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

Interview with Raymond Harbert

April 3, 2006
Las Vegas, Nevada

Interview Conducted By
Mary Palevsky

© 2007 by UNLV Libraries

Oral history is a method of collecting historical information through recorded interviews conducted by an interviewer/researcher with an interviewee/narrator who possesses firsthand knowledge of historically significant events. The goal is to create an archive which adds relevant material to the existing historical record. Oral history recordings and transcripts are primary source material and do not represent the final, verified, or complete narrative of the events under discussion. Rather, oral history is a spoken remembrance or dialogue, reflecting the interviewee's memories, points of view and personal opinions about events in response to the interviewer's specific questions. Oral history interviews document each interviewee's personal engagement with the history in question. They are unique records, reflecting the particular meaning the interviewee draws from her/his individual life experience.

Produced by:

The Nevada Test Site Oral History Project
Departments of History and Sociology
University of Nevada, Las Vegas, 89154-5020

Director and Editor
Mary Palevsky

Principal Investigators
Robert Futrell, Dept. of Sociology
Andrew Kirk, Dept. of History

The material in the *Nevada Test Site Oral History Project* archive is based upon work supported by the U.S. Dept. of Energy under award number DEFG52-03NV99203 and the U.S. Dept. of Education under award number P116Z040093.

Any opinions, findings, and conclusions or recommendations expressed in these recordings and transcripts are those of project participants—oral history interviewees and/or oral history interviewers—and do not necessarily reflect the views of the U.S. Department of Energy or the U.S. Department of Education.

Interview with Raymond Harbert

April 3, 2006
Conducted by Mary Palevsky

Table of Contents

Interview with Raymond Harbert

April 3, 2006 in Las Vegas, Nevada
Conducted by Mary Palevsky

[00:00:00] Begin Track 2, Disc 1.

Mary Palevsky: *Right. So when you're looking at compensation, you're looking for both the [Nevada] test site and the Pacific? Is that what your claim is?*

Raymond Harbert: The accumulation of both. There's not separate compensation for each one, but they have to look at the totality of the exposure. [Energy Employees Occupational Illness Compensation].

So when they [DTRA, Defense Threat Reduction Agency] say they're not ready to do the Pacific yet, they're saying they're still working on the—

Methodology of evaluating the amount of exposure that you had, and they're concerned with the radii that you were exposed to. If you recall in our last conversation, I talked about that individual that worked for me that died of cancer, and that it's always bothered me because of the paper I had to write on it. And not knowing enough. I wasn't qualified to even respond to that. All I can tell you is the type of work and where we were.

So you put this claim in, you say, over a year ago?

Yes.

Now that I asked you the question, I'm sorry to hear that.

Yes, they say, we've got your complete work history, we have the records that REECo [Reynolds Electrical and Engineering Company] keeps, the actual radiation exposure.

Right, at the test site.

At the test site and in the Pacific both.

And in the Pacific both. OK.

But they were rudimentary in those days, and a lot of the times you didn't even wear film badges. You were in low-level radioactive areas and you didn't even wear them.

You didn't wear your film badge, you're saying?

Yes. And when I went into those islands after the Bravo shot, all you wore for protection were booties. And when you came back and when you got aboard the [USNS *Fred C.*] *Ainsworth* [AP-181]—they had a barge there, a RADSAFE [radiological safety] barge—the LCM you were on tied up to the barge and you went in and took a shower, took the booties off, got back into clothes and went on back upstairs, boarded the ship and went up and jawed with the guys. And most of the people did not go ashore and stayed on board. Later, as we got ready for the next shot, I was sent over to the [USS] *Bairoko* [CVE-115], which you couldn't spell.

Thanks for reminding me.

I got you the correct spelling.

I know you did.

From there we flew out on helicopters to ground zero and refueled a generator just before the shot. The islands were already radioactive from the Bravo shot, and it's because they had to get the shots off, you had to go in there; I came back one day and they said, [You] can't return anymore, and by that time I had recorded over about 4.5 roentgens {REM, Roentgen Equivalent Man], I guess, somewheres up in there, 4.8 roentgens. [As of 2007, NIOSH estimated exposure of 10 REMs minimum].

Now at the time that they tell you that you can't go in anymore, and you leave, I'm trying to connect with what it's like then and when did you actually begin to get skin cancer?

About a year later.

Really! That soon.

Or maybe two years later. I started developing it—the first thing I developed after I left there was fungus in my hands. But we were in the tropical environment and everything. And I fought that for two or three years. Then, I guess it was later than that, I guess about five or six years after that. And it started on my back, not my face. And I had some, and then I got some on my arms in Tulsa. I had those removed, but I can't get records for them, because records only **[00:05:00]** go back seven years. I had the same doctor that removed the last four, I had four removed about four months ago here on this side here.

The side of your head.

And he had removed about three or four about ten years ago, but he doesn't have any records of that because he moved and the records had been destroyed. He only has to keep them, I think, for five years or seven years. But he did have records on one other that he removed for me, plus these four. I had two removed by the Cancer Center over here; and I had a big one on the back of my neck removed by Doctor Julio Garcia, I don't know whether you—he's a plastic surgeon, and he's the one who put that guy's ear back on that got bit off in the boxing match. But I wrote to Tulsa where I had quite a few removed back there. They didn't even have a records center back there and I can't find any records there. I had some removed in Burbank or Bakersfield [California]. I couldn't find them there. I had two cancerous growths removed in San Clemente [California] and I can't find any of them there. And all I can send them is the documentation I've got and I sent them a letter saying, you know, I had about another thirteen or fourteen removed and I don't know. But they crop up on me all the time. I think I'm getting another one right up in here but—

On your forehead. Wow.

But anyway. What I thought—you haven't started yet, have you?

No.

What I thought is—

Well, I did leave that on, but let's pause it if you want to—

OK.

[00:07:09] [Pause]

[00:07:12] *Now we're going. All right.*

My assignment with Holmes and Narver in 1957, '58 after I had left Nevada Test Site [NTS] was as chief project engineer for Lawrence Radiation Lab [Lawrence Livermore National Laboratory]. In that function, I handled all the criteria and converted it into construction drawings and other types of support that Livermore needed. I worked with an engineering group up there headed by Cliff Bacigalupi and Bob Petrie. And I would go up there for meetings. The project I immediately was involved in was the next series of the tests in the Pacific, which was [Operation] Hardtack.

Hardtack I, I guess.

Hardtack I, and we went out there prior to the first shots to make sure everything was coordinated and they had all the support that they needed. So I went with Cliff and Bob Petrie and a couple of the Livermore people to the Pacific. I was there for about ten days. I returned with **Rube Alvey**, our vice-president, engineering at Holmes and Narver. When we got back to Los Angeles, I was called into Chuck Kelly's office, the vice-president of operations, and Chuck Kelly said, We would like you to head a new project that Livermore has. And I asked him what it was and he said, A program that was near and dear to the heart of Dr. Edward Teller and it was called Plowshare, peaceful applications of nuclear energy, and because you know all the engineers there and most of the scientists, we think you're the ideal man to handle this, so you'll be chief

project engineer and program manager for Plowshare for Holmes and Narver, and you leave tomorrow to go to a meeting at Livermore, at which you will represent the company. They're getting ready for the first project, which will be in Alaska, and it is called Chariot.

So I packed my bag and went up to Livermore and was briefed on what was happening and what the schedule was.

A little more I learned up there was that they wanted me to participate in what are called **[00:10:00]** Blue Sky Conferences. These are conferences that are not limited in scope or practicality but could use the phenomenology of nuclear detonations to the benefit of mankind. When they discuss the phenomenology, they're talking about pressure from the explosion, shock waves, they're talking neutron bombardment, they're talking about the immense heat that comes off a nuclear—capturing those elements of the nuclear detonation and using it to help mankind. It really thrilled me because I had come from a war [WW II], I was involved in the Cold War for nuclear testing, and now I could do something really meaningful for mankind, and I was thrilled by it. It was probably the most rewarding assignment I've ever had in my life, was working with it, and having a chance to work with Dr. Teller and his people who were great.

Some of the programs in the first Blue Skies Conferences they were talking about were developing a canal across the Boothia Peninsula which is in the northern part of Canada, which when completed would open up the Northwest Passage to shipping. That was a possibility.

Another program was at the atoll of Kapingamarangi in the Pacific, and the problem they wanted to solve there, Kapingamarangi Atoll has no deep water passages to allow ships to enter the lagoon and is pretty much locked away from the sea. The Polynesian's main product in dealing with the commerce of the world was copra, the fibrous husk from the coconut trees there they would harvest the copra, but then they would have to lighter it on the open seas out to the

ships. A lighter, it's like heavy canoes or some other thing to take it from the shore to the ships at sea. The problem with that was that storms would come up while they were out there and many of them were getting killed, so the concept was to open up a passage in the reef which would allow the ships to come into the protected harbor, and then they could onload there.

Another one was—I didn't get involved in this, but it was an early one—opening up the Nile. The Nile was not navigable up too far, and this was before the Aswan Dam was built, and they were talking about using small nuclear detonations along the way to open up the rapids so that commerce could go up and down the Nile River.

Those were the type of projects that were discussed in Blue Sky. My job was to work with the engineers from Livermore and the scientists to see what the practicality would be and what the support they would need to carry out those projects.

As it turned out, Chariot was the first project, and I was told we were to leave in about a week, ten days, and to go home and pack and get everything ready. I flew up to Seattle [Washington] and I got on a plane and I was with Dr. Teller and his wife. The flight was from Seattle to Anchorage. And I had a very interesting conversation with them. It was enjoyable. You can't—when you're in the presence of a mind like his, you're just overwhelmed—so I did more listening than I did talking.

When we got to Anchorage, Teller left for a meeting with Mike Stepovich, I believe that's his name. He was the governor of Alaska at that time. That was while it was still a territory. And he flew over to meet with him at the capital at Juneau. In the meantime, the rest of the **[00:15:00]** entourage I was with, Sam Howell was with me from my company and there were a couple of scientists from Lawrence Radiation Lab and Cliff Bacigalupi, we met with the [U.S. Army] Corps of Engineers in Anchorage and briefed them on what we were doing.

The next day, I flew with that group to Nome.

Let me stop you for a second. I want to go back to the conversation with Teller because you said—I'm just curious. What were you all talking about or what was he talking about?

Everything.

Everything?

Yes. Range of subjects which I had never—I was curious about, but had never—because my background as an electrical engineer tend towards the practicality of it. His mind worked to basic matter and how it worked, things far beyond things I'd ever contemplated. And so this opened up really a new world for me.

When we did fly up to Nome—one of the interesting things that happened, we were on I think it was Alaskan Air—there was an Eskimo woman going back to Unalakleet, and she had been sick; they lowered the seat back and her head rested in my lap all the way to Unalakleet. And we left from Unalakleet and then went into Nome.

And the next day in Nome, Dr. Teller spoke before the Chamber of Commerce. And it was interesting. He talked about the project that we were contemplating, and of course a lot of people were sitting there watching him. Anyone who has been around Dr. Teller, when he speaks—he's got large dark eyebrows and his eyebrows move up and down, and you have a tendency to lose your concentration on what he's saying, watching his eyebrows. But they did ask some interesting questions. One of the questions dealt with, could they use nuclear explosions to surface-strip on iron ore fields? Out on the Seward Peninsula, there's apparently a large ore field of iron, and to be profitable, the topsoil has to be removed. I guess it's forty or fifty feet deep till you can get to the ore, and then they would mass-mine the ore. And so he

discussed that with them, the businessmen there, and said, that's real practical, they could, that's something quite conceivable.

From there, we flew up the next day to Kotzebue and from Kotzebue we got on separate planes and I went into the site at Cape Thompson. Dr. Teller went on to Point Hope. And at Point Hope, he spoke to the natives there, told them what we were going to do, and then he flew back to the camp site and we had a meeting there and he discussed his conversation with the governor of Alaska. And the governor would question whether it really made any sense to build a harbor on the northwest coast. One of the requirements of Plowshare was that you could show that the project was economically feasible and would bring economic benefits to an area. Dr. Teller apparently had told him that there's a lot of coal in the northwestern quadrant of Alaska. Outcroppings showed that between the Point Hope area on the edge of the Alaska Naval Petroleum Reserve that could be profitably mined and brought down and shipped out of a harbor there at Ogoturuk Creek where we were contemplating this harbor.

[00:20:00] The Governor asked Dr. Teller, Could you build a canal across the Alaskan Peninsula? One of the problems we're having is that the fishermen go into the bay up there and they catch their harvestable crop and then they have to go clear around the peninsula and come back up to where the fish processing plants are. And a lot of the seamen were losing their lives because it's very treacherous seas up there. And if you could build a canal across there, it would shorten their trip about 400 miles.

So Dr. Teller turns to Sam Howell, my boss, and he said, We'd like Ray and Cliff Bacigalupi to go down, fly down to Cold Bay, and at Cold Bay, go up to Portage Pass, is where they were contemplating it, and run a preliminary survey, even a fly-through, and evaluate the area.

So that was our assignment. We left the next day, flew into Nome, caught a Wein flight to Fairbanks got in there late in the evening, and we rented a car and headed for Anchorage. And from Fairbanks to Anchorage, I guess, is about 400 miles. We got down as far as Paxton and we had to gas up, and it was about midnight then. We were tired. We went in and had a cup of coffee at Paxton, gassed up and we started down the highway. We had driven about twenty minutes when Cliff thought the hood of the car was loose, so we stopped. And I said, Well, I'll get out. He was driving. I'll get out and I'll put the hood down. So I got out and put the hood down, but I left my door open, and you had the lights on in the car, and there must've been a million mosquitoes come into the car. And so I got in, and we swatted mosquitoes damn near all the way to Anchorage. That car must've been a real mess when we turned it in.

When we got down there, we went to Reeve's Airline [Reeve Aleutian Airways], checked in first at a motel so we'd get a little sleep, checked with Reeve's Airline and made arrangement with [Bob] Reeve to fly us down on the next flight, and also to arrange for a Grumman Goose to meet us there and fly us through Portage Pass, which is about—

What is that, a Grumman Goose?

That's an amphibian airplane.

Oh, it's a Grumman?

It's a pontoon plane. It's a seaplane. And that would allow us to land at each end and we could take a look at it and where we need to. It has wheels on it which can land on either land or sea.

And so we flew down to Cold Bay, and our pilot was on the next segment, next flight to come down. Cold Bay was a refueling station for Northwest Orient Airline. So they put us up. Cold Bay had served as a military base during World War II and so we stayed in a room in an

old barracks that had two cots in it and had a cord with a light bulb on the end of it. And of course Northwest had a kitchen there, and we were able to eat at the kitchen. Of course we had to pay for it but we were able to eat there.

We waited about three days there, and our pilot never showed up. The flight he was coming down on had engine trouble; they turned around and went back to Anchorage. We never saw the guy. So after about three days, Cliff and I decided we had to get out there, so we went down and they made arrangements for us to get on the next flight going back up the Alaskan Peninsula to Anchorage. **[00:25:00]** And it stopped along the way and picked up—they were building the White Alice [Communications System, WACS] stations, they're the radio stations, and also the radar stations. We were in the Cold War, as you recall.

And so we landed at Point Moller. And there were some workers who had been on contract for six months, and they'd thought they'd get on the plane, but the plane was full. And Bob Reeve was on the plane and he wouldn't let them kick us off. He knew we were something, but he didn't know what we were. We couldn't tell him we were associated with the AEC [Atomic Energy Commission] because everything was hush-hush at that time.

Even on Plowshare.

Oh, yeah, you still had to have those big clearances and everything else. So anyway we ended up flying there and then back to the main forty-eight states, and began planning to return to Cape Thompson shortly. I had a project engineer assigned to the project. His name was Ralph Chase and he was to run Chariot on a day-to-day operation.

So let me understand, this other business about the canal just gets put on hold because you guys didn't get out to look at the areas you needed?

Yes. [But later Cliff prepared a project plan and statement of work for Holmes and Narver support.]

And now we're back on Chariot.

Yes, we wrote a report on it, but that was the extent on it; and we said [that] another survey trip will have to be made. Our trip was fruitless, but this is what we found out, and we brought back maps of it and all that sort of stuff so it'd be easier for the next group.

We returned to Los Angeles and began to make some plans. We had to get a company that could cater for us up there and had a guy that knew how to build camps and tents and all that sort of stuff, and I forget the company's name. I think it was Hutchinson or something like that but I don't recall it in detail. And we flew into Kotzebue and he met us there, and then we flew into Cape Thompson. We conducted our survey. We had been asked to survey the entire Ogatruk valley or a large segment of the valley, prepare a topographical map where the harbor would be built. We also conducted a hydrographic survey of forty square miles off the mouth of the creek, four miles deep and ten miles long along the coast.

When we got there, I decided that the camp be set up on a little island in the creek. There was a berm that would protect us from winds coming off the sea. I thought in my stupid mind that was a smart thing to do—as many books have been written will tell you that we got flooded out—that the rains came and the rains whooshed and we scrambled and had to relocate our camp. And of course, being the guy responsible, the old-timers gave me a few laughs, and they remembered it.

Yes, they never forgot, right?

That's right. So it's interesting though how you conduct a hydrographic survey four miles at sea and ten miles long, and you've got a survey crew. I hired a tug run by Eskimos down in

Kotzebue from B&R Tug, and we got a hydrophone put on it with sonar attachments, **[00:30:00]** and we set up a survey crew along the ten-mile stretch of the coast. And what we would have them do, we had walkie-talkies on both shore and on the tug, and we would have a level pointed on the azimuth we wanted, and then we would talk the captain into staying on that line. At the meantime, we had another survey instrument up there and we would cut the angle, and as we cut the angle, he would give us a reading on the fathometer. And so from that, we were able to plot it.

The next summer when we came back up, we had a U.S. Navy icebreaker come in, and they ran a more detailed hydrographic survey. That was overlaid our survey, and we married the two of them, so we had a pretty good comprehensive. But that was the next summer of ’59.

That phase of the program ended just as summer ended there in September because the sun begins to disappear, and of course that was a phenomenon we’d never even anticipated, never thought of because when we first got there, the sun went around us. You could see it twenty-four hours a day. We actually had snow on the fourth of July up there. But it was an interesting experiment.

When we left, we flew down to Kotzebue and then we flew from Kotzebue into Fairbanks. And an amusing incident had occurred. As we got on the plane, the cook from Rotman Hotel, which was the only hotel in Kotzebue, was getting on. She was a Norwegian lady and she was their cook. I believe her name was Olga. And she had a bowl in her arms with a cloth over the top of it. And Ralph said to her, `Olga, you got a bomb in there?` Of course that sent the crew crazy. That was the wrong thing to say. They forgave him. But what she had was her sourdough starter. She was taking it down to Seattle with her, and I mean I don’t know how old the starter was but it kept many generations going.

How interesting.

We got home and our task when we got there was to plan for the next year. When I got back, I was called into my boss's office and he said, Ray, I want you to sit down with Hal Perla. He's going to brief you on the potash mines down in Carlsbad, New Mexico. [That was my introduction to the next project, Project Gnome.]

Now "back" is in California, right, at Holmes and Narver.

Yes. Down on Broadway. The office was on Broadway at that time. And so I went in the conference room and for four hours I picked his brains over how mine shafts were sunk in that area, the problems they had, because one of the major problems were the aquifers cutting across the area. The project as conceived, and I talked to Lawrence Radiation Lab about it over the phone, was to set off a nuclear detonation in an elastic medium, and in so doing you would create the heat. In this case we're looking at salt; and they go back to the Rainier, what happened in Rainier. Rainier when you have this nuclear detonation, the first thing that happened was **[00:35:00]** that it blows a sphere, the area is a sphere; and at the Nevada Test Site, because it was in volcanic tuff, it became glass, and it supported itself with the pressure inside until it began to cool and the pressure dropped, and then it collapsed and did what's called chimney. They took that type information and applied it to a salt mine. And when that would happen you would have this sphere develop, the back would break and drop down there into this molten salt; then you would put in two drill holes and you'd pump in an inert material from one area so it wouldn't affect the salt, and take it out through the other, run it through a heat exchanger, and use that heat exchanger to generate electricity and light a light bulb or whatever you want to do with it, a form of converting nuclear energy to electrical energy.

So off I go the next day. Flew into El Paso and then flew up to Carlsbad [New Mexico] and met up there with the project team LRL [Lawrence Radiation Laboratory], AEC and the U.S.

Bureau of Mines. We put out for bids at drilling a pilot hole to log the geology. We had about three different bids. The lowest bid was bid by a local florist, a guy who owned a floral shop there in Carlsbad. He proposed to use a churn drill rather than a rotary drill. And we went to the AEC and said, We don't think you should award it to the low bidder because you're going to have trouble maintaining the clear passageway because a churn drill will go towards the path of least resistance. And the AEC said, No, you've got to go with the lowest bidder.

So we got this churn drill out there and we kept banging away at it, banging away at it. This was late winter at the time we were down there. I kept getting pressure from Livermore, from Cliff Bacigalupi and Chuck [Charles E.] Violet to get the hole completed, and we weren't making that good a progress. So I called my boss Chuck Kelly and said, Chuck, I'm going to have to pull this guy's contract. Have our lawyers take a look at it and make sure I have authority to pull it, then we can pull his bond on it. We had to pull his bond.

So I got the OK to go ahead and pull it, and went up to Roswell [New Mexico] and hired a regular driller, and then I went back with my project manager. My project manager there, his name was Mike Bickers, and Mike and I went up and wrote a contract on the back of a piece of paper and had this guy move in within twenty-four hours. Then we went out to the field and told this churn rigger, he's got eight hours to move his rig off.

There was a fallout to this. The florist challenged my credentials because I was an electrical engineer, not a drilling engineer. So he went to his senator in Washington [D.C.]. The senator in Washington then contacted the AEC and contacted my bosses. And so the senior vice-president wrote him back a letter. And of course in the senator's letter he'd cited all of these, I didn't know what the hell I was talking about. And he stayed away from the technical aspects of

it and said I was the senior manager there and I made a management decision based on a contractual document. End of conversation. And that was that. That was the last of that.

[00:40:00] *Now a couple of questions. Now this is Gnome, right, this is—*

This is called Project Gnome, yes.

So just on the technical aspects of it, they're not going to bring drillers that they know what they're doing down from Nevada. You have to hire the local contractor?

We had to hire the local contractor, and this was a precursor to sinking the shaft, because you've got to know what type of material, where the aquifers are, as you go down so you can plan your mine shaft.

There was one other political ramification. There were seven potash mines in the area. They were concerned collectively about a nuclear explosion in the area which could drop the backs of mines, because they do pillar-and-post mining there, and they were afraid that the vibration would knock it. They were also concerned about the Carlsbad Caverns. So that came into play. We met several times with the engineers from the mining group and we think we succeeded in finally allaying their fear, but they fought it as much as they could.

Now at that point, do you feel like you have supporting engineering or science that can answer those questions, or is it really an unknown?

It's an unknown. They knew the size of the yield they were talking about, and they knew how it diminished as you got further and further away from ground zero.

There was another series of problems in there. That is oil well country, too, and there were oil wells in the area, and they were concerned about temporarily shutting them down during the detonation. The report I got afterwards, because I left the project before the detonations ever

occurred, was that one oil well sealed up, or at least lost its productive capability for a period of time. None of the mines were damaged, and none of the stalactites fell.

In Carlsbad Caverns.

[Recording paused and resumed mid-sentence]

—project scientist on Chariot.

Gerry [Gerald] Johnson was the project scientist on Chariot.

Scientist and test conductor. And on Gnome it was Chuck Violet. I always worked with the same engineers. And this is one of the reasons I thought I fit a spot in your story that no one else could handle.

Right. It's true. That's great. Because you have that aspect and working with both Johnson and Violet on these things, it's great.

Completely different personalities.

Well, you know, I didn't ever get a chance to meet Gerry Johnson because before he died he was fairly serious with Alzheimer's [disease] when I got into this. So what was he like?

He was a little more dogmatic. I worked with him later at Atomics International. He'd also worked for the Department of Defense [DoD] under [Harold] Brown, when Brown left Livermore and went up there. He went to General Atomics in San Diego, and what he was doing for them, he took the concept of Chariot as an excavation tool; he looked at this same explosion, nitrate and oil—that was used to bomb the Oklahoma City there—used that because it is slow-acting, it has a lower frequency in reaction, and using it as an excavation tool, he looked at Florida and building small harbors and development down there. And that's where—on the commercial, commercialization of what he learned. And that was about the last I **[00:45:00]** heard of him. I made a couple of trips for him and wrote a couple of reports for him. He tended

to be gruffer. He was a shorter, heavier-set—he wasn't real heavyset, but he was stockier than Chuck. Chuck as I knew him was lean and mean. Lean but not mean. He has one of the nicest personalities that I'd encountered. It was really a pleasure to work with Chuck. We stayed in the same hotel down there in Carlsbad, and every night we'd get together and have a cocktail or something, and it was a lot of fun.

But this was by far the most rewarding thing that ever happened. Well, I can't really say that. It was as rewarding as anything.

Let me ask you a couple of questions about the general issue of Plowshare, and maybe you can tell me a little bit about your disagreements with Dan O'Neill, [author of The Firecracker Boys, *New York, St. Martin's Press, 1994] but first of all, when you're thinking about it as an excavation tool, because we were talking about radiation effects, is that something that's factored in as you're beginning to think about these things, possible effects?*

Bob Petrie who was one of the engineers and myself made several trips. We examined this aspect of it. We were concerned about reducing drilling costs, from the economics. When we were drilling holes earlier, we used oil field technology. You used a thirteen-inch bit and you'd drill down, and then if you needed a larger hole, you'd come through and you'd ream it and you'd ream it again and ream it again till you finally got the size. But the deeper the hole, the longer it took to recover it because you'd recover a forty-foot section, then you'd—and so the return time grows. So what they came up with was the idea of doing what they call full-phase boring. Maybe you make a pilot hole and then you go to a forty-two-inch and you muscle it out, and you do that by putting—and you got to keep it straight, you can't move back and forth, so you put heavier weights on it, so you need a very large, very strong rig to do some of this drilling.

So we went down to Hughes Tool, Bob and myself, down in Houston, and we met with them and we told them the problem. Well, immediately we encountered a legal problem. They did not want a contract with the government that had any government things tied to it. Any contract I issued would have to carry forward the government, Davis-Bacon Act and all the other acts as part of the contract. So they said, We'll work with you, but you've got to work through Hugh B. Williams. Hugh B. Williams was a drilling contractor, manufacturer in Dallas-Fort Worth area.

So we said, Fine, we've got no problem, but we need your technology because you're the ones who developed the tricone bits and worked on that aspect.

So we worked with them, and ultimately, if you've gone through the [Atomic Testing] museum, you'll see some of the full-face bits we've been—and that technology developed to where you've got full-face boring machines out here at Yucca Mountain now.

Now in addition to that, the other element is fallout. When you have a nuclear detonation underground, you want to contain everything. How do you do that if you drill a hole down through the center of it? You immediately encounter two problems. What if you get your canister down there with a device in it, and it doesn't fire? You can't leave the device, so you've **[00:50:00]** got to recover it. How do you recover it? You've got to have something that is pumpable and you can remove the fluid from around it. Historically in drilling operations, they use drilling fluids. And in our case, we're looking at those drilling fluids as being what we call stemming fluids. What you want to do with a stemming fluid is pour the stemming fluid after you've got the device, the canister in place with all the instrumentation and the device and everything. You want to be able to pump it out, but you also want to simulate the weight of the overburden right around it. So if you're down 500 feet, it's got to feel—the device has to think

you've got 500 feet of soil over it. So what you do is you beef up the stemming fluid. So we went with Baroid [Industrial Drilling], that's a drilling fluid company, and we told them we wanted to develop a high-density, heavyweight stemming fluid that's pumpable. And so they came up with the idea of adding galena ore. Galena is lead, lead ore. And so we simulated it. Now that allows you to put the full-face bit down there, get your device in place, canister in place, put stemming fluid over the top of it, you shoot it without anything escaping. Now does that answer your question?

Yes.

And that was our job, to solve those type problems.

What about general concerns in the population about things being radioactive? Did you confront any of that?

Well, OK, Chariot. The second year we went up there, one of the things that we did was fly to the various villages. We flew to Nome. We took scientists, Cliff Bacigalupi and myself, and a public relations man, flew to Nome, or Point Barrow, excuse me, and briefed the native elders there. We then flew to Point Lay, to Wainwright. We met with the military that have an outpost there at North Cape. I forget the name of it, I can look it up on a map, but there's a military base there [Air Force Distance Early Warning station]. They were briefed also at Point Hope, down at Kivalina, and we flew out onto the Seward Peninsula to a little village called Shishmaref. It appears on the map.

And we were in a twin Beechcraft chartered from Ween Airlines. And we landed on the beach there. And as we landed, the pilot put the flaps of the airplane down and the plane hit a tree stump that was sticking up and he punched a hole in the flap. So we get out and we pull it off the tree limb that had punched the hole. He [the pilot] goes up to the village, to get whatever

he needs. In the meantime we're briefing the people on it. He comes back and he's got a can and some adhesive tape, some medical tape. The bottom part of the wing had, I guess it was the metal on the—no, the metal was on the top part; and he took this can, cut it open with tin snips, punched four holes in it and sheet metal screws, and screwed it down. On the bottom where the fabric was, he put this tape. And away we went!

But we did brief the Shismaref natives and the other Eskimos up there. Now also there was a scientist or a psychologist by the name of Don [Charles] Foote.

[00:55:00] *Was he a geographer or geologist or—[a human geographer?*

I don't—in the book that—[Firecracker Boys]

I read about it, yes.

If you've read the book, he died in Fairbanks in an icy night after he'd been out drinking, and this was one of the things I objected to O'Neill's book. He says that the AEC was behind getting him killed, which is as far from the truth, at least from my perspective. You know, you don't have to read everything nefarious into everything, although I don't trust some of our administration today, but you didn't have to read that in it.

Right. But he [Foote] was critical of—

He was critical. He and two other scientists, a mammalogist and one other, sided with the natives and aroused the natives to fight it. And ultimately, the project was killed over those sorts of arguments. I can understand their concern. I would've liked to have seen them be more open-minded. I would want to see that we were more positive of our position. But apparently we were, you know, the politics ended up playing into it and it was cancelled. And these three scientists were at the heart of it.

Right. This is a really interesting area, Ray, considering your concerns about what happened to native populations in the Pacific with the nuclear detonations, and then—[see Ray Harbert interview 10/20/2005]

Yes. But that was completely different. And the difference was that in the Pacific the shots were above ground. The surface area was contaminated. And I agree with what they did and the extended period of time before they tried to resettle them, so that the decay factor in the radiation had been able to minimize; the one island that was the worst, they took and concreted over the top of it. But what we were doing up there, we were some thirty-three miles from Point Hope, would have been completely contained. From an engineering point of view, we sincerely believed it would be contained and little or no radiation would escape. That's what we believed.

Right. And there would have been this benefit that you were saying.

There would have been an economic benefit to the natives in that area because they would've been involved in building a road up to the coal fields, and the actual transportation of the coal down to the harbor for shipping to Japan, where they were talking about the market.

So that was one of the things that you disagreed with Dan O'Neill and his book about.

Yes, because in his book, he took after Teller. I'll defend Teller to the day I die. Now that's a different—we're on the opposite sides of the pole. Another area I disagreed with him on significantly was that he only—

[00:59:20] [Pause for telephone call]

Where were we?

Oh, my disagreements with—he made no attempt to contact Bacigalupi. He said there [in letter from Dan O'Neill to Ray Harbert] that he read one of Bacigalupi's letters. I think that's what he said in his response to me. And he said he apologized because he didn't understand the

motivation. My motivation, I'd come out of the war [WW II], **[01:00:00]** I'd been part of the Cold War, and now I had a chance to do something for peaceful—and it really rankled me, and I still have bad feelings about him impugning our motives, because I took it as a personal affront.

So some of the criticism of Teller on that, that I know about, is that it was just a way to keep working on nuclear stuff during the moratorium.

That is what he claims in his letter to me, that documents show that that was Teller's motivation. I think Teller used that to gain government support for the—

Used the fact that—used what? Just—

The fact that he could continue to develop and improve devices, make—see, once you had the first detonations, like the Bravo, now you have to make it deliverable, and you have to make it smaller and smaller, and you need to do that. So Teller saw a need for continual improvement in that area. But I don't think that gives you a right to impugn his motives. I talked to him on the phone about the detonating that device on the moon, which I told you about. That has nothing to do with a weapon of war. It has to do with an excavation tool. A new Panama Canal across the Colombian peninsula, which was one of our programs, a program that Cliff Bacigalupi and I worked out after a Blue Sky Conference at Livermore. Teller asked Cliff and myself to go in and do some preliminary calculations. Well, what are we looking at? We went in and we took the cratering information from a British shot on Christmas Island, those that we knew caused craters, above ground and below ground, and we took all the cratering information we had and came up with a unitized—what does a one-ton TNT equivalent buried at different depths do? And then you extrapolate that. And so we made curves and everything else, and so we started figuring out—we took a map of the Colombian peninsula and laid it out over there, what we thought, you know, it's a WAG (wild-assed guess). OK. And preliminary, that's what you do,

you start from that until you work it out and you get surveys and all the other engineering information. And there wasn't anything in that, that I could observe, from Teller's point of view, that "we're doing that because I want to develop more nuclear devices." Going up to Vintage at Rifle, Colorado, extracting oil from oil shale. That has nothing to do with developing a device. You find a device you've got to use—and that just burned me up. I'm sorry. I'm still angry over it, because I think he [Dan O'Neill] impugned and he was part of the impugning of Teller. And all I saw his book was, was an apologetic thesis, and I've used those words, an apologetic thesis for three scientists. And granted there's a place for environmentalists. I agree with them. I'm an environmentalist myself. But what you do is you protect the environment. You use all techniques available to you. But don't say engineering is the scourge of the earth. Now I don't know whether that makes sense to you or not but—

You're explaining yourself really well. Let me stop here for a moment. I need to make a track.

Yeah.

[01:05:02] End Track 2, Disc 1.

[00:00:00] Begin Track 2, Disc 2.

Recording resumes mid-conversation

Yes, just explain what that is.

OK. I was working for General Dynamics, Astronautics Division in San Diego.

About what era is this? What year, around?

Sixty-two, sixty-three. And I got a call from Cliff Bacigalupi, and he had Dr. Teller in his office, and he said, `Dr. Teller wants to talk to you.` I said OK because I'm now in the rocket business.

So he said, `Could you work with us on a plan to help develop water resource on the moon? We believe there's water underneath the surface, or`

there's oxygen and hydrogen which will end up as a water source for astronauts. So what we would like to do is look at one of your missiles or a combination of missiles, because we had the Atlas, several Atlas and we had the Centaur, which was a liquid hydrogen fueled missile, an upper stage. And he explained to me that what they would like to do is have a nuclear device delivered to the area of the moon, it fired into the moon, with a delayed fuse, and that it would penetrate to a predetermined depth and then explode. He felt it would be sufficiently self-contained, given that theory, to explode under there and coalesce or release any water into a reservoir, an underground sphered reservoir. That was the concept.

And I said, Yeah, I'll go to my boss, Jim Dempsey [President Astronomics Division, General Dynamics] and tell him what you'd like to do and we can put together a support program for you. That was that.

And did you do that?

I took it up—it went out of my hands from there. I got it into the system because I was in product support. I was the Director of Customer Service at that time.

But do you know if it actually went anywhere as far as planning?

No. Probably a couple of reports were written, and I don't know of anything beyond that.

So you disagree with the conception of Teller doing these things because he's basically a weaponeer and wants to have an excuse to continue to make weapons?

Yes. That might've been used as an excuse to help support a program like we were going in because when we went into it initially, it was just to prove that it was practical, controlled detonation to develop a configuration; I guess we were into the Chariot program about six months or so when we were told, Now you've got to prove that there's an economic benefit from it. And it was back in California then. And we got involved with a company in

Minnesota that made a study on, can you build a road up there in that type of permafrost and go up there and then mine the coal, ship it down, and then transship to Japan, and therefore pay for the cost of building the harbor.

I'm going to make a statement and you tell me if I'm getting this right. I want to put this together in my own mind to make sure I'm understanding you. There is Plowshare which is using basically nuclear detonations for earth moving for possible benefits to various regions.

That's one. Yes.

And that sometimes to justify that, there might have to be also some statement that it had a military application, is that what you're saying? You disagree that Teller's purpose was weapons but he might have used that as a rationale?

[00:05:00] Yes. Exactly. They could use stockpile weapons as a source of detonation in Plowshare, or they may have to change the shape of it, but that is not for military application. My God, look at the tests they've run up there [at NTS]. Why would they need Plowshare?

Well, it was the moratorium was going on, I guess, too, was the other issue.

But the moratorium was only for above-ground testing. We shot off darn near a thousand shots underground in mesas up there.

Oh, I see what you're saying. OK. I was talking about the actual '58 to '61 moratorium where there was no testing.

Yes. But sure, he could have—I mean that could have come up in a conversation, but I don't believe it was designed, as O'Neill put, really as a cover.

So you see Teller more as—how would you describe what made him be so interested in these kinds of things?

Well, look at Teller today. One of latest, last statements I heard was that he now rues that he went with the hydrogen bomb.

Really.

Yeah, I read that somewheres not too long ago, that he thought—and so then he agrees with Oppenheimer, because Oppenheimer fought it. You know, that's my feeling.

You want to pick up—I think we should—

I have one more question about this before we go on, which is about the future, because Plowshare was discontinued, do you think, when you look to the future of human civilization, that this kind of thing will—that nuclear explosions will be used—?

Be revived? Yes, I do. I do. I don't think mankind cannot use all sources of energy. It's like you hear a lot of people talking about nuclear power plants. I am for nuclear power plants, provided that you put enough redundancy in it where they're safe, that you train your crews, and that you have provisions for disposing of radioactive material. There's still talk about, and some people say it can't be done, but they've got to look at every way they can to desensitize radioactivity and make it neutral, through a chemical process, through electromagnetic process, whatever process they need, but they're going to have to solve that problem, and it's the same thing with Plowshare. I think I'd be a good advocate, but I get angry at times and that doesn't work.

Well, everybody does. A good advocate for?

Well, I think—see, I've heard people say engineering has been the biggest scourge on the earth. It's caused the biggest change to humanity.

Oh, I haven't heard that.

Yes, because I mean without engineering and engineering concepts, you could never have got into the Industrial Revolution, you know, the building of cars. I mean a housewife doesn't go out

and build herself a car. It takes engineers and people with engineering minds to design it. And each engineering project is a stepping stone to the next one. You take as an example in the rocket business, which I can speak of, once you started going into the concept of space flight, what you had to do, you're limited by the lifting capability of your primary rockets. So what that meant is that you had to miniaturize the weight of the payload. When you start doing that, you start **[00:10:00]** forcing things, you develop new things. As an example, I have a pacemaker. About twenty-three years ago, I had—no, longer than that ago. Anyway, back in that period, I had to have a pacemaker put in. They put in the first one and my skin reacted to it. Put in the second one and my skin reacted to it. So they're going to put in a third one and a doctor convinced me to put in what's called a rechargeable one. I would have to recharge that once a week, I guess, it was. And in the mean time between failure was fifty years by their calculations. It failed in about ten years, and the reason it failed was not the unit failed, but the leads failed. The resistance, the material there failed, was not strong enough. There were only 2,500 of them made by Pacesetter [Inc.]. The doctor who removed that when mine failed has it mounted in his office now as an antique, but there's also one in the Smithsonian Institute, National Air and Space Museum, and that is because it became a fallout of space travel. All pacemakers really evolved, the electronic pacemaker, from the monitoring of astronauts.

So, you know, engineering plays this tremendous role. And every stepping stone. And when I was talking this miniaturization, you remember back when you had these tubes that you put in your radio and stuff. Now it's a little chip. When I was with Astronautics Division at General Dynamics, we had a hybrid computer in there. It was a hybrid analog computer and it was used to configure the settings on missiles and control missiles when they're making like a

shot for the moon. And it filled a room bigger than this house. That little computer I've got in there, that desktop, has every bit as much or more memory that that thing.

I was Director of Customer Service for General Dynamics. I had three divisions working for me. One was spare parts. We had a RAM-1210 with all of our spare part inventory on it. It was for inventory purposes and location. The computer burped and spilled its guts. The information put into that was put in with these little punch cards. It took us about two months to reconstruct that, the data base of our spare inventory.

So you know these iPods they call them, you know it's just amazing. Look at these things in my ear right now.

Right. Your hearing aids.

Yes. And if it weren't for engineers, and granted, sometimes they go wrong, but everything's a series of trial and error, and that includes marriages. So I mean wherever—religions, in some people's cases. Oh, I just—I guess I'm a philosopher.

Well, yes, and thank you for explaining that to me because I've heard the argument in science, as well, so it's interesting to have an engineer's point of view on it.

[00:15:00] Well, see, like Livermore, they looked at me to make things practical and happen. And when you go into a Blue Sky Conference—we can open up the Nile, make it navigable clear up to such-and-such a point. How many devices are you going to have to put in? Is it practical? Can you control the radiation? Is a shock wave going to do damage to anything? You have to look at all these aspects of it. You may not always be right, but you make use of the best knowledge, and many times you go out and test things in miniature to expand it gradually to the next level.

When I first went to college, my professor was Dean Sullivan. He's a great old guy at Santa Clara. And one of his first statements to the student engineers when we came in was, Do you know what an engineer is?

And we said, Well, he makes wheels or he surveys places.

And he says, No, an engineer is a person who can do what the normal person does in half the time for half the cost. And if you keep that in mind, you're going to be a successful engineer. You don't engineer things just to engineer them. You engineer them with a goal in life.

Right. Well, great. Now where are we on your list?

Well, let's go back to Chariot first. Let's start with Chariot. We came back and began the planning for phase two. We had to build a camp, a permanent camp or a semi-permanent camp for scientists, for engineers, construction people. We had to build a new airstrip. We had to move all of this stuff up in a timely fashion, provide the transportation. All of those things, and you had to provide for catering, you had to provide medical services.

So all of this planning fell on Ralph Chase and my shoulders and some of our support staff. We even looked at taking guns up there. We had to have a small aluminum boat so we could go offshore. We had to set up a schedule. We did all these things. One of the things that we wanted to get up there were Weasels, what are called Weasels. They're a small tracked military vehicle, fit into half of this kitchen here, to provide transportation up for the tundra and everything up there. We found these in Texas. They were U.S. Army surplus down there. We got them through military surplus. Had to ship them, and we shipped to Seattle, Washington, and there where staged until they would be taken by a barge and tug up there [by B & R Tug]. We also had to take a drilling rig up because they wanted to drill down through the permafrost and take samples of it so we could get a feeling for the material.

As part of that, I had to learn something about drilling in permafrost, because it isn't like drilling down in the desert here somewhere. So I went to SIPRE [Snow, Ice, and Permafrost Research Establishment] in Wilmette, Illinois. They were drilling in Greenland, part of the Corps of Engineers. And so I went up there and developed all of the information. When I got back, Lawrence Radiation lab was [saying], `Well, we've got a limited budget. You can't take all these compressors up and everything else, so figure out some way you can do it anyway. Do it the cheapskate way or saver's way, whatever.` So we figured out a couple of ways by using the ice; we could get up there and having a tank there that we kept throwing ice in all the time to keep the drilling fluid cold, because when you drill you generate heat, and so you got this fluid going out around there and you want to keep it from thawing the—and so that was a trip. That was **[00:20:00]** made in December. I remember that because I got caught in that snow storm up there. So this was all going on.

We developed these plans and we used Seattle as a staging area. AEC has asked for a planning meeting at the University of Washington at Seattle, and so we went up there and all of the invitees—[Ernest] Campbell from San Francisco Operation[s] Office was the AEC coordinator, but the man really in charge of it was out of Albuquerque [AEC Operations Office], and so we coordinated between the two of them. The San Francisco Operations Office actually controlled Chariot. Ernie Campbell, and he lives here in Las Vegas, if he's still alive. I also ran into Sugden. I don't know whether you've talked to Sugden or not. Jim Sugden. He was a project engineer for Chariot from Nevada Test Site. So we went up there for that meeting and I made a presentation. I had drawings of what the camp would look like and where we planned to build the airstrip and that sort of stuff.

We got up to Kotzebue before the fourth of July of 1959, and the barge was late, so we stayed at the Rotman Hotel there, and there in that hotel you rented a bed. You did not rent a

room, you rented a bed, and they had two, three, and four beds. They had one bathroom and one room with a bathtub in it and one room with a toilet and sink in it, and so whoever got there first got to do whatever they had to do.

We celebrated the first fourth of July with the Eskimos, when Alaska became the 49th state, and that was exciting. They had a blanket toss, they gave prizes, and I got a woven basket. I wish I had been able to keep it, but the kids tore it up ultimately. I had, I think I've still got it around here, a small umiak, which is an Eskimo boat made with sealskin and reed and everything. It think it's around here somewhere. If I ever find it, I'll give it to you and you can put it in your exhibition.

It was extremely interesting. We got stuck there for about two weeks. The barge got caught in a storm. And when we got up there to offload, a major storm had come in. We offloaded, it was raining, and we'd set up temporary camp. But we ultimately built this camp with Jamesway hutments, and there's a picture of them in there [indicating photograph].
Let me look while you're talking. Oh, here you go. "The AEC camp at Ogoturuk Creek." All right. Jamesway Huts.
And they were warm. We had stoves in them and everything else. We built the camp and we had generators and all the other equipment we brought up. A little city.

One of the things that we heard rumors of, and they were only rumors, and this was from the Eskimos, that after we left after the first survey, that there was a landing at the site. People **[00:25:00]** speculate the Russians moved in. I had heard it from several Eskimos. And we couldn't find any trace of it, we couldn't prove it, but they knew that people out of the Atomic Energy Commission were working there and they didn't know what the hell it was. But we assume that's what it was. That's only an assumption. I'd never swear to anything on it.

But we set up the camp there and got everything going. We'd serve meals and they had a sit-down dining room and everything was pretty well planned.

In the early part of it, one of the things that happened before we got the camp set up is we had a flight coming in, a Cessna 180. It was Ween Airline that was coming in. And we had some pretty strong winds. And when the plane landed—it had torsion landing gears, torsion bars and they're bars that spring like—and the wheels mounted on the outside of them. And when it landed, one of the wheels broke off and it stabbed the strut into the runway and the plane spun around. The pilot was OK, but now we've got a downed aircraft. I went on the radio and tried to contact Ween Airlines, and we couldn't contact them. So I contacted the FAA [Federal Aviation Administration]. I had a radio there and contacted the FAA in turn contacted Wein. We and told them the plane was down, the pilot was OK, what do you want us to do? And they said, `Well, we'll send a barge up for it.` And they sent a barge up. [They flew another plane in to pick up the pilot of the downed plane.]

One of the stories I missed telling you about the first survey was that when we went up to do the survey, we were waiting for survey equipment to come in from Enewetak, we waited at Kotzebue for the surveying equipment to arrive. And while I was waiting there, one of the pilots from Wein Airline came over and asked me if I'd like to go on the mail run with him. So I got on a pontoon plane, a Cessna 180 with pontoons on it, and we flew up to several little villages, and we'd land in the water there and the natives would bring a canoe out and we'd give them the mail.

The pilot asked if I would you like to go fishing. And I said, `Why not?` So we flew down where the Selewick River meets the Selewick Lake and he lands on the river and beaches on the sandbar there, and we get out of the plane and he opens up the pontoon, it's hollow, it's a

metal pontoon, it's hollow, and he takes out some fishing gear. And so we began fishing. And there's a fish called a Shee fish. It looks like a white salmon. And they were migrating up into the lake. And so I'm casting out there and I hooked one and I'm pulling it and it was the toughest thing to pull in. I hooked it in the back, so I was pulling it broadside in. We caught several other fish down, and Olga the cook at the Rotman Hotel took and cooked them. Oh, they were good. But it's called a Shee fish. But that was one of the—and the equipment showed up a couple of days later and we were able to go on with the survey in the latter part of that first summer.

But getting back to what happened as we set up the camp, the camp was set up, we had contracted with BNR to provide some heavy equipment operators because we brought in heavy equipment up there. And we guaranteed them a sixty-hour work week; but—you got [the] sun—they wanted a seventy-two-hour work week, I think it was. I could not get permission **[00:30:00]** from the AEC to work them that long, and so they went on strike and we had to fly them out. And it was foggy. We had radioed for two planes to come up and take them out, and I went out with them. And it was another charter outfit that flew up with two planes. And because it was foggy—you don't have good equipment there—we flew what's called wire line. They flew with visual contact to the coastline. So you're going down this way. You don't know who's coming up the other way. So we flew that 180 miles or what down that way. And then we got a new crew in there and they agreed to work for the hours, but the first crew wouldn't.

Seventy-two hours. They want a longer work week to go up there?

Yes, and I can understand it because in winter it shut down, and so they got to make their money during the summer, and so you're dealing with heavy equipment operators who were engineers. It's called the engineering trade.

Some of the things that we found there in the Ogoturuk Valley, one you've got a picture of, is that little igloo there, a mud igloo; another thing, right near where we built the first strip, there was a grave, and it was a grave for a small baby, and the skull and everything were still there. Because it's permafrost, you can't dig down, so they put rocks around it. We also found a mastodon tusk, and I gave you a copy of the telegram that I got from AEC. That was last time, when you were here the other time.

I've got it in your file then.

And when I notified AEC we'd found it, it was buried along the edge of the creek, they said that Arctic Research out of Barrow would come down and recover it, which they did, and I was to provide them whatever support they needed.

And I told you about the trip that we made to the various villages to brief them on what was going on.

I did not stay there for the rest of the summer. I left. I had other projects I was working on. But we got one assignment before we left, and that was to go to the Kennecott mines on a potential Plowshare project. Kennecott's were a copper mine and they're near Copper River in the lower part of the state [Alaska]. And the concept was to set off a nuclear device in these abandoned mines, because they were abandoned in 1938 when copper was found in Peru. And we'd go in there and you would set off a device, then you would flood the mine and you would use electrolysis to extract the copper. That was the concept.

So the water goes in and how does the electrolysis work? It pulls the copper—

Well, it's like a battery, and the copper will stick on one side on the two electrodes, would be attracted to the electrodes. OK. That was the concept.

So we're in summer clothes. I went up there, I had shorts and T-shirts, that's all I had. So we went down to Copper Center and from Copper Center we went up to the Kennecott mines. There's a little town just below the mines, and some tourists go there—they still had shoes **[00:35:00]** from the late 1920s in their display window. This was a huge camp. People lived there year-round. They had private homes, they had hotels or motels, they had dormitories, they had eating areas, and everything. Why it became abandoned was when the copper was shipped, it was shipped from there by train, and it would go down across the Copper River and then down to Cordova or one of the areas down there on the coast for shipping to foreign harbors. That bridge would be knocked out each year by the ice floes, and so it got the name Million-Dollar Bridge because they had to send a million dollars to rebuild it every year.

And in 1937, '38, the miners had gone on strike. They were only making like $8.00 a day. They were going on strike. So Kennecott blew the whistle and said, `we've got cheap copper down in Peru and Chile, and we're going to mine down there, and the train's going to leave and you guys got to get on the train and get out of here.` And just a maintenance crew remained there.

So when we got there, we found these abandoned buildings. The mines were up on the side of the mountain and the processing was down towards the bottom of the valley. And what you would have is these buckets on cables and they came down a series of—they were still loaded with ore, and they'd go through this process. But they were just abandoned right there.

We went up to the bunkhouse up at the mine. We actually went into the mines. I damn near froze there because the temperature in the mine was 32 degrees and you could see, when you went into the mine, there were stopes, which are vertical rises, ladders coming up out of these stopes, and the stope would be full of ice because there's enough moisture go in there and condensate and they froze up.

In the bunkhouses, you found old *Collier's* magazine, *Liberty* magazine, all of these ancient—were still laying there on the floor next to some bunks and stuff. Abandoned shoes, everything.

So we spent a couple days there and got the information we needed, so that went back to Livermore and I never heard anymore about it. But we flew on home from that thing.

Let me go back one more time to the Ogoturuk Creek, because there's an interesting—it's a large alluvial valley, and the surface was—you had hummocks there. It would rain during the summers at that time and the ground would crack, and when it would freeze it would pop up, so you would get five-sided figures actually in the surface because ice would drop down in there, so when you walked, you had to walk from these hump to hump to hump to hump. But on each side were these areas. On the north side between us and Point Hope was an area called Crowbill, and I'd been up on top of Crowbill, and we found—the elevation there is about 850, 900 feet, I forget the exact, but there were seashells up there. But the seashells got there because at one time that had been under water. Now the ocean side of that was sheer cliffs, and it is the largest rookery for crowbills and puffins, one of the largest in the world. And we took that aluminum **[00:40:00]** boat out there in the bay and we took the oar and we'd smack the water and you'd see those damn birds come off and you'd cover your head to make sure nothing happened. But you know, it was adventure. And to say I didn't love it would be a lie.

I went up the last time—when I notified Holmes and Narver I was going to leave them—my father convinced me I should take over his business—I was going to leave there on the first of April (it was a huge mistake but I made the decision and did it), so they asked me to go one more time to the camp. And we had left a crew of two men there, and we found that to be a mistake. You got to leave three; you can't leave two. They get on each other's nerves and

everything. You're isolated like that. We had three of them there. But we flew up there and they wanted to take me—we had some rifles there and they wanted me to go hunting, so I said OK. We took a Weasel and went up, and the caribou were in season, and we went up on this ridge and there was a couple buck caribou came up. And the temperature was about thirty below zero. And I took my gloves off and grabbed a rifle, and I shot the first caribou. That scattered whatever were left. And then one came back up, and this guy I was with said, `You're not going to let him stand there in defiance of you, are you?` And I shot him. The last animals I've ever shot in my life. I would never go hunting again. I regret deeply doing that. But there's a picture of the two heads there.

Did you regret it at the time, Ray, or was it later?

No, it was a macho thing, but it's not that macho. It was an insult; to me it was an insult to the human race. I did the lowest, to me the lowest form of—if you have to do it to eat, that's one thing. But when you do it to kill, that's another thing, and I did it to kill two animals, to prove I could point a gun, and that was stupid, and I've never killed another animal, nor would I. Except to fish. I've fished a couple times, but other than that—but there is a picture of them.

I see that. I was wondering about that picture. Well, thank you for telling me that story.

OK. Where do we stand on time?

So let us continue.

I've completed discussion on Project Chariot and I introduced Project Gnome a little earlier. I think I explained to you but I'll go over again, Project Gnome was designed to recover the heat from a nuclear detonation and convert it into electric energy. The first thing we had to do was to understand the geology that we were going to be performing the experiment. The AEC had

already leased the land from the owners down there and made arrangements to proceed with it. And I told you about the drilling contractor.

One of the things, on this type of project, you're living in a different area and you're pretty much with a cloistered crew because we have my support team, you have the scientists from Livermore, you have the engineers from Livermore, and in this case we had **[00:45:00]** Ernie [Ernest] Weinkoop from AEC, and Ernie was the representative to make sure everything was properly authorized, T's were crossed, the I's were dotted and we did it by the government's way. We stayed in a hotel in Carlsbad and we ate together and drank together and the things that you do on these type of projects.

One thing that occurs, and this occurred in Alaska and wherever we went, we're strangers to the area, and so we become curiosity items of the curious. What are these people doing here? And that's what happened when we went down to Cold Bay. We were two people. What are these two strangers doing here? And you're limited somewhat by what you can say because in those days a lot of the things the AEC was doing was hush-hush. And that was the essence of it.

I told you about the drilling, and we would go out every day and check on the progress of the drilling. One day we went out. I had three scientists with me, three people from I guess it was the labs, and when you went out you crossed the Pecos River. And it was in the dead of winter. And we'd driven out there mid-afternoon and we returned in late afternoon. And when I got to the bridge, it's a long two-lane bridge, I was about halfway across and I was driving, and we hit black ice, and we were probably going about forty miles an hour, and I started veering to the right, and there's a railing there, and I was able to keep it pretty much on the road until we got right to the end of it, and I hit the end post, tossed us across the street, and there's about an eight-foot bank over there, almost vertical bank. I don't know how, but I hit that at just the right angle

because I was able to go up that bank and come out on top. We got out and stopped a car coming through shortly after us and they gave us a ride into town. It was a car that I'd rented in Carlsbad which had thirteen miles on it when I rented it from Hertz, and I gave it back to them in an interesting condition. Luckily I took out insurance on it.

But it was interesting, the confrontation with the florist and his partner. I learned a great deal from that. I would've argued from the technical point of view that he hadn't performed by contract, but our executive vice-president wrote the response and argued from the point of managerial responsibility and breach of contract, and we prevailed on that.

I was not around for the completion of the project because I'd left to go with General Dynamics in this case. I had left to go with my dad and then I went to General Dynamics.

Another project that we were involved in was Cowboy. Cowboy had an interesting concept. It was not really a Plowshare project. The test ban treaty discussions were—negotiations were going on in Geneva, and a scientist from RAND Corporation, a scientist by the name of Latter, came up with what he called the Latter Theory of Decoupling. He postulated that **[00:50:00]** if a nuclear device was set off within a configuration and a medium such that when the pressure wave reached the constraint of the medium, that it was within the elastic limits of that medium, and if that were true, it would substantially reduce the seismic signals. If that being the case, there were a lot of salt mines in Russia and the Russians could thereby be able to hide underground nuclear tests, and that would have to be an element of the discussions.

So our job was to go down to the Carey Salt Mine in Winfield, Louisiana. We got licensing rights down there and set off two high-explosive detonations, one within a drill hole with a tamped shot, so that it was a constrained shot. The second one was in a mined-out sphere

wherein we believe, and then we'd set off a detonation which would not yield a greater shock wave, pressure wave than the elastic limits. And we proceeded on that basis.

I had assigned a project engineer to it, and he was down there, and one of the jobs that we had to do was to drill an air hole down into the mine to allow circulation down there. The salt was a bedded salt. On top of the salt was an anhydrite, which was impervious to water, and on top of that was an aquifer, an underground river. And when we drilled the hole in there, started down, when it hit the anhydrite, it broke the anhydrite and allowed the water to wash in around and wash out areas around there so we couldn't stop the flow.

The first approach was to try to cement it using Halliburton, an oil field cement. We had every train available to Halliburton bringing in cement. They brought it down, they started pumping it down there, and the next thing we knew, five miles down the way in a lake down there, it started turning white. This underground aquifer fed that lake and the cement was washing down to that lake as fast as we could put the cement in the hole.

So that was the cement that was making it white in the lake?

It was the cement. Our next attempt was to, and I had a project engineer there, I was not there, put some cottonseed hulls down there and see if we could stop it up that way. We weren't making progress and we got a call from Livermore to come up and give them a progress report. So Chuck Kelly and myself flew up to Livermore and we went in for the meeting and got nothing but complaints over not getting the air hole down there fast enough. And so my magnificent boss said, `Ray will be down there tomorrow.`

And which "magnificent boss" was this?

Chuck Kelly. And so I called home, I had a suitcase packed, and it was just before Christmas, and I was told to go down there and get the job done, and don't come home until it's done, and that means leaving the family alone for Christmas. And away I went. That's what you had to do.

And so we went down there. We ended up using chopped-up tires and cottonseed hulls, **[00:55:00]** and we got it stopped and then cemented it, and then used the proper tools to go through it, and ultimately got it down there.

So it was just a matter that the tool was not right and that's why you broke that—

Well, you couldn't get it to seal off. You've got to be able to seal your penetration and not let the water enter.

Yes. Right. And explain what anhydrite—what does that mean?

An anhydrite is a non-water-permeable material. It's primarily calcium, and it's a real hard material, and so the water just flowed over the top of the salt without eroding the salt.

Yes, I understand. So when you go again, you have to have it seal itself in such a way—

We had to stop the flow into the salt, number one. Then we had to seal it off to where we could now drill through it and seal off the aquifer, above the aquifer, and then drill below it. So we were fighting that problem. But that problem went on for three or four weeks before I got directed to go down there and solve the problem. See, they called me the problem-solver, decision-maker, and that's what you're trained to be as an engineer, I guess.

So anyway, we got that done, and we got the sphere done, and we got the tamped hole done. And the decision was made that we wanted to fire them at night because what you're trying to find out is what the differential is in the seismic signal. OK. So we're all set up to go, I think it was about midnight, and we've got the countdown going and everything, and all of a sudden the seismic machines go like this [motioning]. There's a train going by, and we had to

postpone it and make arrangements to make sure there weren't any trains, because your countdowns, with instruments and everything, it was about forty-five minutes, and you had to make sure it was going to be clear during that period. But they were shocked because all of a sudden the machines are going like that.

So it was a successful project, and they went on to forward that information. They proved that you could hide a detonation underground and substantially reduce the seismic signal. And although this was not a Plowshare project, it was carried on by the Plowshare organization.

Now one of the aside[s] is that we stayed in the Huey P. Long Motel. Winfield is Huey P. Long's hometown, and his pea patch is just up the road. And the help at the motel were indentured people. They were prisoners who had been paroled to Ortho Long who is a cousin of Huey P., Orthil Long, and they were indentured. They were prisoners but this was part of the Mississippi chain-gang era. One of the shockers we got there was going into the railroad station or the plane station, and they had black-only drinking fountains, black-only restrooms.

As part of this, we went to Jackson, Mississippi to the experimental lab there where they have made a model of the Mississippi and Ohio Valley for flood control. It's at the Engineering Test Center there. And we visited that and learned a lot about it. And those were two of the engineers that were in that car that I almost smashed up.

[01:00:00] But again, it was a cultural shock, and that was another lesson I learned. In fact, a lot of this, like dealing with the Eskimos, dealing with the Enewetakese, the Bikini natives, the culture in Mississippi, I was not used to it; I think [it] has changed me from the dyed-in-the-wool Midwest conservative Republican to the liberal Democrat I am today. But that's of my own choosing, but it's because I've learned a greater appreciation for people and their culture. I've learned a lot about geology and a whole spectrum of things as we went along.

The next project was Vintage, which is in Rifle, Colorado, and the [U.S.] Navy had been at Rifle, had been running some experiments there to extract oil from oil shale. It's one of the largest oil reserves in the United States if it can be economically extracted. Economy is the byword right now. My first trip up there, which was an experimental one—let me tell you what the concept of the project was, to set off a detonation in oil shale. In so doing, the pressure would break up the oil shale into retortable sizes. The heat retorting the oil from the broken shale would then leak to the bottom of that reservoir. You would be able to tap it and pump it out. They saw this as being an economic solution. What the Navy was doing when we went up there was mining into the side of the mesas below the Mahogany Ledge, into the oil shale, dynamiting it, breaking it out, taking it down to equipment in the valley, and crushing it, then putting it into a retort, and the oil would come out. They used that oil actually to pave the roads there. They had extracted it.

So when I went up, I went up with Bob Petrie and a scientist from Livermore. The scientist happened to be Jewish, and at dinner that night, we stayed in Grand Junction, Colorado, we were at dinner and we started talking philosophy and religion, and I told them I was Catholic and I'd been educated by the Jesuits, and he says, `Oh, that's interesting.` And he said, `What'd you learn?`

I said, `Well, the seven proofs of God's existence, based on Saint Thomas Aquinas's *Summa Theologica*.` And I went through the seven as best I remembered them.

And he shut me up by saying, `Ray, that's great. Only problem is, everything you've said is based on man's experience, and you're postulating to an infinite being. Therefore I reject your entire argument.`

But that was part of my learning experience, because I had made an assumption, and it was like you can fool some of the people some of the time and you can fool all of the people

some of the time, but you can't fool all of the people all of the time. It falls into that same vein. So I enjoyed that.

But we went ahead with the project, and to carry on a project as always, we had perform initially an HE [high explosive] experiment without nuclear. And that was done. We drilled a **[01:05:00]** hole and then we set off some HE in it, which would simulate the same frequency of wave as would a nuclear device. Then we went in and mined out the area to see what the particles looked like. The Navy in their experiment had shown that particle size could not be over three inches by three inches by three inches. Unfortunately, shale is slabbed. It's laid down in layers. So when you set off an explosion in it, it breaks off in slabs, and therefore we had to give up the project. But it was an interesting one.

OK. Let me stop.

[01:05:48] End Track 2, Disc 2.

[00:00:00] Begin Track 2, Disc 3.

Let me go to one other, I'd mentioned it before, the Panama Canal. On a Blue Sky Conference at Livermore, Teller had asked Bacigalupi and myself to come up with a WAG (wild-assed guess), and we did that. We went down to a desk in the engineering area and got out some drawing paper and searched the old files to find out what we could find out about excavation, what had happened in previous detonations, whether it's on the surface or it's buried, how deep was the burial, what was the ratio between the yield and the burial depth, so we could find out what the craters would look like. So we developed a series of equations in which we could be there. We also made some assumptions on the size of the canal. Now this was to be a sea-level canal, not a locked canal, as the Panama Canal was, but the Pacific was to flow to the Atlantic and they were to be able to just pass through it. So we got some geological maps from the [U.S.] Geological

Survey of the area in Colombia that we speculated—and if you recall history, Panama was extracted from Colombia. It was originally part of Colombia before it was made separate, thanks to Theodore Roosevelt, and ended pretty much with [Jimmy] Carter.

But we did some of this preliminary estimate. That information was given and the information was turned over to the Corps of Engineers out of New Orleans. They went on with a detailed study, working with Lawrence Radiation Lab and with Holmes and Narver. They ultimately abandoned the project. I don't know why, but I'm sure politics and a lot had to deal with it. The area that we were looking at was pretty wild. We would've had to pretty much destroy a lot of the vegetation and some of the other crucial environment down there. But that was interesting.

Another project was a project initially started called Peacock, and that was in Hattiesburg, Mississippi, and here we were trying to develop a cavern—

*Right. I'm going to look and see what the other name of it is. Keep talking. I'm just going to look in the book [*DOE/NV—209-Rev. 15*].*

OK. Develop a cavern using nuclear detonations for future storage of oil product, petroleum products. That did go on to fruition and an explosion did take place down there.

But a lot of the information we gathered was from Phillips Petroleum out of Bartlesville [Oklahoma]. They had probably done more work up there on underground caverns for storage tanks than any other company in the United States. So Cliff Bacigalupi and I flew into Tulsa and drove up to Bartlesville and met with their engineers, got all the data we could. We did develop down-hole cameras so we could work with them. We worked with the development of them; we didn't develop them ourselves. And also caliper tools, to be able to measure them. Those were part of the criteria.

[00:05:00] *But when you say it went to fruition, the explosion went to fruition—*

Yes.

But it was never used for—

I don't know. I don't know what the ultimate use, but the theory was proven.

Got it. See, here the first Hattiesburg I'm seeing is Sterling, but it's for a nuclear test detection experiment. That's not the one you're talking about.

They might've changed the name of it, but originally it was an excavation—

What year was it, do you recall?

Well, I was working on it in '59, and it probably occurred in '61, '62.

They've got something called Salmon also in Hattiesburg.

That's probably it.

But that's '64.

That's probably it.

OK. "Nuclear test detection research experiment." But then that's—. They changed some things in here.

Oh, yeah. Well, I mean, when you start on something.

But they also told me, the DOE [Department of Energy] people told me they changed the yields and things?

Yeah.

It's scrubbed, they said. So maybe some of the information is changed. But that's so maybe when you say Peacock, they changed the name.

They may have never gone through—I thought it went through to fruition, that they did conduct and prove the development of a cavern. But I don't know because I was no longer on the project,

so I can't attest to it. I know the limits. I learned that from the [U.S.] Air Force. If you don't know the answer, say, I don't know the answer. I had heard that from—you know, you keep in touch with people. Now you can have this if you want it. I don't know whether there's anything of any use on there or not.

Oh, there is. This would be great to have, your notes. Great. I think you went through everything here.

I think you've got me tapped out.

We'll stop for now, then. You've told me a lot of stuff.

Unless there's something you want to discuss.

No, I think that we've covered a lot and you've given me a lot of the philosophical viewpoints as well, so that's really wonderful. No, I guess the only question would be that on a lot of these things, it sounds like similar to straight Plowshare, that there's something other than nuclear weapons testing that's going on.

Yes. Oh, yes. And that's why when you look at the objective in most of the Plowshare, you find out the objective is not, quote, "develop a weapon.' That might be incidental to it. But you get the Chamber of Commerce involved in them, like in Carlsbad, they were involved. You get local industry involved. You get the native population involved. You may have several industries, like in Carlsbad we had the oil industry and we had the potash industry, we had the visitor industry, all of them were deeply involved because of potential ramifications. We ended up making a presentation to the Mining Engineering Institute there on the project. And why did we think—? [They asked us] visitor[s], `Why do you think you're not going to knock down something, the stalactites in Carlsbad Caverns?` And so, you know, you go through things like this.

They're fascinating, but they all start—they start from one of two theses. One thesis is the Blue Sky Conference, where scientists think of, what can we do with this huge animal that we've got? We've got it somewhat under control, but what can we do with the spillout? The other comes from political and industrial and commercial needs: can we remove the topsoil or the overburden over the iron fields in eastern Alaska, out on the Seward Peninsula? That was to solve some local investor's [problem], and Teller's the first one to say, `Yeah, that's feasible. We can do it.` And then of course after you go through that, it comes down to making these things **[00:10:00]** work, and that's where Bacigalupi and I meet and begin the problem-solving of how do you get this done now. And that's what that was all about. And when I called you and said I thought I could provide a different dimension to what you've heard in the past, you can talk to a lot of people that have worked out—built towers or dug tunnels out at the test site or drilled wells out there, but they don't know what went into "why" of it, or what was—why do they have a hook at the end of the Rainier tunnel? [Chuck] Violet told you that. Violet came up with the idea. And when Violet said, `We're going to want to drill from the top,` I'm the one that went out in the power wagon to get up on top to see if we could drill down. It wasn't Cliff Bacigalupi or any of the others. It was a surveyor and myself and a truck.

And that is one of the things, as I told you, I was selected by the twenty-sixth distinguished engineering grad from [University of] Santa Clara, and they were fascinated by what I had done as one of their graduates. And I'm proud of everything, whether it's building silos or missiles or planning projects on the moon or talking with a brain like Edward Teller. I would never trade my life for all the tea in China. And I appreciate your tolerance in putting up with an old man.

No, it's very interesting and real contribution, so thanks a lot, Ray. We can stop here.

OK.

[00:12:09] End Track 2, Disc 3.

[End of interview]