DOE/EH-0476

HUMAN RADIATION STUDIES: REMEMBERING THE EARLY YEARS

Oral History of Physiologist Nello Pace, Ph.D.

Conducted August 16, 1994

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

FOREWORD

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 As part of this initiative, the Department of Energy undertook an effort to identify and catalog historical documents on radiation experiments that had used human subjects.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

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

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

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

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

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DISCLAIMER

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

ORAL HISTORY OF PHYSIOLOGIST NELLO PACE, Ph.D.

On August 16, 1994, Ms. Anna Berge of the Lawrence Berkeley Laboratory Archives and Records Office interviewed Dr. Pace at his residence in Berkeley, California.

Dr. Nello Pace was selected for the oral history project because of the positions he held with the U.S. Navy, at the University of California at Berkeley (UCB), and as the Director of the White Mountain Research Station near Bishop, California. This oral interview covers Dr. Pace's service in the Navy during World War II, relationship with UCB's Donner Laboratory, and directorship of the White Mountain Research Station. He also offers reflections on Dr. John Lawrence and others he worked with at Donner Laboratory and White Mountain.

Short Biography

Nello Pace was born in Richmond, California, on June 20, 1916. He has been married twice and has two children. He attended UCB and received his B.S. in Chemistry in 1936 and his Ph.D. in Physiology in 1940. During his graduate years at UCB, he knew a number of the people working in Ernest Lawrence's group. From 1940 to 1941, Dr. Pace was a research associate at the Medical College of Virginia in Richmond. During this same period, he was in the Naval Reserve and was called to active duty in the summer of 1941. During World War II, Dr. Pace served as the head of the physiological facility at the Naval Medical Research Institute in Bethesda, Maryland. In 1946, he returned to UCB and took the position of a research associate for the Division of Medical Physics. From 1948 to 1957 he went from assistant professor to associate professor of Physiology and obtained full professorship in 1957. Dr. Pace served as Chairman of the Department of Physiology from 1964 to 1967. He established the White Mountain Research Station near Bishop, California in 1950, where he worked from 1950 to 1977. In 1977, he became an emeritus professor of Physiology at UCB.

During his long career, Dr. Pace has also held the following positions:

- 1951 to 1953—Officer in charge of Unit 1, Office of the Naval Reserve
- 1954—Assistant leader and chief scientist for the Himalayan Expedition to Makalu, Nepal
- 1957 to 1958—Leader of the International Physiological Expedition to Antarctica
- 1963—Consultant to the administrator of the National Aeronautics and Space Administration (NASA)
- 1965 to 1970—Experimenter on Biosatellite III
- 1971 to 1980—Chairman of a panel on gravitational biology for the Committee on Space Research of the International Council of Science Unions
- 1973 to present—Member of a commission on gravitational physiology for the International Union of Physiology Science
- 1978 to 1980—Experimenter on *Cosmos 1129.*

Dr. Pace is also a member of the American Association for the Advancement of Science, the American Physiology Society, the Aerospace Medical Association, and the International

Academy of Astronautics. In 1990, he received the Founders Award from the American Society of Gravitational and Space Biology. Dr. Pace has published on his main research areas of gravitational physiology, environmental physiology, and in vivo body composition.

Education at UC Berkeley (1932–40) and Medical College of Virginia (1940–41); Service in Naval Reserves

BERGE: This is an interview with Dr. Nello Pace by Anna Berge of the Lawrence Berkeley Laboratories Archives and Records Office on August 16, 1994 at his office.

I was wondering if you could start and give me some background information on yourself, such as where you're from, what your education has been like.

PACE: I was born in Richmond, California, and moved to San Francisco when I was four years old and went through public schools there. I'm proud to say I graduated from Mission High School and came to Berkeley and spent four years as a Chemistry major, then went on and got a Ph.D. in Physiology four years after that.

I graduated from Berkeley in 1936; in 1940, I got my Ph.D. I went on a year's postdoctoral to what was then the Medical College of Virginia, in Richmond, Virginia. I spent a year there.

In the summer of 1941, I was in the Naval Reserve and got called to active duty as a physiologist and spent all of World War II pretty much in the Bethesda, Maryland/Washington, DC, area with the Navy. During my time in the Navy, I was doing applied physiology, looking into the effects of high-altitude flying and deep-sea diving and carbon monoxide poisoning and the effects of extremely hot spaces on personnel that had to occupy them; the effects of cold—all of the discomforts known to man.

Tritium Injection Experiments in Animals and Humans During WW II

PACE: I should say that in the time that I was a graduate student at Berkeley, I got to know a lot of the people in Ernest Lawrence's group that had just built the cyclotron.[1] I worked a little bit with radioactive isotopes. In the Navy, during World War II, the occasion arose to try to measure the total amount of water in the body of personnel, total body-water content. A method had been developed using deuterium[2]-labeled[3] water [("heavy water")] as a tracer.[4] Even though I was in the Navy, I couldn't

1 an accelerator in which particles move in spiral paths in a constant magnetic field

2 a isotope of hydrogen, having twice the mass of ordinary hydrogen (protium); "heavy hydrogen"

3 incorporated with a radioactive isotope to make a substance traceable

4 a small amount of radioactive materials used in place of stable forms of the same element to track a biological or chemical process

get my hands on any heavy water. I didn't realize that all of it was being used for the Manhattan [Engineer] District project[5] at the time.

I did remember reading about a radioactive isotope of hydrogen with three times the atomic weight: tritium. And I read that I could obtain tritium from beryllium that had been bombarded with protons to make a neutron source in the early days of cyclotrons.

There was a cyclotron at Silver Spring [Maryland] at the Carnegie Institute. A younger physicist, who had trained with Ernest Lawrence, had built the Silver Spring Cyclotron, a small one. I can't recall his name; I want to say "Dean" Somebody, but that's not quite it. He had the terrible habit of looking over the shield to see where the beam was, and he came down with cataracts[6] in due course. They operated.

At any rate, I knew him and I said, "Hey, have you got any beryllium targets around that have been bombarded to produce neutrons?" He said, "Yes." Then he opened his desk drawer and gave me a couple. They weren't that radioactive. I took them back to my lab in Bethesda and dissolved them and made some tritium-labeled water. In those days you built your own Geiger tubes. You didn't buy them, you made them. It was kind of a cute Geiger tube that had been developed by some people at Princeton [University] to measure tritium, where you let a little bit of the water vapor into the tube, which contained the tritium and filled the tube with argon and counted the radiation internally in the tube. It worked very well. So I had a way of making tritium and measuring it.

I went ahead and we played around and injected some tritium-labeled water, very low levels of radiation, first in rabbits. I sacrificed the rabbits and measured the amount of water they had and showed that you got an accurate measure of the water content. Then they did this in some human subjects and measured total-body water with tritium-labeled water. These turned out to be the first biological experiments that were done with tritium. This was published in the *Journal of Biological Chemistry*.

Hospitality to Manhattan Project Researchers Staying in Washington

PACE: I always think of the irony of this. The reason we did this was that we couldn't get any deuterium because it was all taken by the atomic bomb development people. With all that background, I knew people from Berkeley, they'd come through Washington[, DC]. People like Glenn Seaborg[7] would come and Joe Kennedy, who had gone from Berkeley

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5 the Manhattan Project—the U.S. Government's ultrasecret project to develop an atomic bomb

6 an abnormality of the eye in which the lens becomes partially or completely opaque

7 U.S. chemist, born 1912; discovered plutonium in 1940 and played a key role in the discovery of more than half a dozen new elements through the 1950s

to St. Louis University. All of them were working for the Manhattan [Engineer] District [(MED)],[8] but they'd come to Washington.

I had a big old farm house that I was renting, and so they'd stay at my house out there and save hotel bills; nobody had much money. They just said they were busy on a project. There were a lot of people working on wartime projects. I didn't give it that much thought. They never even once peeped anything about what they were really doing. It turned out that all of them were highly involved in the atomic project, which I didn't learn until after the war. The upshot was that I kept in touch with the people at Berkeley this way.

The other connection that I had was that John Lawrence, Hardin Jones, and Cornelius Tobias[9] during the war had a project for the [Army] Air [Corps][10] to look at the production of bends[11] in aviators who fly too high and come down with bends, just like a diver. They were using radioactive argon as a way of measuring the diffusion of inert gases from the lungs. Of course, we at Bethesda, at the Naval Medical Research Institute, were quite interested in this from the point of view of the bends [underwater] divers [can experience if they return to the surface too rapidly]. There was really, physiologically, no difference. They'd come to Bethesda, and we'd do joint experiments on divers coming up from the high pressures [at their working depths underwater].

Incidentally, I had known Hardin Jones when we were graduate students in Physiology before the war. John, I met through this; I didn't really know him at Berkeley. Tobias, I didn't know either; I met him this way.

Return to UC Berkeley to Research and Teach

PACE: To make a long story short, after this background, I wanted to come back to Berkeley, and had a chance to get a research grant from the Office of Naval Research, but I needed a home to do this. I asked John Lawrence[12] if he'd be good enough to let me set up my shop in Donner

8 the U.S. Army Corps of Engineers organization set up to administer the development of the atomic bomb under the ultrasecret Manhattan Project. Originally headquartered in New York, it was moved to Washington, DC, and finally to Oak Ridge, Tennessee, in the summer of 1943. In 1947 it became the Atomic Energy Commission.

9 For the transcript of the interview with Tobias, see DOE/EH-0480, *Human Radiation Studies: Remembering the Early Years; Oral History of Biophysicist Cornelius A. Tobias, Ph.D.* (July 1995).

10 The U.S. Army Air Corps became the U.S. Air Force, a separate military service, on September 18, 1947.

11 The bends are caused by tiny air bubbles released into tissue by a too-rapid decrease in air pressure after staying in a compressed atmosphere, such as the too-rapid ascent of a diver from deep in the sea to normal atmosphere at sea level. It is potentially fatal. Aviators experience a similar phenomenon in ascending too rapidly to high altitude in an unpressurized cockpit without the protection of a pressurized flightsuit. In this circumstance, aviators are at high risk of blacking out and losing control of their aircraft.

12 Director of the Division of Medical Physics at the University of California, Berkeley. He operated a clinic at Donner Laboratory, where he treated leukemia and polycythemia vera patients with radioactive phosphorus. For a colleague's recollection of Dr. Lawrence's clinic, see in the interview with Dr. John

Lab.[13] He said, "Sure, as long as you've got your own money, that's fine." He was really nice, wonderful to me in fact. He gave me lab space and office and access to the secretaries. I got an appointment as a research associate in Medical Physics, when I joined that group.

I remained in that position for a couple of years until I finally got an appointment as assistant professor of Physiology at Berkeley. Since then, I've gone on in that direction. I always maintained a relationship with Donner. I ended up, years later, in the Bohemian Club[14] as a campmate of John Lawrence's. That was so funny and ironic, and he turned out to be a real close and good friend. There were many other connections in-between. John was always very good to me and very helpful; I can't say how much a debt of gratitude I own to John Lawrence.

Development of Medical Physics Degree Programs at UC Berkeley

PACE: Now in Medical Physics, where does that come in? The Medical Physics Group was just being formed when I got here. In the history of that, I wasn't directly involved, but I saw it happening while I was there. It really started with two people, aside from John Lawrence, who of course was pushing very hard for it. He needed some backing from other faculty members on the campus, and there were two in particular. You probably know of Leonard Loeb, who was a Physics professor.

Leonard B. Loeb, very well known, outstanding physicist at Berkeley in the '30s and '40s. He was the nephew of a really famous physiologist named Jacques Loeb. Jacques Loeb came to Berkeley in 1906 or '07, right after the earthquake, and was brought to the university primarily through the medical school connection in San Francisco. The earthquake had ruined a lot of their facilities over there, so they decided to move the first two years of medical school to Berkeley.

Loeb was brought in to head the Physiology Department of this new setup. He preferred to be on the Berkeley campus because he wanted access to the Physics and Chemistry Departments instead of just the clinical facilities in San Francisco. He was very famous. To this day he is held in awe by most physiologists as one of the really great ones.

Leonard Loeb had this family connection and had an interest in physiology. Then we had another member of our department, named Sherburne

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Gofman (DOE/EH-0457, June 1995), the sections "From Research to Laboratory Production of Plutonium," "Medical Treatments With Radioactive Phosphorus (^{32}P)," "Conflict Between University of California San Francisco and Berkeley," "Heparin and Lipoprotein Research With Human Subjects," and "Radiophosphorus Therapy for Polycythemia Vera."

13 a laboratory set up at the UC Radiation Laboratory in Berkeley during the 1930s specifically to conduct experiments in medical physics

14 an exclusive social club in the San Francisco area, known for back-to-nature retreats to Yosemite and the power and influence of its members

Friend Cook, who was a professor of Physiology—and a very distinguished one.

These two men drew a lot of water politically on the campus. They were wonderful allies for John Lawrence. So they were able to propose and get through the concept of a graduate degree program. There were two: one was for M.S.s in Medical Physics, and the other was for Ph.D.s in Biophysics. This drew heavily on the courses that were being given elsewhere on the campus and went on to become a two-pronged program. I guess it's still going today; I presume they're still giving degrees in Biophysics and Medical Physics.

Of course, when the great genius, Dan Koshland, came to the Berkeley campus, he decided to abolish these programs and the classic departments of Biology, including Physiology, Botany, and Zoology.

In 1948, I moved down to the Life Sciences Building, although I retained lab space in Donner Lab for a number of years. Both Biophysics and Medical Physics were highly successful "group majors," as they were called. Eventually, they were able to set up the proper Department of Biophysics. But, that didn't come for a number of years. These were group majors operating under the aegis of Donner Laboratory, a unit of the [Lawrence] Radiation Laboratory,[15] as I'm sure you know. I've forgotten the exact year, but it was quite late that they finally got a proper academic Department of Biophysics, which then gave degrees as part of the department itself.

I don't know where you want to go from here. That's just a rough outline of my connection with it. I was more an observer of all of this than a direct part of it. But a very interested observer, and I thought the whole thing was great.

BERGE: With respect to the Medical Physics program, do you have any idea about some of the dates? For example, when people like Sherburne Cook and Leonard Loeb proposed [the program]?

PACE: It was about '45, '46, '47, in there; I don't think it was in effect when we first got to Berkeley; I think it [the program] was still being proposed. I may be wrong about that. This is what I remember: I didn't come until the fall of '46 although the war had been over for a year.

Conducting the First Radiation Survey at Nagasaki After the Bomb

PACE: Incidentally, why it took me this long might interest you. Because of my doing work with the tritium and building Geiger counters, I guess I was one of the very few people in the U.S. Navy who had a Geiger counter.[16] The end of the war came, and when they exploded the bombs that ended

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15 now Lawrence Berkeley Laboratory, a National Laboratory under the U.S. Department of Energy; originally founded by Ernest Lawrence as the UC Radiation Laboratory in 1936

16 an instrument for detecting ionizing radiation, used chiefly to measure radioactivity

it,[17] people in the Navy were just as shocked as anybody else, because this was such a deep secret. The Manhattan [Engineer] District, of course, was running the whole show.

MacArthur, who was the [Army] commander in the Pacific area, was sitting in the Philippines masterminding the occupation of Japan before he went to Japan himself. He was furious: nobody had told him the bomb was going to be dropped. [The Navy's Commander-in-Chief Pacific (CINCPAC), Fleet Admiral Chester W.] Nimitz, wasn't told,[18] let alone anybody else in the Navy. I get this [impression] because the Manhattan District people weren't allowed to go any further than Okinawa.

MacArthur was so provoked that he said, "I want my people, my doctors, in there looking at the effects of this, not these Manhattan District people!" Of course, the Navy had Ross McIntyre, who was the Surgeon General. He wasn't quite as frontal about the whole thing; he was a little more subtle. He said, "Geez, we've got to find out something about what happened to those people and how much radiation there is."

The Navy had something called the Naval Technical Mission to Japan, which was really an intelligence-gathering outfit, which went in quickly to find out all they could about Japanese optics and other technical developments. I got called in and McIntyre said, "We want you to take a small group over to Nagasaki and Hiroshima to see what went on and how much radiation there is."

[In that small group there] was another fellow, named Shields Warren; he was a commander in the Navy. At this time I was a lieutenant commander. Shields Warren [came from] up in Boston. He was a big expert on radiation effects in humans. They also got him to go on under this same aegis, but independent of our group. I got a physiologist Robert E. Smith, who was a lieutenant working in my lab in Bethesda. The rest of the group consisted of four hospital corpsmen, adept at doing blood-cell counts and that kind of thing.

We packed up our Geiger counter, and we had these incredible orders of 1A priority, which enabled us to fly in military aircraft, all the way, right to Tokyo. This was five weeks after the bomb had gone off. They had had some terrible typhoons in Japan and nobody had been able to get in, anyway. We still couldn't get into Hiroshima, but Nagasaki they said would be okay.

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17 the atomic bombs dropped by U.S. bombers over Hiroshima and Nagasaki, Japan, on August 6 and August 9, 1945, respectively

18 Both General Douglas MacArthur, who was Commander-in-Chief Southwestern Pacific, and Admiral Chester Nimitz, CINCPAC, had been informed by the War Department of the existence and impending use of the atomic bomb in late July 1945. See William Manchester, *American Caesar*, Boston: Little, Brown and Co. (1978), p. 438. MacArthur was greatly angered on being informed that General Eisenhower and several other commanders had learned of the atomic bomb much earlier than he. See Michael Shaller, *Douglas MacArthur, the Far Eastern General*, New York: Oxford University Press (1989), p.117.

The Marines were just about to land and occupy Kyushu, beginning in a place called Sasebo in southern Japan, fairly near Nagasaki. Aerial photos had been taken by the Air Corps, and there were some buildings left standing that they could use for headquarters that would fit what ever they call an Army group of the Marines. So, we went to Tokyo, and we had a hell of a time figuring out how to get from there to Sasebo, where the Marines ostensibly were.

We finally got a very nice marine colonel who sent a couple of his pilots in a DC-3,[19] and they flew us down to Sasebo from Tokyo. We couldn't land in Sasebo because what had happened was, the next-to-the-last day of the war, before the [Nagasaki] bomb went off, the Air Corps had gone in and bombed the place, and the Navy didn't know it. So all the buildings they were going to use were all damaged and destroyed. So things were chaotic when we got there.

We landed in a little village called Omura, which was halfway between Nagasaki and Sasebo. A Marine met us there. From radio communication, they knew we were coming. They took us to Sasebo and the headquarters for the regiment where the colonel was. He said, "Boy, am I glad to see you guys. I understand you've got Geiger counters with you. Can you tell how much radioactivity there is?" I said, "We're here to measure how much was left." He said, "Wonderful! I've been worried about our troops entering Nagasaki without knowing what we were getting into. Maybe we could make a reconnaissance." I said, "Fine."

This is, so help me, a true story: The first American body part to enter Nagasaki was my right hand, which was holding the Geiger counter. I was leaning back and trying to read it. The colonel had to look over my shoulder, and the driver was next to me, leaning backward too. The Japanese by then had cleared paths through, but there were still a lot of corpses; it was a messy situation. We made a transit through the bomb-damaged area, and found the radiation was well within tolerable, safe limits.

Then that was it. The colonel said, "Fine." So that's when the Marines went into Nagasaki. We spent three or four months there making our radiological survey. I took some blood samples and then went and did the same thing in Hiroshima. Our data were some of the first data on a place that had been attacked with atom bombs. Highly classified stuff.

Censured by the Military for Underclassifying His Nagasaki Report

PACE: Another funny story. When I got back I wrote the reports, and I classified them Secret—which was as high as I was cleared for, and that was fine to me. So one day I got a phone call to go down and report to Ross McIntyre, the Surgeon General. I thought, "Maybe they're going to give me a medal"; I was pretty proud of what we'd done. I go in there, and

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[19] a commercial airliner; the military transport variant was known as the C-47.

there's McIntyre sitting there and another guy that looked familiar; I think he was introduced to me as General Groves.[20]

They were there with a big scowl on their faces. They wanted to know why I'd classified this report so low, when it should have been classified Top Secret. I said, "I wasn't cleared for Top Secret. I had no idea." They said, "You should have classified it as Top Secret." This was a very serious thing. McIntyre said, "I want you to destroy any piece of paper that had anything to do with this, any of the data." "And furthermore," he said, "I want you to forget. I'm ordering you to forget what you wrote in this report."

I didn't make that up.

I said, "Yes, sir!" I went out with my tail between my legs, and I went and did as he asked. Now of course, everybody is screaming at me still, "Where are the original data for your report?" Because this turns out to be highly valuable data. Of course, [decades later,] people at Livermore had access to this, and they were reading my report that I hadn't seen for twenty or thirty years. Finally they declassified it, and I got a copy.

But anyway, in all this time I was at Donner, and it was great. I know you're interested much more in medical physics than my war stories.

Reflections on Shields Warren

BERGE: No—that was fascinating! I'm interested that you had some contact with Stafford Warren. Now you said that he was another Navy person.

PACE: Not Stafford: Shields Warren. Stafford was at Rochester,[21] and I then got together with him. We brought back dirt samples and samples from sulfur insulators. We took a lot of them to Rochester because Stafford wanted to analyze them and follow the half-lives.[22] Then he wound up, of course, coming out to UCLA[23] as the first dean of the Medical School.

I knew Stafford pretty well. But the guy from [New England] Deaconess Hospital was Shields Warren, who was the big radiation-effects man on more clinical stuff. He was out there [in Japan] and we interacted not in a very nice way. He didn't like our taking blood samples; he didn't think we were licensed to do it. It was that kind of nonsense.

BERGE: What was Shields Warren like?

PACE: He's dead now, so it doesn't matter. He was kind of a turkey, full of himself—not like Stafford. Stafford was just wonderful. But Shields was very old-fashioned in his attitude that some M.D.s have: "Only M.D.s and God can touch people."

BERGE: Was he also a physiologist?

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[20] General Leslie R. Groves, U.S. Army, took command of the Manhattan Engineer District in 1942 and led it to completion of the Manhattan Project.

[21] the University of Rochester, Rochester, New York, site of research involving plutonium and human subjects

[22] plural of half-life, the time required for half the atoms of a radioactive substance to decay

[23] University of California at Los Angeles

PACE: No, he was a clinician, a radiologist. He was involved with the atomic. He stayed on and made a big career out of it. He was on the U.S./Japanese Atomic Bomb Casualty Commission that was set up after the war to follow the Japanese victims medically. He was very big in that.

The Public's Attitudes Toward Radiation, Then and Now

BERGE: What was the attitude of people during that time towards radiation?

PACE: There was a lot of confusion; it was a mixed thing. They felt that it was terrible, but they had some very distorted views, like "You become a puddle of goo" or something, completely crazy. At the other extreme, people realized that the use of radioisotopes in treating various conditions is extremely important: [they felt] it was fine, it was miracle stuff.

BERGE: Can you talk a little bit about the use of radioisotopes in medicine?

PACE: They're a tool. I think that there's a big misconception. People don't understand the concept of dose rates. Low doses are quite different from high doses. You can't just make a blanket statement and say radiation is good, or is bad, or radiation is harmful, or harmless. It depends on so many factors.

I think there were some mistakes made, certainly, in giving people things like plutonium or uranium. On the other hand, the use of low-level radiation for metabolic studies certainly has been a tremendous thing. Good Lord, the departments of nuclear medicine[24] in hospitals all over the country are, to this day, using radioisotopes for thyroid treatment and bone cancer very effectively.[25]

I have a friend named David Price who is a product of the Medical Physics program at Berkeley. He's now the Chairman of Nuclear Medicine at UC [University of California)] San Francisco. I was talking to Dave about this the other day. He said something like 15 million doses of radioisotopes are given annually in nuclear medicine practice. Most people don't realize this.

Then I know, from some firsthand experience, there was a flurry [of opposition] a while back, and it's still going on to some extent. Some of these guys that were in the Marines and went in and occupied Nagasaki, tried to sue the Government because they're coming down with cancer as a result of having been exposed to radiation in Japan. I think that is a totally specious argument, based on the evidence that we have. This becomes a very emotional kind of thing very quickly. It's hard to be judgmental about it because, to some people, it's a very real threat. You've just got to be patient and try to explain it to them.

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24 diagnostic and therapeutic medical techniques using radionuclides or radioisotopes

25 For an extended review of the use of radioiodine to treat thyroid disorders, see see DOE/EH-0465, *Human Radiation Studies: Remembering the Early Years; Oral History of Dr. Nadine Foreman, M.D.* (July 1995).

Establishment of a Research Lab at White Mountain (1950)

BERGE: If we go back: I took some notes while you were talking. There were a couple of things that I thought we might elaborate on a little bit more. Can you talk a little bit more about the applied physics that you were doing for the Navy—for example, the high-altitude flying. Did you have any connection in doing that with the people at Donner at the time, or did that come later?

PACE: I was the one who started the lab at White Mountain [near Bishop, California]. This was another thing about which John Lawrence was very nice. I got the idea of building a facility in the mountains because during the war I had been involved in high-altitude research in connection with pilots flying planes. We all had gotten interested in the possibility of high-altitude acclimatization. There was even talk about whether pilots should be acclimatized to high altitudes so they could fly higher. So when I came back, this was still a pretty hot topic.

I thought, "Gee, here in California we have Mt. Whitney,[26] the highest mountain in the United States." At that time, Alaska wasn't a state yet.

I used to hike in the mountains before the war, and I was pretty keen on it. I knew that a man named Abbott, who was a physicist, had built a stone building on top of Mt. Whitney, around 1912, [from which he] measured the solar constant, the total amount of radiation the sun puts out that reaches a square inch of surface on the earth.

I talked to the National Park [Service] people in Washington and said, "Would it be possible to use that building that's still up there?" They said, "As far as we're concerned, it's fine." It was at the very corner of the National Park, so it wasn't a question of going in. And it had been used for that purpose in 1912. Of course, it was a job getting to the top of Mt. Whitney. You couldn't drive up. You had to use mules to get supplies up there, and you had to hike in.

I was all set to go ahead and try to put a high-altitude facility up there, a laboratory where people could go to study the effects of high altitude. I talked to the people in the Office of Naval Research, and at that time they were keen on basic research support [for studies in high-altitude effects]. They said, "Fine, go ahead."

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26 a mountain in eastern California, in the Sierra Nevada; 14,495 feet (4,418 meters)

Well, the Sierra Club found out about this, and one of the members, Dave Brower, was a man in my neighborhood, and has since become a patron saint of the Sierra Club. The other guy was Dick Leonard, and he was at that time President of the Sierra Club. They said, "We're going to fight you. We don't think that the top of Whitney ought to be desecrated by having a laboratory on it." I said, "Well, I got permission from the Park Service." They said, "We're going to go talk to President Sproul."

Here they were threatening to come and talk to my boss, which made me madder than hell. I said, "See you in court." Then they backed off a little bit and said, "We'd like to suggest a better place." I said, "I'm always interested if there's a better place." They said, "There's a very nice mountain range in back of Bishop. It's called the White Mountains. That peak is only 250 feet lower than Mount Whitney and the terrain is much more gentle at high altitude and there's a dirt road that goes almost to the top. In fact, there's a Navy project up there. Why don't you at least look at it?" I said, "I'd be glad to." I don't know if you've run into Will Siri.

BERGE: I haven't talked to him yet.[27]

PACE: I knew Will; he was at Donner Lab. His lab was sort of next-door to ours. We had some projects that we were doing together. He was a big hiker. He had been to the top of Mount Whitney, and I hadn't. I told him my story, and I said, "Let's go down some weekend and take a look at these together." He thought this was great.

We looked at White Mountain first. It looked terrific. It was easy. We drove most of the way up in the regular university car. The next day we went down to Whitney. Then we climbed to the top of it. It was 14,500 feet. We could only do it on foot. That evening we camped. Both of us were young; *now* I couldn't walk ten steps [up such a mountain]. So we climbed the two peaks, one each day, in two days, which was quite something.

We took one look at Whitney, and we found the stone house. Will said he did not think it would be very good for a lab, but I wanted to see it. I realized that it was kind of impractical. The summit of Mt. Whitney has all these big boulders; you can't do anything. Whereas at the top of White Mountain there was lots of space.

We went back, and I said, "I'll get hold of the Office of Naval Research [(ONR)] guy and he'll come out and take a look at this." An ONR man, William V. Consolazio, came out from Washington, [DC,] and I took him up to White Mountain and showed him what I wanted to do. He said, "This is great, and we would be very interested in supporting a small facility up here." I said, "Fine."

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[27] Berge later interviewed Siri for this publication series, but the resulting transcript was unusable as it is full of lacunae.

We went back down to this little building at 10,000 feet that the Navy had built to do their research. We talked to the Navy people there. It was a nice little building. We were delighted that they would be neighbors, but we wanted to build our laboratory a little bit higher, because 10,000 feet isn't really quite enough to get the good altitude effects. They said, "If you want to come up here, we'll be glad to cooperate with you."

When we went back [to the Navy crew stationed in the building at 10,000 feet], they said, "We just got word that our project is being closed down." This was being operated by the people from China Lake at Inyokern Naval Air Station. I asked, "What's going to happen to this building?" They said, "They'll probably tear it down." I said, "I wonder if we could get them to transfer it to the Office of Naval Research to save them the expense of destroying it." They said, "That's a good idea."

So, Consolazio and I went down to Inyokern and talked to the people there. They were pleased they could just wash their hands of the whole thing without going to the trouble of clearing out. They said, "we'll be glad to transfer the facility to the Office of Naval Research." After driving back up to White Mountain, Consolazio asked, "What is it going to cost us to run this place?" I said, "I don't know, but for $1,000 a month you could do anything." This was 1950: that was a lot of money; $12,000 a year was a generous grant.

So we talked to the two guys who were working there, Paul Manis and Bill Roche, and said, "What are you going to do?" They said, "We're out of a job." "Would you like to stay on and keep running the place?" They said, "We'd love to." So we had the personnel, and the Navy was willing to transfer all the vehicles. They had a couple of snow weasels[28] and a bulldozer and jeeps. That all went with the package.

This was July, and the Navy said, "We have to be out of here by the first of September." Bill Consolazio said, "I'll go back to Washington. As far as I'm concerned, it's a done deal." But I said, "I have to get it through the University." He said, "That's up to you."

I went back to the campus, and that's when I talked to John Lawrence. I was still coming under, to some extent, Donner. My ONR research grants were still being administered through Donner, although I was in the Physiology Department. I was an assistant professor by this time.

PACE: Robert San Souci was the business manager at Donner at that time. He later went on to Livermore.[29] San Souci was a genius. He could get things done within the University. John Lawrence said, "We'll be glad to act as the home for the administration of this project." So I went

[28] tracked, all-terrain vehicles with covered cabs for use in arctic areas

[29] Lawrence Livermore National Laboratory, Livermore, California

ahead and submitted a proposal on it through Donner Lab, and that's how the White Mountain Research Station began.

Use of the White Mountain Research Station

PACE: I ran it for 27 years, and it's now being run by Professor Clarence Hall of the Geology Department out in UCLA and is still going strong. It's turned out to be a very nice research facility in the mountains.

BERGE: Do people at Donner ever use it?

PACE: They did then, but now nobody in Berkeley is doing this kind of stuff anymore.

BERGE: What kind of work are they doing now?

PACE: High-altitude acclimatization. The other thing that John Lawrence was interested in was a disorder known as polycythemia vera, which is an overproduction of red blood cells, sort of a form of cancer. One of the things that happens when you go to high altitude is a large increase in the number of red blood cells. John was interested in comparing true polycythemia to the increase of red blood cells produced at high altitude. We did a lot of that work, and he and Siri and several others went down to the Andes[30] and did some work on the natives, because of course we didn't have any natives at White Mountain. There were others from Donner who used White Mountain, too.

BERGE: How did it work? Did they get volunteers to go up there and stay up there for a while?

PACE: In those days there wasn't all this brouhaha about using human subjects.

BERGE: Where did they get the volunteers? Were these Navy volunteers?

PACE: Students. They would hire students.

BERGE: And they would stay up there for how long? A week, a month?

PACE: We had subjects up there for two, three, four weeks at a time. Scientists came from all over the country to use the facility, and they'd bring their own subjects with them. It wasn't just Berkeley that used White Mountain. Then we had all the cosmic-ray people from the Rad Lab who went up to measure of cosmic rays at the summit. That was before the space program.

BERGE: *(glancing at a book in Pace's hands)* Is that a history of White Mountain?

PACE: Yes; it's the only copy I have.

BERGE: Do you know where it's possible to get hold of copies?

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[30] the Andes mountain range in the western part of South America

PACE: I suppose in the library. I wish I had more but they've long-gone. That's the only one I've got. If you want to borrow it to copy and promise upon blood that you'll send it back, it's all right with me.

BERGE: That would be wonderful.

PACE: *(leafing through the pages to reach the back of the book)* What I'm looking for is in the back here. We have this bibliography that should list some of the investigators. You know, the carbon-14 dating of the bristlecone pines, where they have been able to correct the carbon-14 decay data, was all done at White Mountain. That is the habitat of the bristlecone pine.

(scanning the book's bibliography) Let's see if I can spot these Rad Lab names. We had geologists and all kinds of people. I see a lot of cosmic ray stuff here, but I don't see the name I'm looking for. Here's one—I don't recognize his name: Boley, B-O-L-E-Y. Paul Sedge and Balum, *Altitude Dependence of the Longitudinal Distribution of Atmospheric Cerenkov Radiation.* I'm looking for a name that I know is up there. —Here's one: Nobles, Newkirk, and Walt, *Cosmic Ray Neutron Multiplicity Monitor*. Now this is a bunch of Berkeley guys I know. Nobles, Alber, Hughes, Newkirk, Reynolds ,and Walt. Just a second—Wade Patterson. Do you know that name? He's with Lawrence Labs. I've known him for many years. *(handing the book to Berge)* Now be sure to get it back to me.

Research in the Organic Distribution Rate of Carbon Monoxide

BERGE: Thank you; I promise I'll get it back to you. How about your work with the carbon monoxide poisoning?

PACE: Most of that I did at Bethesda during the war. One of the projects we did at Donner was kind of interesting. We tried to see how carbon monoxide distributed within the body; the rate at which it reached the different tissues [via the bloodstream]. There was a neat isotope of carbon—carbon-12, I think it was. It has a very short half-life of 20 minutes or something.[31] I got the idea of making some carbon monoxide in the 60-inch cyclotron, the one Joe Hamilton was running. Tobias helped me with this picking out the procedure for bombarding whatever we were bombarding; I've forgotten what we bombarded at this point. The deal was that we'd bombard the target for a period of time and then shut down the beam, and I'd run in with a [long] pair of tongs, like you use for getting tin cans off of grocery shelves, and pick up the target and run up the hill from the 60-inch cyclotron to Donner—*(pointing out the window)* it's just across where that fountain is there—and put it in [an acid bath] and dissolve the target. I collect the gas and convert it into carbon monoxide.

[31] Carbon-12 is the ubiquitous stable isotope; Pace probably meant carbon-11, which has a half-life of 20.4 minutes.

We'd have the subject all lined up. The guy would have [Geiger] counter tubes placed around his body. This guy inhaled this; it was very low dose rates. With a 20-minute half-life, the total amount of radiation you get is vanishingly small. We'd try to see if it went to the liver or wherever.

I'm very much afraid that our technique didn't produce definitive measurements, but we had a lot of fun doing it. That was the only carbon monoxide stuff I tried to do.

BERGE: What was the purpose of this again?

PACE: To see the rate at which it was distributed among the different organs of the body.

Research in Physiological Responses to Thermal Extremes and Burns

BERGE: What about, you said you did some work with hot spaces?

PACE: Like the engine room of ships—hot in the temperature sense, not radiation.

BERGE: Did you ever do any work with shocks and burns?

PACE: We did some. It was not very pleasant work; I didn't care for it, myself. There was a great concern about burn shock.[32] We used dogs for the purpose and [it's] not one of my finer things. I'm not real proud of it, but the dogs were all anesthetized. But, it was the Korean War and all that; there was a great concern about burn casualties, and they [(burn victims)] would go into shock. We were trying to figure out how to prevent this, using saline, as opposed to blood plasma; treating by injections; increasing the blood volume; and that kind of thing. We got some nice papers out of it, but I don't like to think about it.

BERGE: We'll go on to the next one, which is the effects of cold.

PACE: Yes, we went down to Antarctica. We also worked with the Marines up at Pickle Meadows,[33] looking at the level of physiological stress engendered by exposure to cold. Like many of these things, there were all these old wives' tales about what a terribly stressful thing it is. When you come to measure the effects of cold, they are not that extreme.

How He Procured Isotopes for His Research

BERGE: You mentioned you used to get your isotopes from the 60-inch cyclotron. What were the procedures? My understanding was that at least

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32 a condition of pallor, very low blood pressure, feeble rapid pulse, decreased respiration, restlessness, anxiety, and sometimes unconsciousness that may be experienced by someone who has just been severely or extensively burned

33 the U.S. Marine Corps' Cold Weather Training Facility in northern California, near Bridgeport

during the war, that they would get them from other places, like Oak Ridge.[34]

PACE: No, this was after the war. This was in the early '50s, and there were some isotopes. Of course, there were companies just beginning that would ship you radioactive isotopes, but they were the very popular ones like radioactive sodium, radioactive iodine, or radioactive phosphorus. But, if you wanted an exotic isotope like carbon-11, which in no way a company could ever supply to you, because of its very short half-life, you'd have to make it yourself. That was one of the great things that Donner Lab had, was access to cyclotrons for producing almost any isotope you wanted.

BERGE: You could just go in and request them?

PACE: No, you had to talk to somebody, get permission, to get cyclotron time. It was really expensive to run the cyclotron. There weren't that many of us working in this field anyway. So, it wasn't that hard, provided they knew you were qualified to use the isotopes and more or less knew what you were doing. It wasn't that difficult to do, but you still had to go through the drill of getting assigned time on the cyclotron.

Willingness of Students and Naval Reservists to Volunteer for Radiation Experiments; Informed Consent

BERGE: You said you had volunteers lined up? How did that work?

PACE: We had students, and I stayed in the Naval Reserve. I'd get people from the Navy. They all volunteered, and they were quite glad to do it. Of course, you had to do two things: tell them it was important, and assure them that you had tried this on yourself, before you did it on them. This was very important. Which we did. Our golden rule: "We never do unto others anything we haven't done to ourselves." It was easy enough to live up to that: there was a completely different attitude about these things in those days [which allowed us to experiment on ourselves with comparative freedom]. It was not like it is now at all.

BERGE: What do you mean? What's it like now?

PACE: All these activists. It's very depressing for people of my generation to see that, how totally inane the whole thing is. The attitude is just different.

BERGE: What was the attitude then?

PACE: Everybody was wide-eyed and eager to help, and this was for the good of mankind. Now they're looking to sue you or something. All of the fun has gone out of it.

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

BERGE: Were they at all worried about radiation?

PACE: Sure, but you explained to them. Number one, "The dosage is this low." Number two, "We've done it on ourselves." Number three, "It's extremely important to do this. And it's entirely voluntary." We weren't forcing anybody to do anything. We didn't even have to *pay* them! *Now,* it's a different ball game. It's hard to describe. Maybe I've just gotten cynical.

BERGE: I usually get cynical when I'm hungry. I was wondering, you mentioned that you did some work with—I forget who it was, Siri, Tobias?

PACE: Both of them.

BERGE: Was this the type of work you were doing with them?

PACE: Carbon monoxide was Tobias. He was a physicist primarily, and so he knew the techniques for preparing the isotopes in the cyclotron. He was a good guy. He and I were friends. Siri was more of an engineer than anything else. He helped with the instrumentation in the lab. These were friends. It was not that they were fellow physiologists.

BERGE: And your interest was primarily research?

PACE: Yes.

Inert Gas Research for Treating the Bends in Divers

BERGE: Did you ever do clinical work?

PACE: No—I have a Ph.D. [rather than an M.D.]: they won't let me; it's against the law. But we did do research on humans.

BERGE: I had a question about the earlier work. You mentioned that Lawrence, Jones, and Tobias were in the Air Force working on the bends and that they used argon.

PACE: I think it was radioactive argon that they used.

BERGE: Why would they use argon?

PACE: Maybe it was xenon. There wasn't a good isotope of nitrogen, which is what causes bends in people. The inert gases generally—helium, neon, all those—act like nitrogen in being an inert gas in the air that dissolves in the fat of the body, and then, when you release the pressure too fast, it's like opening a can of soda water: you get the bubbles, and that's what causes the symptoms of bends.

There was not a good radioactive isotope of nitrogen that we could use. I think we used argon. It seems to me it was xenon rather than argon that they used, a good isotope that had a convenient[ly brief] half-life.

BERGE: I think I've read somewhere that they actually used a number of them such as argon, xenon. I forgot what the third one was.

PACE: Then they used them for all related experiments on the effects of the inert gases themselves. They did quite a lot of work, and it went on after the war, as well as during the war. But I was never involved with them. The work I did in that area was done in the Navy at Bethesda.

How Naval Research Projects Were Decided Upon

BERGE: In the Navy, were you given free range to do research, or were you specific?

PACE: It was a mixture. It was a very interesting system that they had. Roughly half the time, we could do research of our choosing, in exchange for which we were expected to work on practical problems that were referred to the Naval Medical Research Institute for solution by the operating Navy. Many of those were fascinating problems to work. So it was quite a good system, and we did a lot of interesting things.

During World War II, practically the whole scientific community was more or less drafted—not in the military sense, but were given grants by the Federal government to work on practical problems of a wide variety. That's how Donner Lab, for instance, got money from the Air Force to work on the problem of high-altitude bends.

Reflections on Hardin Jones

BERGE: You mentioned Hardin Jones, and that you knew him quite well. Could you talk a little bit about him? We don't have any sense of records of him.

PACE: He became a colorful and controversial character toward the end of his career. He was a physiologist. He got his Ph.D. in Physiology at Berkeley a couple or three years after I got mine, and we overlapped as graduate students. Then he went to work for Donner Lab. John Lawrence had both Hardin and Tobias as his very close collaborators for a lot of the work that was done.

Hardin was really a very brilliant guy. My admiration and regard for him were unbounded. He got into a lot of very interesting areas. He was one of the early people interested in the whole phenomenon of the changes that occur in humans in aging, and the rate at which they die from different diseases. He was one of the first unequivocal foes of smoking, long before it became a cause. He had some of the early data to demonstrate that there was a significant shortening of the life span in smokers as compared to nonsmokers. He did work on bends. He had a theory on the way in which inert gases are distributed by blood circulation to different tissues of the body. Hardin made a major contribution.

Where he went off on the deep end was when the glorious '60s came along, and he was absolute death on student activists. He'd go down to Sproul Plaza, for instance, to the noon rallies. They'd have a loudspeaker, and they'd be ranting away on the steps of Sproul Hall. He'd go up and pull the plug on the microphone while someone was speaking. He was a great big guy, about six-foot four or six-foot five, and he was not intimidated by anybody or anything. I would never have done that in a million years, much as I might have liked to.

Then he got off on the drug thing, and what a potentially terrible thing that was. He got off on a lot of the more controversial sociological phenomena. He had the courage of his convictions and became quite a crusader. He was no longer [a] scientist. Then he got mixed up with the Hoover Institute[35] down at Stanford. I think he left all of his papers to the Hoover Institute instead of to the Bancroft Library, for instance. He was a very interesting guy. He died quite young, unfortunately. I still miss him.

Reflections on John Lawrence

BERGE: Can you talk a little bit more about John Lawrence?

PACE: He was a character. He was one of the brightest guys I've ever known, and a most very capable man. But he was the quintessential absent-minded professor if there ever was one. Little things never bothered him.

One wonderful story: He had to fly to Washington, and he was busy trying to finish writing a paper. He had a thing about using an old-fashioned pen and inkwell on his desk. Hardin was supposed to drive him to the airport to catch a plane and John said, "Just a minute, I'm trying to finish this." Hardin said, "Come on, you've got to go!" It was in the winter, and he grabbed John's overcoat and his suitcase. He said, "Come on, John!" and pulled him away. John gets up and says, "Okay," and he grabs the paper he's working on, the pen, the open inkwell and starts to go out. Hardin says, "What are you doing?" He says, "I want to finish this on the plane." Can you imagine—an open inkwell? Hardin finally convinced him to leave it behind. This was the kind of thing that John would do that you find hard to believe.

But, he was a wonderful man. Really a wonderful man. He did so much. He's called the father of nuclear medicine for a very good reason, for nuclear medicine involves the use of radioactive isotopes in the treatment of patients. He was a major influence who brought about the development of this whole field through the agency of Donner Laboratory. It was a mecca for people interested in nuclear biomedical activities of every kind. He was never afraid to try anything new. He always tried to remain on the cutting edge of progress. He had the ability to pick good people as well as being a bright guy himself. He was the big reason Donner Lab is as famous as it is. It was John Lawrence all the way.

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35 Hoover Institution on War, Revolution, and Peace, founded in 1919 by Herbert Hoover and located at Stanford University, Stanford, California. Hoover researchers conduct interdisciplinary research in the social sciences and public policy.

BERGE: Can you tell me a little bit more about Bob San Souci?

PACE: He's still alive. He went to work, he transferred over to Livermore; better-grade job. I urge you to talk to him. I don't have access to the catalogs anymore [to get the exact spelling of his name]. "Robert San Souci"—two words. Tell him I suggested you call him. I know he has a good memory, and he has many stories that I think you'd find very illuminating from a slightly different point of view from the typical scientist. He was purely a business person.

BERGE: Do you know where he's living?

PACE: I don't know. I'm sure that at Livermore, they'd be able to tell you. It wasn't too long ago I heard something about him. He was doing fine. He may be retired by now, but they'll surely know; there must be a directory or something. I'm sure you can get it from the Personnel Office.

Reflections on Joe Hamilton

BERGE: Did you know anyone at the Crocker Laboratory?

PACE: Joe Hamilton, of course, I knew very well. Pat Durbin.[36]

BERGE: Can you tell me a little bit about them?

PACE: Not really. I knew Joe. He was a Chem[istry] major, actually. He was a little older than I. My fraternity was a chemistry fraternity, Alpha Chi Sigma. I remember meeting him when I was a freshman in 1932. He was already a graduate student. Then he decided to go to medical school and disappeared for a while and then came back. When he came back, he might have had a Ph.D. in Chemistry as well as an M.D. Very bright guy.

He was the first director of the Crocker Lab, which was the home of the 60-inch cyclotron. I didn't have all that much interchange with him. He was enough ahead of me that I was not contemporary with him, as I was with Hardin Jones or Tobias. I certainly wasn't as closely associated with him as I was with John Lawrence, who obviously was my mentor and my father figure.

Differences Between Berkeley's Medical Physics and Biophysics Program

BERGE: One more thing. You mentioned a while back about the Medical Physics program, that there was a program for M.S.s in Medical Physics and Ph.Ds in Biophysics. Can you tell me a little about the difference between the two fields?

PACE: The Medical Physics emphasis was on the clinical side of things, which led to a master's degree, whereas the biophysics program led to a Ph.D.

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[36] For the transcript of the interview with Durbin, see DOE/EH-0458, *Human Radiation Studies: Remembering the Early Years; Oral History of Dr. Patricia Wallace Durbin, Ph.D.* (June 1995).

BERGE: What was the Biophysics [program] for?

PACE: That was pure research on using radioisotopes and radiation effects of things. More typical of a standard Ph.D. program, whereas in the Medical Physics program, the emphasis was on the clinical side of things.

Donner Researchers Who Went On to Serve in Area Hospitals

BERGE: Did you ever have any cooperative work or corroboration with area hospitals?

PACE: I didn't, but certainly Medical Physics did. In fact, all of the nuclear physics departments in Bay Area hospitals are staffed with people who came from Donner Lab, originally. In fact, they're now retiring.

There are a couple of guys around that you really ought to talk to that would give you a lot more insight on medical physics. One is this man I mentioned, David Price, who is the Chief of Nuclear Medicine at UCSF.[37] He lives in Berkeley. A very close friend of mine; you can tell him I suggested you call him, if you like.

The other one is Paul Weber, who was the head of nuclear medicine at the Kaiser Hospital in Oakland and has just retired in the last year or so. He's got time on his hands, and he would dearly love to talk about this, I'm sure. They both could help you a great deal.

Who else was around here from that era? There are others still floating around, but they're all in the East. Guys like Nat Berlin. They'd just be too hard to reach, unless you want to go East and talk to them. Who else? They are the only two that come to mind. Some that have died: Al Gojo would have been a good one, but he's gone.

Radioisotopes He Used in Research

BERGE: So after about the mid-1950s?

PACE: Then I gradually drifted away, as I had more and more my own program. I got away from radioisotopes. I still used it as a tool, but I wasn't in it nearly as much as I had been.

BERGE: What radioisotopes did you find were particularly interesting or useful to your work?

PACE: Carbon-14, of course. Sodium; potassium. I did a fair amount [of work with] radioactive sulfur.

BERGE: What were they good for?

PACE: All of these were used to measure different fluid spaces of the body, the extracellular fluid space; your total-body water, or plasma volume; that kind of thing.

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[37] University of California at San Francisco

Recollections on John Gofman

PACE: I have a feeling I'm forgetting somebody who could be very helpful.

BERGE: I can give you my phone number.

PACE: What about John Gofman?[38]

BERGE: I haven't talked to him yet.

PACE: He was a major player, although he became extremely controversial, as I'm sure you realize. He was good. But he certainly was involved in the early history of medical physics and biophysics. Nice guy. Of course, he's the one who thinks any radiation is lethal. I have never understood his position on that. He's pretty firm about it. It's hard for me to visualize, because there is a lot of potassium in the human body; there's a big isotope of natural potassium that's naturally radioactive. So we have a large amount of natural radioactivity that's part of our composition, and then we get about an equal amount of radiation from the cosmic ray background around us. It's hard to see how increasing this by a tenth of a percent is going to have any perceptible practical effect. Guys like John Gofman say, "Oh, yes, it does." Then they never can answer the question, "When you go to Denver," let's say, "you double the amount of background radiation you're exposed to. Yet, there's no indication that people in Denver have any more cancers than anybody else." They're perfectly willing to forget all that. I've never understood, but everybody is entitled to his opinion.[39]

BERGE: I can't think of anything else to ask you.

PACE: If any questions occur, don't hesitate to give me a call.

BERGE: I want to thank you very much for the time.

PACE: I don't know if it's any help.

BERGE: Sure, any little piece, since we don't have very much to go on these days.

PACE: I was not as closely connected as some others. Unfortunately, most of them are gone. As to projects like this, I'm really glad to see you are doing this kind of thing. It's extremely important.

BERGE: I appreciate all the anecdotes, too.

PACE: It's an old man's war stories.

BERGE: They are things that you would never know happened. ❑

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[38] For the transcript of the interview with Gofman, see DOE/EH-0457, *Human Radiation Studies: Remembering the Early Years; Oral History of Dr. John W. Gofman, M.D.* (June 1995).

[39] Gofman addresses the background radiation in his interview, under the section, "Concern Over Low-Dosage Harm; Public Acceptance of Nuclear Energy."