible during World War II. This was a very important thing because so many people were killed or died of natural causes after the war was over, and so records and photographs got lost. Unless some care was taken to accumulate these things during the process they'd be lost. It's just like the oral history idea.

TUSLER: They miraculously disappeared.

WARREN: Yes, they somehow disappeared. And I have hung on to a lot of things, which I'll turn over to you, from this operation that are, I think, unique. I have a series of 18" x 28" color pictures of the detonation made by a specially built Mitchell movie camera which used this huge-sized movie film. When I was able to get one of these cameras, it was contaminated; so I brought it back home. It's up here with the project, but I don't know what to do with it. [laughter] It's now a museum piece. The lenses in it were very expensive, but they're not usable. There's no real use for it anymore. I had a lot of things, including a pair of shorts that were taken off the commander of the submarine Skate, which are still radioactive twenty years later because of the rust. I have a lot of little things like that. I don't think that you will have the opportunity to have a museum, but when we get through with all this we'll have to look through this and see what you want.

In November 1945, I was trying to get together the report on the Japanese survey from which I had just returned. The Manhattan Engineer District was shutting down so we didn't have any secretarial budget and not much could be done in the way of dictation. My staff, of course, was all dispersed by this time. Dr. Hymer Friedell was still in the office. Captain John Ferry was still making a few visits to industrial concerns that were refining uranium. (Remember, I talked about uranium X^1 and X^2 hazards.

This is a compound of the thorium atom and is insoluble in the acid solutions that dissolve the uranium. That's why it's left behind.) Well, anyway, General Groves called me in and said, "I'm going to assign you to the committee that's meeting on a big test. In the meantime I want you to go and kind of keep an eye on the conversations that are occurring between Dr. Conant and Dr. Oppenheimer and Secretary of State James F. Byrnes. Be sure to protect the interests of the Manhattan Engineer District and not give away any secrets, because what they are talking about is what they're going to give the Russians."

These meetings would occur about once a week and there were, as I recall, five of them. Henry DeWolf Smyth, who had just finished the Smyth report, was also a member, as a civilian consultant. These meetings on what to say to the Russians and what to give them were very argumentative. Dr. Oppenheimer kept insisting it was possible to give the Russians the design of a poisoned pile, a poisoned reactor, which meant that they could use the power but could not make bomb materials. Well, I didn't know the intimate physics as well as Smyth did, but it seemed to me that this was something that was impossible, because if you could poison the pile you could also re-refine the metal and take out the inhibiting substances, the so-called poisoning materials, and therefore it was very dangerous to do this. Well, in the long run, it was agreed that the negotiations with Premier Stalin would proceed at different levels. There would be general talks; then each meeting would get a little more specific. And it was agreed that at the end they would offer to discuss with the Russian scientists the construction of a reactor.

The committee was abolished, and Dr. Conant and Secretary of State Byrnes left and went to meet with Stalin. I think they actually went to Moscow. It was in the middle of winter when it was bitterly cold. When they came back, Dr. Conant reported to General Groves--I was at the meeting--that Stalin had just brushed them off and wasn't interested, at all, in any of this. The whole thing was a fizzle, and they needn't have gone to all this trouble. Either Stalin didn't understand what they were talking about, and the concepts escaped him, or the Russians already had enough information so that they didn't need it. And, of course, the latter was true. Later they found out about the [Allan Nunn] May exposures; and the defection of others--Pontecorvo and particularly [Klaus] Fuchs, I suppose. The disclosures through Gold and the Rosenbergs of the bomb mechanics, or the implosion method, probably gave Stalin the feeling that he had all he wanted and that he could just keep us guessing--which he did; there was no doubt about that.

I think at the time, General Groves and Colonel Nichols and certainly I were of the opinion that we definitely should not withhold the fact that we had the bomb. We had delivered it twice. We had tested it once. Therefore, we should use this as a "big stick" in our negotiations with the Russians and others. And, of course, we sympathized with the developments later with the Yalu River plan of General [Douglas] MacArthur. But who can tell what history would have been like if we had pounded on the table and said, "You must not have the Iron Curtain. We must get to discuss these things openly. We will help you," as we did. We poured money into Russia in fantastic amounts of goods during the Marshall Plan period, but it never amounted to anything in cementing relations or improving anything tangible.

So one of the questions that was brought up in the ensuing months was "What about Russian observers at the test?"--because everything was going to be in the open. The Smyth report told everything, except the actual design of the bomb. I think I have an extra copy of that, too, which I'll give you. That was really a key document, and that came out in the fall of 1945, as I recall. And, of course, the minute it hit the newsstands, the Russian embassy office was seen to have sent somebody down to buy fifteen copies. That cleaned out that particular newsstand. So within one day after it was out, the Russians had everything they wanted out of it, or at least they had it on its way.

Now, we'll get back to this Joint Task Force. At first we had daily meetings at the Navy Building on Constitution Avenue. Vice Admiral W.H.P. Blandy began to transfer officers out of the services who were now considered no longer needed. I think he was assisted by a committee that advised with Secretary of the Navy James Forrestal. He was an important force in suggesting men, although he did not himself participate directly in the conference. It became clear that we needed Captain George M. Lyon who had been an observer at Alamogordo during the first bomb test. He had been transferred from England, from the Navy Medical Corps where, although a pediatrician, he had been attached to the bomb casualty studies in London, gathering evidence which might be helpful to us when we became heavily involved. He knew quite a bit, of course, about blast and things like that.

It was decided, or agreed between us, that he would study bomb damage; that is, he would do ordinary bomb damage surveillance in Operation CROSSROADS. He and I were to work together to create the organization because it was quite clear by Thanksgiving 1945 that it was not going to be easy to recruit the men to go out there, or to get the instruments, or to plan an operation by only one person. So it was agreed that he would stay in Washington and plan and write the "Annex Easy," which was the label given our operations manual. I would stump the country looking for men and materials and get certain kinds of things done that we hadn't been able to do during the war that would make our program go.

It was decided that there would be at least two objectives. My instructions from General Groves were to set up a radiological civil and military defense to protect the troops and then to create the information which would enable a force to occupy an area whether it was military or civilian. This gave me a pretty clear operating order. Admiral Blandy accepted this and said, "That's it, you go ahead."

Well now, the organization was set up in the regular G-1, G-2, G-3, and G-4, which means that there was intelligence, supply, and personnel, et cetera, and that all of these groups had to be coordinated at what amounted to a board or committee meeting level. We dealt separately with each one of these divisions for each part of the operation.

For example, for our supplies and instruments and so on we dealt with one man who was a very able army officer. Well, anyway, personnel was closely tied in with security, because even though, presumably, we were going to invite the Russians, we had no thought of having Communists in our group. We thought it likely that many men who had not been in classified programs during the war would try to get on this. This was going to be a very exciting thing, and some of these men might be subversive Communists. So there was a huge problem for security in clearing personnel. This meant that I would be traveling maybe three days a week, all over, recruiting people. At first it wasn't very difficult to persuade them to continue working on the things they hadn't finished for the Manhattan District and also to prepare some new things that might be useful.

The CROSSROADS operation was divided up into the fleet operation, which was a navy show and was mainly a transportation problem of getting vessels prepared beforehand for being target objects, getting them out there, anchoring them in place, and then servicing them through the entire period. Laid on top of that was the scientific task force under the direction of the technical director, Dr. Ralph Sawyer, a very able physicist, prominent in the Manhattan Engineer District program during the war, and a very good organizer. Attached to him was Captain William S. Parsons, who became later rear admiral (he was rapidly promoted). He was the liaison between the technical scientific force and the navy operation group who would do the work of installing equipment. Parsons and particularly Sawyer would meet with the scientists in groups around the country and plan the scientific experiments: those who were going to measure the infrared radiation; those who were going to measure the gamma rays, the neutrons, and the blast forces; those who were going to set up tests of fabrics, paints, metallic surfaces, shapes, damage to vehicles, airplanes, clothing, all kinds of things. You can just imagine. There was an almost unlimited amount of money. I think that operation, alone, must have cost in the neighborhood of $100 million. It was done with an open budget, you might say.

The navy had to do something with these obsolete vessels. They were either going to mothball them, sink them, or sell them for junk. The easiest way was to put them out as targets; if they sunk, fine (and later most of the big ones did sink at Kwajalein). But you know the standby costs on these ships in mothballs is just terrific. Later, I tried to get the flattop Independence, which had been towed to Mare Island and run in a mud bank up there, used as an educational training station, because they could never clean her. She was contaminated enough so that they couldn't live on her more than eight hours; that is, you couldn't put her out to sea and stay twenty-four hours a day on her.

But the maintainence cost was such the navy wouldn't do it. They couldn't get the legislature to do it. The university, of course, wouldn't think of it; it would cost about $100,000 a year. I said, "Well, let her rust until somebody gets enough money to make it a state park or a national park or something." Well, I couldn't get anybody interested. The cost of this operation, then, was not altogether an extra one. The cost of getting these ships back and put up in some kind of standby condition or keeping them in operation would have been a good part of what the operation cost was in any case.

Well, after traveling, I would come back and confer with Captain Lyon and spend maybe a day and a night--literally twenty hours--talking over how we would enter the lagoon, what protection would be needed, and how the directions would be written. Then, when I would go away, he would spend the next three or four days writing up this procedure. The following week we would sit down and rehash it and reedit it. And I think I have one copy of what's called "Annex Easy." The different annexes were labeled A, B, C, D, and E. Ours was E; that's why it was called "Easy." You know, in talking over the radio, the military began to adopt this system. You'd say A, ABLE; B, BAKER; C, CHARLIE; D, DOG;

because it was hard to spell a word over the radio, with all the static interfering, and understand it; but if you went through this sequence, there was no question. Then it would be "Roger, over," and this meant that you were terminating. This is hard to learn at first, particularly if you're a little embarrassed when you try it the first time. But I got so I could do it without any particular trouble. It got automatic after you had done it enough; it was like saying "Hello" on the phone.

I had a lot of things to do in an office that was in the old War Department Building in Washington. This is essentially just a couple of blocks away from the Navy Building. So I would oscillate between the two, trying to get the various programs nailed down. Getting ready to depart was quite a job. We didn't know what to do about this.

Well, while I was sitting in Washington, Viola and Roger still sat at Oak Ridge, though Roger was ready to go to college. The older boy, Dean, by this time had joined the navy and had been in the navy about two years. I persuaded him, with some difficulty, to stay another year and go to Operation CROSSROADS as something that would be quite interesting, since he hadn't actually been in any battles. He would, at least, see something of an operation of this size; and I felt that the future would be determined to a great extent by what happened and that he ought to have some understanding of it. Well, he was very much disturbed at my suggestion because he was a hospital corpsman, I guess, first-class. Anyway, this was a lowly rank and I was a very high rank, and this embarrassed the devil out of him. His confreres would tease him, and he, being a shy lad, was very susceptible to being teased. We also later made similar arrangements for a couple of other scientists' sons who were in college or at the PhD level; and this was fine.

From my standpoint anybody who could read and write and was mobile was useful, because we had had such great difficulty in getting scientists to respond. We needed about a hundred people who could be trained to take the Geiger counter and do a specific job. They were to be trained to go to a certain place; measure it on the Geiger counter; record down the reading, the location, and the time on a piece of paper, and maybe bring back a sample of that water. Well, this was not a highly skilled operation. More than that, we needed scientists who had some training in some specific thing, like measuring the isotopes in the seawater or in the samples brought back, or in evaluating the hazards to determine when we could let the people back on the target if it were contaminated.

We considered the first test as a dry run because the contamination would be negligible, but it ought to give us a lot of information. It would be a training operation for our people. And the prospect of our people having to get in and out of small boats and go around the lagoon was sort of intimidating to a landsman, as you could understand. You wouldn't want to have your husband do this, probably.

The point of this is, that when it got down to June 1946, it began to be clear that we were going to be short of people. Some of the other operations were going to be short, too. So they postponed the operation until a little later. I got on the phone and talked with all the wives of all the prospects I had. It took me about two and a half weeks, all day long and part of the night, too, on the phone, because mama wanted papa home. They said they were going to take their first vacation in three years, and all that sort of excuse. And papa would have rather stayed home, too. We couldn't draft him. The war was over. But the operation was exciting. Finally, we ended up by having about 280 people.

Now it soon became clear that our operation was going to be so sizable, particularly with all the measurement the conference board and advisory committee had agreed to, that we needed a large laboratory. Finally Captain Lyon and I were able to get the Haven, a hospital ship, assigned to us. She was about due to be put up in mothballs. At that point, in May 1946, I moved to Berkeley. In the military, of course, wherever the man goes, there is where his wife and family are stationed. So they threw us out of our house at Oak Ridge by just sending a little note. So I moved her to Berkeley. We stayed in the Durant Hotel, and I had my office on the Haven at the Oakland Army Base. We began then to remodel the Haven. We needed a lot of sinks; looking around after walking through the Haven, it was clear that the toilets--the "heads," as they were called--probably offered the most opportunity for remodeling with the least cost. So we just took out the partitions betwen the toilets and put a bench top over them and bored holes in the bench top and put a funnel there. Then the Geiger counters with the special "pigs," as they were called, were put on the bench. There were big, lead, cylinder-like objects, about a foot in diameter and eighteen inches high, which had a door that could be opened. You put the sample in and closed the door, and any contamination in the room or nearby would not involve the readings so that you got the readings only from the specimen.

We were planning to use open-mouth pint bottles, which we obtained in large numbers--I guess, 20,000 or more. We had to have this many because once they were filled with contaminated water they had to be discarded. We had no way of cleaning them. These samples were to be brought in by the monitors. We had trained technicians that we took out of industrial plants, who were mostly GIs, but we had some civilians, too, because we couldn't get quite enough GIs. In this way these men were each able to do twenty to thirty samples a day, and we could get through the huge survey problem and have a plot of the contours of the radiation level of the lagoon by, say, four o'clock in the afternoon. This gave us some idea of what the radiation levels were on the ships. So this meant we had to have a big planning and coordinating center.

We had a lot of trouble about the radio communication to that center. We finally settled, before we left, for one channel, which was to be our channel. This was keyed in, then, to the lagoon patrol which we already had received permission for. It consisted of three Chris Craft taxi boats, very high speed, thirty-five-mile-an-hour jobs made of plywood. They were very seaworthy and durable. I've forgotten the name of the ship we had which was kind of a tender, that had a radio on it. It could act as a leader; and with a small walkie-talkie and these three taxi boats spread out behind it, it could sweep all segments of the lagoon. Since the taxi boat was near the water, the men could just reach out and fill the bottles at specified locations, you see. These were all numbered ahead of time and labeled so that we could identify them when they got back on the ship. Otherwise the confusion would have been ghastly, with hundreds of these samples brought in at a time.

TUSLER: Of course, there was no way to really practice this operation; it was all planned on paper.

WARREN: It was all planned beforehand on paper. Then I began to get worried about the underwater business. I attended several meetings of the oceanography section, which, of course, had a big role in determining what was going to be done in the second test. By this time--this was, say, in January or February--they had decided to do three tests: an air drop, an underwater test (these were the ABLE and BAKER tests), and then there was CHARLIE. CHARLIE was going to be put out in the deep water to the west of the lagoon where the tide all went that way. The wind went westerly, and so the surface waters all went westerly. This meant that all of the lagoon channels had very high currents going through the reef. This was a hazard if you were out in the taxi boats or in a small boat, and your engine failed; you would go right out to sea. The next land in that direction was about 1,400 miles. One of our party did have this happen to him. He was rescued just as he was about to go into the slot and go on out. He was Lieutenant G. B. Collins. He is now head of the Collins Electronic (or Instrument) Company, I think it is called.

We negotiated for the Haven, and it was turned over to us. By this time we had a fantastic network beginning to develop all over the country. It was just as it had been during the war, except that now it was much more open and people were able to get together and chitchat about things. One of the things was what Captain Lyon and I began to call "phenomenology." This was related to what happens when the bomb goes off. I did most of the talking because I was almost the only one who had witnessed the whole Alamogordo episode. I'd just returned from Japan, of course, where I had studied the results there. Even though I had not written it up and could never find the time to do it, I could get up and give a factual description of what I saw and what I thought.

The meteorology at Bikini was something that we hadn't experienced, but I could make some pretty healthy guesses and began to look into what had been done by the group in oceanography to study the shape of the column. Dynamite or baritol has a very quick detonation pulse. The atom bomb is a slow push. Well, the only water columns they had seen--and there's a picture of this in Operation CROSSROADS--looked just like a Lombardy poplar, a very tall spire, with not a very wide base; the water was ejected above the dynamite as a kind of missile, which fragmented right away. It didn't have very great height in proportion to the amount of dynamite exploded. There was no way of scaling what they had found.

They made a model of the lagoon before I left Washington. I listened to a discussion when they explained the currents. The water on the surface went downwind, and as it hit the reef, it went down and then came back east maybe fifty to seventy-five feet down. Then it upwelled out on the east side to the Bikini Island side. The upwelling occurred about a mile from the shore; this was where the coral was eroded, and there was a kind of a cliff there. Suddenly, the water became shallow--only about fifteen feet or twenty feet deep. That's why, later, when the bomb was detonated, the wave came ashore only three or four feet high instead of one hundred feet or more, as might have otherwise been the case if the deep water had come right up close to the shore. But, anyway, this upwelling was a fact that began to bother me. We began to worry about how we were going to measure the radioactivity in this counter current so as to identify it and prepare for it. We spotted it, later, on the grid where one of our lagoon patrols had gone right over this upwelling. And then, of course, we worried about the meteorology.

I tried to get some more information about the effects of blast. We did some experiments of our own, finally. We weren't satisfied with the rat experiments that we had done at Alamogordo. [Robert J.] Buettner was my executive officer, who, by this time, had been transferred with me and located on the Haven. He made arrangements with the ordinance people at China Lake out on the Mojave Desert east of us to do some experiments. We got Dr. Hempelmann and some of the other boys who came here to UCLA later to help us on the scientific side. There were men like Kermit Larson, who had been in the S-50 program at Oak Ridge and was a sergeant. We had him lined up. Later, he was assigned to the routine analysis of the seawater, which worked out very well.

Well, we got some rats and cages, and Dr. Hempelmann went to China Lake. Dr. Walker was very kind; he was the administrator at the time. Also, the naval ordinance people made it easy for us and gave us various kinds of charges which were put on posts out on the desert and then detonated. The boys put up posts with wire strung between them, and we hung cages with rats out in the open. Other rats were strung up by their tails with battery clips, just as we had done at Alamogordo. They began to find some interesting things; i.e., the cage, even a kind of open-wire cage, reduced the blast effect--at least in killing the rat--maybe 50 to 75 percent. In other words, there was a refraction of the physical wave that was going by in the air. The energy delivered to the objects inside, therfore, was very much reduced. This was fine, but we really wanted to know what happened, what kind of pressure was required to kill the rat in the open.

Well, I finally went over there, myself, to meet with the boys, and took Captain R. H. Draeger along. He was a close friend of Captain Lyon and was on the Burleson. This was the ship that had the dogs and the pigs and the goats on it. They were to be exposed to these pressures and get irradiated. Captain Draeger was the director of these studies, and Dr. Shields Warren was his deputy. They did very elaborate planning and measuring with good measuring devices. They checked back and forth with us, and we shared a lot of our equipment with them. They had a lot of their own made, too.

One of the first things we did at our conference after the China Lake studies was to find that it was quite clear that the rats had an imprint of the rib markings on the lungs. There was hemorrhage and the extravasation of fluids from the lungs so that the rat essentially drowned by a combination of mostly clear fluid and a little blood. There were intestinal ruptures, mesenteric tears, things like that, with a lot of excessively high blast pressure. There was nothing in the literature about this as far as humans were concerned. The casualties from blast had not been autopsied. Even in London they didn't have a very good idea about what went on when the V-2s went off close to people. As I've said, we found that reflections produced bizarre things. Two people were sitting side by side in the second or third story of a hotel, in one case, facing a blast. The window in front of one would be shattered and the individual badly hurt; and in the other one, just five or six feet away, the window glass would be intact.

TUSLER: But it wasn't clearly understood why?

WARREN: It wasn't understood. So the next day we had another test out in the desert. We raked the sand smooth and put the charge in the usual place, about four and a half to five feet above the sand. Then six charges were put around the periphery of this explosive disk, which was about eighteen inches in diameter and four inches thick. Just think of a hunk this size of dynamite or baritol; it made a sizable whack. Well, we had the rats spread out, mainly with battery clips. We found some very interesting things right away--which the boys had also noticed but hadn't done much about; they hadn't had time to study it. There would be one set of rats that would come into the lab from a string right up close to the dynamite. These would all be killed. Then there'd be a bunch six feet away that would survive right up close. Well, this seemed impossible; but on the smooth sand there was a cloverleaf design from the blast pressure. The center of the stem of the leaf, in each case, being the site of the detonation point; so there were four or six or eight cloverleafed blast fronts that went out from the detonation point. They didn't really fuse until they got out quite a way. This showed that if you were close and in a position between two detonation points, the blast pressure was very low, and survival would be quite easy. It was clear, too, that if there were objects like a piece of rock or something else on the sand, there would be reflections off of that. You could see this.

It was a beautiful physical demonstration which delighted Captain Draeger. He had been interested in what was called solid blast. This meant that if there were a detonation below deck and someone were standing on the steel deck above it, he would get a translated pulse to the feet, which would break the ankles. This had occurred often and was a rather common casualty on battleships, in destroyers, and in other places where a detonation would occur immediately below a plate. We didn't have any experiments nor did he ask for any in this regard; but he was quite satisfied. We all had to be, because time was running out and we had to quit these studies. We had gotten enough, now, to know that we were dealing with things that could be analyzed with ordinary geometry. We could now understand a lot of the reports that came in from the Princeton group, who were working on the stem effects--the mock stem effect--and the reflections off of surfaces, particularly in the air drop.

Dr. [William G.] Penney from Britain joined us, but he didn't spend too much time talking to us; he was interested in the excessively high pressures. My contacts with him mainly were for follow-up on the Japan episode. There he had gathered five-gallon empty kerosene oil cans and beer cans as really reliable blast-measuring devices. He had been able to estimate how much of a dent was produced by a certain blast pressure. We used to make sly fun about it, but it was a really good observation. It was better than the bending of steel beams and posts because they were such odd shapes that it was very difficult to calculate what the blast pressures were. He was quite interested in this cloverleaf effect. It was kind of a surprise to him, I think.

We had some commanders and other men interested in the radiological safety who were attached to us from Britain. But that's all; we didn't have any French or other scientists. The French were, of course, rather out of favor because [Frédéric] Joliot-Curie was a Communist and was not friendly at all in this whole situation; so he was never brought over.

TUSLER: When were you conducting these experiments you've just been describing, in the spring of that year?

WARREN: I think it was sometime in March or April 1946. We were getting close to departure. It was quite clear that we were going to have to have a training program. We decided to do this on the Haven on the way over, because the trip would take us maybe five or six days. Dr. [Gerhard] Dessauer from the University of Rochester physics department came. He had been involved in the Manhattan Annex Program there during the war. We had Dr. Ralph E. Lapp, who helped. He has later been a writer in this field. Dr. [Kenneth G.] Scott from Berkeley came. It was quite a distinguished roster of people. Of course, Captain [George] Lyon and Peter [Herbert] Scoville, [Jr.] came. Peter got to be quite interested in the meteorology. He and I devised a method of reporting, each morning, to Admiral Blandy and to the conference group how we thought the meteorology was going to affect the clouds. It was then that we devised a pile of plastic plates taken from dive bomber windshields. Each one represented an interval of 5,000 feet. We could make a plot of the data taken from the meteorological observations of wind direction and velocity. We could then make a drawing for any altitude of what would be the direction and disposition of the cloud that was at that particular altitude.

We had a hard time with Colonel B. J. Holzman and Captain A. A. Cumberledge, who were the two official military meteorologists, because, as I said earlier, Holzman had been at Alamogordo and wouldn't take any responsibility. It wasn't in his competence, he felt, to make any prediction. So, at first, my proposals or interpretations were just accepted by them with a dull silence. Yet, I am sure I had

Admiral Blandy's agreement that this was the only logical way to proceed.

General William E. Kepner was the commander of the air force section. He had all the problems of carrying the bomb and launching it by air in the first test. He also had all of the drone plane programs, which were then just a brand-new idea. He was in charge of all the planes, all the practicing, and so on, from the airfields at Eniwetok. Well, I had several meetings with him. Well, since I was obviously just a doctor, you know, and a no-good practitioner at that, [laughter] trying to act like a scientist, I didn't get very far at first; but pretty soon he began to get the point that I was working on his side, too.

There was one thing that kept bothering all of us and was brought up at every conference: what if the bomb-carrying plane stumbled in getting off the airfield and crashed? At Saipan, at Guam, and at other places this was not an infrequent occurrence in the bombing of Japan. Something happened when the engine got just about so far and it went cough and stopped, and the airplane went kaput. Well, the conference was always assured by people at Los Alamos that the material would only burn. So then it was immediately my problem: what to do with the volatile bomb materials containing plutonium or uranium, which were very intense alpha emitters. This was then an industrial cleanup problem. It was necessary to isolate the area until we could mobilize cleanup operations which we might feel were important. You had to just keep it isolated. You had to worry about water, wind, erosion, and so on; but this was a thing that could be taken care of later and didn't have to be met right away. However, it was necessary to evacuate the inhabitants as a precaution.

This is where General Kepner and I locked horns. He felt this was an unnecessary precaution. And I said, "Well, I'll be satisfied if you'll write me a letter guaranteeing that no planes will stumble."

TUSLER: You said this?

WARREN: Yes. And I said, "Otherwise I have to insist. But if you write me a letter guaranteeing that there will be no planes stumbling carrying the bomb, I'm fine." Well, of course he wouldn't do that. So then he had to go ahead and subscribe to this plan. We reported to Admiral Blandy that this was our decision, and he said, "Fine, we will do it that way."

This was the nice thing about the general organization. We would have a conference, reach a conclusion, could go to the admiral to report, and he would say yes or no. He would listen and almost never would he say no. Of course, I knew from past experience with General Groves that I had to have all the _t_'s crossed and the _i_'s dotted before we went to him, because from then on the plan was an operational order. It became part of the agenda.

I was able to convince General Kepner after he really understood what our plots showed. As a matter of fact, I've got the little board here, which I can show you. I'll turn it over to you any time, if you want it. On this little board, I had four brass posts, really just long bolts, about twelve inches long, and I had a map of Bikini Atoll just big enough to fit on the board between the posts. Then I could stack our plastic plates marked with grease pencil by just threading them over these holes. So Mr. Scoville and I prepared each day's observations. We were getting these all the time now, since we asked and got permission to be on the list that got the weather predictions and observations. We received these almost by the hour, as it turned out later, when we needed them very urgently.

Well, by showing the general that if the column was up 40,000 feet and his airplane, whether it was an observer or any other plane, was flying at, say, 20,000 feet, and if the wind was taking the radioactive material, say, westerly or northerly, as the case might be, his pilot could get under the invisible fallout. We could show him with pencil dots where his plane would go and where the fallout would be, say, at one hour afterwards. He finally was convinced and was really in our camp after that. We had no trouble. They set this kind of model up for themselves, too.

One of our problems, of course, was to furnish the phenomenology to each one of these services and groups promptly, so then their training program could go on from that information. Of course, it was just pitiful that we didn't have the time or the people to write this all up. There was no tape recording mechanism, and no one took it down in shorthand; but they wrote sort of an analysis from their memory of what I said. Of course, later, Captain Lyon got so he could do this teaching, too. Hempelmann and Nolan were still in Los Alamos and didn't come into Washington, so they couldn't help very much. When you assembled these people it took a week to do these indoctrination lectures.

I met Commander Revelle, Roger Revelle, during the oceanographic contact. He was in the navy and a highly respected scientist in the oceanographic unit. I'll tell you about a very interesting contact we had which resulted in his finding a deep-water mountain range. In between the tests we, of course, were training our people. One of our problems was shortage of equipment and Geiger counter tubes. We finally made arrangements with the Victoreen Instrument Company in Chicago to make a lot of them.

But one of the elements in the meeting with Dr. Revelle came up between the tests when we were trying to install our deep water counters on destroyers. Dr. Revelle asked for the destroyers to make some oceanographic surveys during this month interval between tests. By this time we had acquired enough of these deep water counters to equip the ships. I put an electronics man and a monitor on each of the destroyers he was going to use with the promise that he would be back in time for the test. He took two of the destroyers that had been assigned to us. These were to be the distant monitors in the ocean so that on their way back, if they were late--as it turned out they were--they could do some of the distant monitoring downwind.

It was during the use of these destroyers that Roger and his party discovered a deep-water mountain range. I guess the mountains were about 10,000 feet high in 20,000 feet of water. They found a big trough, too, at great depth, that was not known before. I thought this was a very fine thing that he was able to do, and was glad to be of some service to him, even though I was on tenterhooks the day before the underwater tests and wasn't sure if these destroyers were going to be in place, but they got there just in time. The wear and tear of uncertainties in such an operation is quite a big factor.

I might say here in terminating this particular part that I had so little sleep and was under so much strain that on the way home on the Henrico, which was given us for transportation back to San Francisco, I slept four days continuously.

They thought I was dead part of the time. I awakened just enough to eat and then went back to sleep. I had found by long experience that this was the only way I could restore my energy level. If I could sleep this way, then I could survive these periods.

For the last month of the operation, during the disbanding of the fleet and afterwards, I had to stay at Bikini to be sure that the cleanup was going to be satisfactory. You have no idea of the difficulty, as the technical force melted away, in keeping track of things, being sure that people went home with the proper instructions to safeguard themselves against the contamination that existed in their equipment. This was quite a problem.

TUSLER: Were most of the analyses of your findings done back here in the United States afterwards?

WARREN: No, we were current on everything. This material was then later turned over to the Joint Task Force Two, which was organized after the war. Then Rear Admiral Parsons became commodore, then vice admiral. It's interesting that the rank of commodore is only a very special one, sometimes an honorary one; but it was the only progression that he could make without fleet experience, from commander to commodore and then to vice admiral, which he had as a postwar rank.

TUSLER: Well, in preparing everything you have described today for this operation, were you still operating out of San Francisco?

WARREN: From the Oakland Army Base, and a little bit was done out of Oak Ridge. During this time, they had that violation of rules at Los Alamos, and the boy, Louis Slotin, got killed. I'll tell you about that, because that will take some explaining. Dr. Alvin Graves, who was going to be Dr. R. A. Sawyer's right hand at Bikini, was also injured. This prevented him from going there. It was a great tragedy to him, scientifically, because he had had a very great part in organizing a lot of the preparations for the bomb's scientific measurements as well as the actual bomb construction. This was to have been a kind of high point in his scientific career.

TAPE NUMBER: XV, SIDE TWO

OCTOBER 5, 1966

TUSLER: Dr. Warren, we're in the midst of the Bikini episode. I believe last time you described the events leading up to taking off for the islands. Did you have something more you wanted to add?

WARREN: Well, there are a few things. Last time we discussed the preparation of the equipment and covered different aspects of the problems, such as the minor experiments on blast that Dr. Hempelmann, and Dr. Nolan, and others and I did at various times to get some idea of what the blast was like and its vagaries. I mentioned Captain [R. H.] Draeger who went with us to China Lake to watch some of those experiments with rats in the desert. Captain Draeger had command of the Burleson experiments which had all the animals to be studied on board. His deputy was then Captain Shields Warren, who was to be such an important man in all later developments, since he eventually became the chief of the medical section of the Atomic Energy Commission. He followed me when I turned over the Manhattan District to the AEC and subsequently to civilian control. There were several things that were of interest, I think, in this preliminary period.

I mentioned that I was transferred from Oak Ridge to the Oakland Army Base headquarters where the hospital ship, Haven, had been put at the disposal of my section. That ship was to be our laboratory ship and headquarters at Bikini.

So, Mrs. Warren moved out of Oak Ridge, since we were no longer authorized for quarters there, and moved into the Durant Hotel in Berkeley where she stayed for about three months during the period of staging out. Captain Robert Buettner, my executive officer from Oak Ridge, also moved to the Berkeley area to help in the organization of the Haven and the personnel procurements and all of these kinds of problems. Later, we were joined by Captain Fred Bryan, who had been formerly in Rochester working on the dust problems and had been one of the inspection crew for the manufacturing operations through the Northeast.

At that time, Lieutenant Commander Draper L. Kauffman was attached to me as a naval aide from Admiral Blandy's staff. He was my liaison officer between Washington and the Oakland Army Base operation at such times as I, myself, could not get back to Washington.

There was a very dramatic episode, which we recalled the day before yesterday at luncheon. He is now Admiral Draper Kauffman and is in charge of the Annapolis [Naval] Academy. He came here to speak, I guess, to the beginning class of midshipmen on the campus. The chancellor gave a luncheon for him and his associate, Admiral [Carlton B.] Jones, and some aides and others from his party. We had a very nice luncheon. The admiral recalled that our most dramatic episode occurred when he flew into the Oakland Army Base with the completed draft of our procedural annex or instructions for our section in Bikini. It was called "Annex E," or, in the vernacular, "Annex Easy." Well, this was a big, thick manuscript of about 300 pages. He came in by air, having flown in overnight on the "Hotshot," which was MATS--Military Air Transport Service. This meant he didn't have any sleep. These were mainly DC-3s, and so it took about twenty-four hours to make the flight. He walked in on the Haven very sleepy eyed, saluted, and said that he had this manuscript, and since this was Friday, his instructions were to get it back in Washington by Monday. He didn't see how this could be done, but I had a temporary opening and no urgent things to get done, so I said, "Well, let's sit down and do it."

We started in at, I think, eleven o'clock that morning and worked right straight through until Saturday night--about thirty hours. He was astounded that doctors and men in the army and others might work like this. This made a lasting impression on him because he still remembers this. We just drank only coffee.

TUSLER: And you kept going.

WARREN: We kept going and got it done. As a matter of fact, he got back about a day earlier than he thought he would. Of course, he didn't have very much sleep, but being young and full of resilience he was able to get back on the plane and get back into Washington on Sunday.

Well, this annex had been prepared by Captain George Lyon from conferences which he and I had, either by phone or in Washington when I would get back. We would sit and debate what was then called the "phenomenology" of the explosion. He had been, as I think I said earlier, at Alamogordo at the first test and had been assigned to me as a representative from the navy. So it was natural that he would continue in his assignment for the Joint Task Force. He, himself, had the bomb disposal safety supervisions; that is the disposal of the unexploded bombs, or the noxious fumes from exploded bombs, or burning bombs, or conventional bombs. This was all relatively simple with so much information already available, so the writing of the annex for that part took only a little time. But the writing of the annex for the radiological safety part was extremely complicated because it was the first time that anything like this had been put together. Since my instructions from General Groves--and my assignment was continued and extended by Vice Admiral W.H.P. Blandy--was to design both a military and civilian civil defense operation, and since we had both civilians and military in this operation, it was quite feasible. In fact, there was no distinction between these categories except that we didn't have families with women and children involved in this. Well, I have mentioned the various sections, more or less, and I will give you a copy of "Annex Easy." I think I still have one at home. I'll give you this Operation CROSSROADS, which is the official pictorial record, because I have two [copies] and I'll give you this one now, or as soon as we finish this series.

While I was sitting in the Oakland Army Base--sometime in April, I think--Dr. Louis Slotin, a young scientist at Los Alamos, made a proposal to the committee which supervised and authorized all of the experiments that involved any hazards or that were of any consequence. His suggestion was that he take two of the hemispheres that were left over and were still present in a laboratory in one of the canyons near Los Alamos, and bring them close together to see whether a controlled reaction could be produced. The committee thought this was too hazardous, that there hadn't been enough preparation and that there ought to be a long preparation with a lot of complicated equipment and very careful protection worked out.

Well, he didn't like the committee's negative decision; so after the meeting he got in his car and went down to the laboratory. Of course, there were two guards there. Without paying any attention to them he went over to where the spheres were. Apparently, these had been machined with half the critical mass in each one. He pushed them around on the laboratory table with a screwdriver and a pair of pliers and got them in such a position that he could tip one hemisphere over against the flat face on the other one. And then, of course, the inevitable happened. The screwdriver slipped and the hemispheres came in contact with each other, at which point they started to glow. There was a flash of light or a very strong glow. He instinctively pushed them apart with his arm and hands, which fortunately stopped the process. The whole episode probably occupied no more than perhaps a second and a half or so. If it had gone on longer, of course, there would have been a very serious burn if not an actual detonation. But in the process he got a tremendous amount of radiation--neutrons and gamma rays. The two guards outside got some, too. Well, fortunately, the guards were protected by piles of uranium metal and other metal that were in between them and the laboratory where this occurred. As a result, they had some minor reduction in their white count, but nothing else.

The young scientist started back to Los Alamos and began to get nauseated on his way home. So he went to the hospital where he was immediately made an emergency case. Dr. Hempelmann, Dr. Nolan, and Dr. Harry Whipple did blood counts and began to worry about what was going to happen. I was called early the next morning and told about it. General

Groves also wanted to know, having heard about it. Of course, this accident was reported immediately all up and down the line. Arrangements were made to fly me over there in a little navy military trainer out of Alameda. A couple of other men went along, too, because they wanted to go to Los Alamos for other purposes. This was a very rugged flight, as far as I was concerned. We went through the Tehachapi Pass, which is noted for its great turbulence, and flew on to the Santa Fe airport where we were transferred to cars for the drive to Los Alamos.

I got there, I think, a little after noon and was immediately taken over to the medical laboratory by Dr. Louis Hempelmann. We had a consultation about the situation and what they had found. His teeth were very radioactive and his gums were beginning to get sore. His white count had gone way down and he was beginning to have edema of the arms and some redness--some erythema. They thought that the main exposure had been mostly to the chest and the head and neck, above the abdomen. But there was no doubt about the fact that he had had a pretty high, probably a lethal dose of radiation. At this time, the only thing I could suggest was to pack his arms in ice, because this seemed to be one of the ways of reducing shock and the rate of disintegration of the tissues. I approved of what they were doing, which after all could not be much. There was no sense in trying to transfuse him because it wasn't his red cells but his white cells that were affected, and we had no method of getting large numbers of white cells at that time.

So, I went back to the Oakland Army Base. This time we were really essentially lost. After we got through the Tehachapi Pass, our only way was to follow the highway. It was pouring rain, and the question was whether the ceiling would close down and whether we could get back to Oakland or not. There was no place we could land before the base. It was another one of those nice episodes, which was very traumatic to me; plus the fact I was airsick from the turbulence and from trying to help the pilot, because we were closely associated in this small plane, and he would worry out loud. I would keep looking out the window to watch the wet highway. We were only about 300 feet above it and going between the hills. If you remember, the road goes around Morgan Hill and then to San Jose and on to the bay. I was awfully glad to see the southern end of the San Francisco Bay. Finally, we came down on the Alameda landing strip, where Mrs. Warren and Captain Buettner were wondering whether we were going to make it. The tower had closed the field and had told them, "Nothing but ducks could come in." Even the sea gulls weren't flying. It was raining so hard you couldn't even see the bridge; you could just see the water, and we were just high enough to make it.

Well, in a few days it was obvious that Dr. Slotin was going to die, and there was just nothing that could be done about it.

TUSLER: There had been some hope, I take it, originally?

WARREN: Well, originally, it was felt that he would not have the bone marrow destruction and all the rest. But he had much more than that. He was in bed and able to talk when I looked at him with Dr. Nolan and Dr. Hempelmann. His arms were about eight or nine inches in diameter, particularly the left one, which was apparently the one he used to sweep the spheres apart. We had good dentists there, so they made gold caps for his teeth to keep the radioactive calcium and other salts in the teeth (these had been made radioactive by the neutrons) from burning his gums; the exposure was that intense. He had very high intensity radiation in the bones, too. He eventually died. At the autopsy he had a very diffuse distruction of his bone marrow; all the lymphatic tissues--in fact, all his blood-forming elements--plus a lot of edema as fluid extravasation or accumulation in the tissue.

Well, then it wasn't very much later, when we were within two or three weeks of leaving the port for Bikini, Dr. [Alvin C.] Graves was showing a party around at Los Alamos. This group of four or five people were getting ready to leave for Bikini. Dr. Graves was going to be Dr. Ralph A. Sawyer's assistant in the technological measurements, and had great plans for that, and really a great deal depended upon him. Well, when they went through this same laboratory, one of the persons who was in the party said, "Well, what, actually, did Dr. Slotin do?" So he said, "There are the spheres"--and without thinking (here is the same screwdriver and the rest)--"He tried to do this." And just then the screwdriver slipped again, but the apposition of the spheres was not very good, so that he and the others didn't get a very large dose. Dr. Graves did get enough to have cataracts. A couple of guards got it again. These weren't the same guards, but they did get reduced white counts.

We had a problem, however, with one of the visitors who had a testicular injury. Of course, so did Dr. Graves. But this other man had just gotten married, so this was very important to him. He eventually sued--a friendly suit--and was given a large cash settlement. He permitted us to carry out a lot of observations. We did biopsies and sperm counts on him for months. It was quite obvious that he didn't have any sperm for, I would imagine, three years or four years, and he was advised to have no children. Well, in spite of everything, he didn't take any precautions and he did have a child or two, and maybe he has had more since--this was five or six years later when his sperm count did come back. So far there have been no evidences that these children are defective in any way. Of course, the problem is that the first-generation survivors of this kind of exposure might not show anything. The gene damage might be a "lethal" which might show up in two or three generations later. Well, if it's only a lethal, then there will be sterile marriages, which is only of importance to the local family, but to the race it has no importance. We don't know much about nonlethals that are abnormal, but it is possible that there would be some differences in some of the subsequent generations. This is a matter for which we have very little real information. The Japanese data has not supplied very much, nor have the Rongelap findings disclosed much, in this respect. If we go on the basis of animal and fly work and agricultural experiments, one can be ambivalent and say that some of the changes are desirable and good, and some might not be.

TUSLER: In other words, there hasn't been enough elapsed time?

WARREN: Nor has there been enough exposure to large numbers of people for this to be determined. Well, Dr. Graves had to go in the hospital and resign his post. There was some problem in getting his replacement. And, of course, the others, who were visitors with him, couldn't go to Bikini either. There were four people affected by this peculiar quirk of circumstances.

In April when we got ready to go, I wasn't sure that I had enough monitors for all the tests. So we divided our monitors into groups. Some would serve on the first test. Most of these would go with the ship Haven and be trained. Then we would have a big turnover and send most of that group home and then we would have a new crop for the second test. I didn't have enough on the roster for the second shot, which I was expecting to be the worst one. The first one would be more or less a dry test run for the second. I felt very uneasy about this and I expressed this uneasiness to Vice Admiral Blandy and the staff at the meeting in Washington. They were rather angry that I had not been able to be successful, but some of them were having the same trouble. This was the time when the families of the men had decided to have their first vacation after the war. You see, this was a big summer. And, therefore, you had to practically twist mama's arm off over the phone to allow her to let papa go. I didn't bother, very often, in talking to the man at all. I talked to his wife on the phone. I said this was important and necessary and it would help his career and all of that. I would finally try to convince her that papa should go and that they should delay their vacation.

TUSLER: Why was it all left on a volunteer basis?

WARREN: Well, all of the military could just be assigned;

but you needed civilians in large numbers, because the Manhattan District had done most of its operation through civilian contractors and university groups. They could come and go as they pleased. We almost had to get down to asking anyone who could read, write, and be active for monitors. This was all right. If they were reasonably intelligent we could take people with a high school education, but then there was the added problem of security and a few other things. We finally managed all right, but it was nip and tuck. We were running scared all the time, at least I was, that we weren't going to be able to do what was required when the chips were down. However, it worked out all right. We never did have an oversupply of personnel.

The Geiger counter tubes had been made by one woman employee by hand in the Chicago Metallurgy Laboratory. Finally, we made the contract with the Victoreen Company. Mr. Victoreen, who was a good scientist, was very much interested in getting this material made up. So he hired this woman. She tried to train some others, but it turned out that she was the only one who could made a successful Geiger counter tube. These were airmailed to us, specially, or sent by courier from Chicago to Bikini. Then we had every GI with any electronics training at all--about thirty of them in all, I think--parasitizing defective instruments and repairing others in order to keep some going. Getting this group together in the beginning was quite a difficult thing.

I was very fortunate in having Lieutenant George Collins, an electronics engineer who had been with me in Japan, as my instrument officer. He now runs a big company that makes instruments of this sort. He kept track of all these people and of all of the radio transmitting and receiving apparatus that was involved in receiving the reports of the radiation dosages from the lagoon and other places brought into the headquarters. We had a big problem with the radio channel because I kept insisting that we would need more than just one channel. Every section was assigned a channel. There were about twenty channels available. Finally, it worked out that during the first test we got a couple more channels. By the time the first test was over, the need was quite clear, and we were given eighteen channels by general consensus of the group, because the rest of the units couldn't move. They were paralyzed until we got our data plotted, and they could see that they were in the clear. In fact, I wouldn't release the various areas until they were clear. This was one time in history, probably the only time, when military scientists had the ability to say, "You cannot go there until it's safe."

Since we were not in a war, the safeguards had to be at a civilian level on a long-term basis. Of course, my primary orders from Vice Admiral Blandy came directly from the president; namely, that no person shall be injured by the special attributes of the atom bomb. You see, this gave me a clear authority which was resented, of course, by a lot of the officers who didn't like to be under the orders of a doctor who was no real military person. They showed it by calling me "doctor" instead of "colonel," which is a covert insult, you see. Although, later I am convinced that it became a term of affection, because we ended up pretty good friends, except for Captain Teakel of the *New York*.

TUSLER: Was their general attitude that you were making too much out of this?

WARREN: [They felt that] I was making too much out of this. But they were afraid enough and impressed enough, when they saw the thing go off, to realize that this was something that they had never dealt with before. The immensity of the problem was clear when they tried to wash down the ships and clean up. They just couldn't do this adequately. The problems were compounded by the fact that the radioactive material would act as a mordant with all of the cordage, ropes, mats, cloth of any sort, including clothing. And it had a particular affinity for rust. Any rusty surface would just grab these radioactive materials almost preferentially, so that you couldn't clean down to the bright metal.

Wood surfaces, of course, were pervious to it. The grain of even rather hard woods would absorb the radiation. These woods were not fine-grained. Teak was not a fine-grained wood. The decks of the Prinz Eugen and some of the other ships were made of four to eight inches of teak. Teak doesn't splinter and it's hard and doesn't swell too much when it gets wet. It makes a beautiful surface and can be polished nicely after it's mopped. Yet, we found on the Prinz Eugen they would have to take off a good half-inch with a plane before they could get down below the penetration of the radioactivity. This made it hopeless, you see; they just couldn't clean these ships. Except in wartime emergency conditions, where it was normal to the crew in any case, the ship would have to be evacuated if it were in the mists downwind from the underwater detonation. This radioactive mist would get in the ventilating system and then be taken everywhere in the ship. This was something that I had to talk about a lot in our indoctrination sessions in order to convince the captains of these vessels that these were real problems and that it didn't help matters any for them to find it out, the hard way later, that this was true.

You'd have such crazy things happen that it sounds impossible, but it really wasn't. The cockroaches were one of our best ways of identifying the amount of contamination in any one particular section of the ship. At night they would go around and get contaminated with the lint. They would feed on dust particles and other things so that if you picked up the cockroaches you had a pretty good idea of how radioactive that particular area was. Purely by accident, we had a specialist with us, Robert Webster, who had specialized in the life of the cockroach. He was one of the navy officers that I had attached to my program. He gave me quite a nice rundown on what their habits were. The cockroach could go in a sewer for 200 or 300 feet. They could go in the interstices of the end joints in the walls and along electrical conduits wherever the conduit went through the wall. This aperture wasn't always tight, so the cockroaches could go all around. After we found this out I gave this officer the job of going around and collecting the cockroaches and measuring their radioactivity. This was easier than trying to sweep up the floor. Well, how would you know how much you should sweep up, a square foot, a square yard, or what?

The cockroach was a good finder. In fact, I suggested this to the military intelligence as one way of finding out about radiation in other places. There were two things that could be done. One was to ship cockroaches that were collected in your hotel in a newspaper. The newspaper could be washed in the nuclear reactor cooling stream, and in this way one could tell whether the stream had been contaminated by the effluent from the reactor. We had found this out the hard way.

The cockroaches could tell you what was in the sewer segment within a couple of hundred yards of the hotel. At that time, we didn't know that they had stopped making parts and refining uranium as they had been doing in factories spread everywhere. If you were in the same sewer system with a uranium refining unit of some sort--which might be just a shed--the sewer would begin to get contaminated, and the cockroaches would bring it throughout the sewer system. It wouldn't take more than a month, maybe, to travel a couple of blocks into the hotel. The hotel made a better attraction because of the restaurant and the other things people would have around that cockroaches liked. I've always been astonished and impressed about these little approaches to the problems of contamination. Of course, our whole detection system at Bikini was based on things like that.

We also were going to look for contaminated silver nitrate and iodide solutions and even table salt in these vessels. We had put silver and then sulfur buttons out in various places. You'll see in some of the pictures a wooden block about eighteen inches long and a foot square with the

USS Haven's name on it and a number which gave the location. This block was tied to the various parts of the target by a rope so that it could be recovered even if the vessel sank. The divers could pick them up. This would give us an indication of the neutron bombardment. We also had film badges around in various places. Bill Bale had designed a kind of a nest of cylinders of different lengths which were stacked together almost in a circular pyramid. The film was put in the innermost one, and the various thicknesses of the iron acted as absorbers. This turned out to be a very good neutron measuring device for certain energies of the neutrons. Then, of course, we had a tremendous organization for the measuring of the film badges of the personnel. These would measure the gamma radiation which the personnel of the fleet were exposed to. Dr. [Gerhard] Dessauer from Rochester, a physicist, was put in charge of that program. He still writes on nuclear warfare. He was one of our instructors and was a good physicist.

We had a couple of hundred classes on the Haven, all the way over, even though we were continually combating seasickness. We had classes about twelve hours a day, and the boys worked like mad to get themselves indoctrinated. You see, there was very little real information that you could put together in the usual way, so all the instruction had to be by word of mouth. I described what I had seen at Alamogordo. My description of the column of hot gases, the colors, and the lack of very much noise was really the only factual information we had about what to expect. And, of course, when I would tell the officers of the Joint Task Force, that this column would go 60,000 or 70,000 feet in the air, they would all sniff, you know. This was just not so.

So I would pull out the information on Krakatoa, which, by the estimates of sea captains who saw the explosion in 1883, apparently sent a column about 140,000 feet in the air. Well, the officers thought this was unreasonable. It might be all right for a volcano, but, my Lord, anything that man could detonate would not go more than 1,000 feet or so, because this was all that explosions from dynamite and baritol and gunpowder had done. The point is, they had never seen a big enough explosion. The fact this had a mushroom top was contrary to all of the plumes that were seen on experimental detonations. Those were all like Lombardy poplars, you know, straight up with a point at the top. Well, here again, it wasn't enough.

The fact that the planes wouldn't be high enough to go over it when it was in full scale was another thing they found hard to accept. So in devising our meteorological model with quarter-inch-thick dive bomber windshields, I had to convince, as I said earlier, the meteorologists of the army and the navy--Colonel B. J. Holzman and Captain A. A. Cumberledge. The two of them were, of course, professionals, and I was just a country doctor. They wouldn't believe me; it really took almost to the end of the whole procedure out there before Captain Cumberledge and Colonel Holzman were less inclined to scoff. But they finally began to plot this kind of model themselves. Since it was reasonable and seemed to follow out what they saw in the first test, they then began to accept it. With the model we could show Major General W. E. Kepner, for instance, that his airplanes were running the risk of getting underneath one of these downwind drifts and having the heavier materials come down if they were wandering around. This radioactive material would be invisible. Unless the boy had a monitor on board he would never be aware of this fact until he got back to the base and they found his plane contaminated.

It was a matter of convincing the military staff and some of the civilians that these things weren't just fantasies. I didn't have very much help from the physicists. Drs. Edward Condon and George Gamow and some of the others would sit at the beach and at the officers' club where we would have impromptu seminars every once in a while. Dr. Gamow said one time, "Well, if you really wanted to give them the worst to speculate about, you could say that if the target ship sat right over the center of the detonation, it might be raised maybe 10,000 feet in the air, be poised there, and come down safely just like a rubber ball on a fountain."

Well, you could just see the navy sit around and laugh. They couldn't think of anything that they knew of which was this powerful. Of course, this is why they were very much upset when they saw the Arkansas going up in the edge of the water column. This is what I believe happened. It gave that defect in the glowing bubble that you see in the photograph which I have up there--a picture which they promptly confiscated. That's a very rare picture and I feel very privileged to have it. As a matter of fact, that was given to me privately, you see; it's not an official one. It has the defect on the right hand side. The defect is maybe 700 to 800 feet tall--more than that, about four times the length of the battleship--and it's several hundred feet wide because the column is 2,000 feet across, or more. The Arkansas was right there, and it probably caused the defect in the wall of the column as the mass of water and foam went by it. Then it fell back down and collapsed on the bottom, the plates all torn loose, and the hull in great big twisted masses. At least, this is what the divers described to me when I asked for a report on this.

I got none of this, you see, from a document. I went and talked to the divers. In fact, I was waiting for them when they came up on deck after they had gone down to see the Arkansas, and I, personally, talked to them. This was unorthodox. In fact, they were indebted to us because we were using film badges on them and had an underwater Geiger counter probe, about two and a half feet long, stuck in the harness on their backs. On the deck we had equipment tracing a chart which would indicate the intensity of the radiation that they were getting into. Then, we could tell the diver by telephone whether to back up or not, you see. Their feet really were subject to the greatest hazard because the water acted as quite a protection against the gamma radiation, but their feet walking on the coral bottom, where the mud was contaminated, would get a very high exposure, even though they had lead weights on the soles of the shoes. It was important for them to be protected in all of these underwater things. They were quite anxious about it, too, you know. In fact, I myself came and watched the first ones and got the reports. But they knew I was there to be sure that they didn't get into any trouble. It was a great morale builder to them. I certainly wouldn't like to be a diver down a couple of hundred of feet in dark, cold water, even though it was pretty transparent and the sun made it fairly light down there. I wouldn't pick out a diver's life as something I would enjoy.

TUSLER: Did they come through all right?

WARREN: Oh, yes; none of them got any exposure. Of course, this was my assignment and my orders: I had to see that they didn't, that nobody did. During the period after the first shot, ABLE, there was essentially no contamination. There was a little bit of alpha and beta radiation on some of the decks from the immediate fallout. We were able to find small beads that represented the melted superstructure of the Gilliam, the ship next to the Nevada, which had been the target vessel. The bomb missed the Nevada by a couple of hundred yards, but that was awfully good bombing, anyway. It didn't hit the Nevada or go off above the Nevada, but it went off above the Gilliam. The Gilliam was fairly radioactive from the neutron bombardment. After a lot of argument, I brought home the Gilliam's two stanchion posts that were used to snub the hawsers and the cable for the anchor. The divers had brought these up for me. These stanchions are over here in the Nuclear Medicine [Laboratory] now. I think you can still detect a little radioactivity. But the steel cable, I thought, was a very prized exhibit because it showed the attenuation of neutron bombardment below the surface of the water with depth. As the cable went deeper and deeper the neutrons that were able to reach it were greatly reduced in intensity. Dr. Bob Newell, who was one of my chief monitors, spent a lot of time with this on the Henrico while coming home. We had that cable stretched out on the deck, and he and his son spent a lot of time measuring the radioactivity of it in proportion to its length. They could tell you exactly where it entered the water and then how quickly the radioactivity decreased. Unfortunately, when we arrived back home at the Oakland Army Base, when my back was turned, during the ship cleanup, they dumped the cable overboard because it was rusty and didn't look like anything. It is now in the Oakland Army Base harbor. So we lost an artifact of scientific interest.

After five weeks or so the main program was over, so Admiral Frank Fahrion, the local commander in this area of the Pacific, came in and took over. After we had decided there was nothing more that we could do and they had decided to tow certain target ships to Kwajalein to have them as standby for study, an order was issued to sink everything that wasn't going to be taken home. Anything contaminated was to be sunk. Well, I had a little barge out in the back of the Haven with all kinds of museum collections. I'm a regular pack rat. These were things like shoes and underwear from some of the commanders, various objects that had been neutron bombarded, collections of silver nitrate, salt, and soap from the laundries--things that we were going to measure more carefully subsequently. Well, I left the ship for just one hour, and when I came back, I noticed the barge was gone. I got aboard and they said, "Oh, yes, the admiral said sink everything, so we sank everything." This meant they sank barracks ships with everything on them--clothes, silverware, everything--because they were contaminated and couldn't be cleaned, as they found out later at Kwajalein. To get a good idea of what went on there you have to read No Place to Hide by Dr. David Bradley, one of my aides, who had the terrible assignment of staying at Kwajalein and monitoring all the personnel who were unloading the live ammunition and everything that was salvageable.

I think that the navy just turned its back and forgot to supply the budget for pumping, so a great many vessels were sunk in the harbor, including the Prinz Eugen. Some were prepared for towing home. I had a terrific argument with the navy about this. They couldn't occupy the ships. They couldn't put anybody aboard more than eight hours on some of these, particularly the Independence, even though they had just beaten the tar out of her trying to clean her. But this is one reason they wanted to bring her home, with the New York and a couple of subs. So these were towed at great expense across the Pacific. Fortunately, the weather was good, so they didn't have any real bad time with them. They were in San Pablo Bay down at the Mare Island Navy Base. The New York was finally sunk by gunfire. They had no way of disposing of it and they needed practice, so they towed it out in the Pacific and shot it. They didn't sink it as easily as they might have, either, which was a good thing. It was a good test of the ability of the ship to stay afloat in a battle. I tried to keep an eye on the Independence, because I felt that it could have been an awfully good training device. One of the things that gives trouble is the first experience that anybody has in going into a contaminated area: realizing that he is in contamination; that it's all around him; that he can't get away from it as long as he stays there; that there's no way of protecting himself; and that all the time the Geiger counter is going click, click, click, his little film badge is getting darker and darker. He often just panics. When we let anyone aboard these ships for the first time after the second test, he had this reaction. Officers, who had medals for bravery, acted this way. This was something that they couldn't see, they couldn't feel, and they couldn't taste.

TUSLER: They didn't know what the results were going to be.

WARREN: That's right. And I felt that we needed something like that around for demonstration and training. I prevented it from being sunk about three times. Then one week, when I was in Washington, they took her out and sank her. The navy said, "Well, fine, get the governor to declare it a state museum or a state park or something. We'll run her on the mud for you. But you've got to have it on state land or university land." Well, you can just imagine my trying to get a budget for that sort of thing. Nobody wanted to touch it. Everybody was putting their money into other things. So we don't have any residuals.

The worst problem was toward the end of the first month after the second test. All of these GIs, of course, were waiting there, doing nothing in the heat and the high humidity. I had taken away most of their clothes because the work parties got so contaminated. They were beginning to revolt; they wanted to go home and be discharged. They weren't going to obey all these regulations. If they had to clean the place, they said, "Let's go on and clean it, the hell with regulations"--the typical impatient American. So we had a conference, several conferences in fact. I had the good fortune of having Dr. Robert Newell, Dr. Elmer Belt, Dr. William Edward Chamberlain from Philadelphia, and a couple of other good solid authorities in radiology. They were all civilians and worked as my advisory committee. We finally figured out how to solve this. The best way was to get brutal about it. It had to be done by the civilian committee and not by me, because a military officer would be suspect. So Dr. Newell and the rest of the party went off to the barracks whose crew was the most vocal and vociferous about this business. The crew insisted it was all monkey business and the colonel didn't know what he was talking about. They said, "Heck, nobody's dropped off yet; everybody's got their hair," and so on.

TUSLER: This was after the testing.

WARREN: This was a month after the testing, while we were waiting to let the people go on the ships to get their equipment back, you see, or maybe clean the ships enough to take them home. But no one except the work parties under the careful observation of a monitor were allowed on the ships. The ships of the scientists and of the fleet admiral were the only ones that we had kept from being too contaminated. I was aware of the fact that that even their hulls were just hotter than a firecracker. You could get a picture of the welds from the radioactivity of the barnacles, the algae, and the other crud on the outside, by just putting a film on the inside overnight. We had to move the bunks away from the hull so that these boys wouldn't get exposed.

Well, anyway, our committee went on one of these barracks ships where there were about 1,000 men and went down into the sleeping quarters where their hammocks were. They had a couple of petty officers with them, and, of course, a jeering crowd gathered around. Our people said, "We're here to look for radioactive material."

"Oh, no, doc, we haven't got a thing. We obeyed all the orders." (It was a court martial offence to bring anything off the target ships.)

"Oh, yes you have. Somebody here had got a radium dial from those that were put on the ladders or on the doorways in the ships before you came here. You brought it in your dunnage here and expect to take it home as a souvenir." You know, in the blackout, the only way you could walk around was to see these little disks that were put on the wall of the stairwell, or on the door, in the dining room and heads, and everywhere else. A lot of the boys took these for they were easy to get off, you see. They're about as big as a watch, an inch to two inches in diameter.

TUSLER: A very good souvenir.

WARREN: Yes. All of these had a little radium on it. "Oh, no, no, no, nobody's got this."

"Well, let's see." So they went up and down the bunks and the hammocks, and the boys were giving them the Bronx cheer, and it looked as if this inspection was going to be a dud. All of a sudden they found one.

The boy said, "I haven't been off the ship. I haven't been in any work parties."

"Well, let's see your dunnage. Put it out here on the bed." So everybody was really giving the boy the business; and sure enough, he had one of these. So then they said, "Now this is the kind of thing we have been looking for. This is what's dangerous to you if you get it on your clothes. If you happen to get radioactive rust on your underwear, you can't be sure you won't be sterile when you go home, and there'll be some questions about your manhood, brother." This is the only thing you see that would impress them.

TUSLER: Get through to them.

WARREN: Yes. Well, sir, what's called the "latrine rumor system" went through the fleet that night. The next morning we had not a peep from any of them, and all of the enlisted personnel were just as good as gold after that. They did everything they were supposed to do, and we had no more backtalk. When they'd come aboard, they'd get their hands monitored and they'd get their underwear monitored. [laughter] There was no backtalk when we'd say, "You have to go in the shower and wash again. You aren't clean yet. Sorry, you can't have your underwear back."

TUSLER: So nobody had to be courtmartialed or pushed to the end.

WARREN: No, it's too bad we hadn't done this earlier. I don't know if this isn't a little ribald, or a little earthy, but you know athletes wear jockstraps. I had my fiftieth birthday party there. Unfortunately, I was that old and somebody found out; so they had a big meeting of appropriate staff and others on the Haven on the foredeck. I came back from an inspection trip and wondered what all the excitement was. I heard the band and everybody up there. So when I got on the gangplank I walked by a huge blast of the band and a lot of cheers. I was ushered up to the middle of the foredeck and they played "He's a Jolly Good Fellow, He's a Jolly Good Fellow" and congratulated me on reaching the half-century point. Well, of course, I didn't want this advanced age known. [laughter] Anyway, they made a presentation. They gave me a "Mark III," lead jockstrap, with great cheers. They had a little ribbon--well, it wasn't little; it was about a foot and a half long and six inches wide--which they brought up. It said, "Mark III" on it, and the admiral pinned it on my chest and handed me this gift with appropriate remarks. Of course, the word got around everywhere on that. But this was good, too, because this was kind of a symbol of the protection that was necessary. It's funny how corny you have to be sometimes. But sometimes the more corny you are, the more the point goes across; it's easier to accept.

I didn't finish up on Admiral Draper Kauffman. This young man had originated the idea of the navy frogmen. He introduced the technique of swimming underwater, going ashore in enemy territory, and putting demolition charges around. They went into the German submarine protection areas where there were big twenty-foot-thick concrete underwater sheds. The Germans would move their submarines into these pens where they couldn't be bombed. The frogmen would swim underwater and get through all the protective devices and chains, and put the explosive devices in and get out.

Before the Normandy operation, there had been quite a bit of consideration given to the possibility that the Germans might have had a nuclear reactor. If they were as far along as we were, say in the spring of 1945 before we used the bomb in Japan, they could have spread reactor ashes all up and down the twelve or so beaches which were the only places where the Allies could come ashore on the continent. It would have been relatively easy to prohibit our landing if the Germans had made those beaches radioactive for a half-mile inland. It would have incapacitated the troops going across if the doses were high enough, and, of course no commander would go across it if his troops were going to fall by the wayside in a few days. It could have been done easily with crop duster airplanes. They had a lot of Polish pilots in prison who could have been offered freedom if they would dust the beach. The Germans would have known, of course, that the pilots had no chance. They would have died in a few days from exposure to the radioactive dust that was in their equipment and plane. Probably it would have been intense enough that the pilots would be made somewhat suspicious, because this material would glow in the dark--in the concentrations that they would have had to use in the plane.

I had lunch at Dr. Conant's invitation to discuss this, and we agreed that if they had the potential they would use it. So we ought to safeguard against it. Arrangements were then made to build some waterproof ion chambers and film badges. These measuring instruments were fabricated in the [University of] Chicago Met Laboratory and then taken over to London by courier. Two weeks prior to the Normandy Beach landing, the frogmen distributed these in the vegetation of the shore areas. Then, a day or so before the assault, the frogmen went back and recovered this equipment, which fortunately showed no contamination on the beach.