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

Interview with Clifford W. Olsen

September 20, 2004
Las Vegas, Nevada

Interview Conducted By
Joan Leavitt

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

Joan Leavitt: *OK, if you could just kind of give me some basic background, personal background, and kind of leading up to getting to the lab. I guess it was the Livermore lab.*

Cliff Olsen: I suppose the place to start would be college. I was at the University of California in Davis from my junior year on through graduate school. I got my bachelor's in chemistry in '57 and then went on to graduate school. And my graduate advisor, Charlie Nash, who is now professor emeritus at Davis, had been doing some work within a very fledgling Livermore laboratory, so he knew some people down there and managed to get some funding for me to do graduate work. The laboratory didn't fund me but they provided some equipment that I used in my graduate research. Through that, I got to know some people down here, and then I started working on one particular special project in 1961. Then when I got my doctorate in 1962, I went to the lab full time.

I worked for about two years in N Division, which was neutronics. In particular, pulsed reactors is what I worked on. It was a way of getting a radiation pulse without a bomb. We used that to irradiate electronics components in stuff. And then N Division went away for administrative reasons and I moved to L Division in 1964, I guess. Yes, in late '64. Jim Carothers was the division leader then, and that's when I went full time in the normal nuclear testing. N Division had some stuff at the test site, but it was in a sort of out of the way area and wasn't part of the mainstream testing. N-Division was Neutronics; we ran several reactors, pulsed and static. It was disbanded in 1964-65.

Now, were you part of Pike? Is that when there was a Testing Evaluation Panel?

Yes, the TEP preceded that. Let's see. The TEP started in, what, '64?

Right after Eagle, which would've been '64.

Yes,, that would be '64. The TEP was kind of funny. It was an administrative thing primarily. The laboratories were represented by people like test group directors and not containment. It would actually review hardware and things like that, and sometimes even suggest changes to hardware, which the CEP [Containment Evaluation Panel] never did.

Now this was the precursor to the Containment Evaluation Panel, wasn't it?

Yes.

Now were they concerned about containment or radiation problems with the TEP?

They were, but not in the sense of the CEP. During that period, a little bit of radiation leakage, especially if it didn't get offsite, wasn't viewed with a whole lot of alarm. And it was pretty much almost accommodated. One of the major things you didn't want to do was have radiation fog film on the diagnostics trailers because nearly all of the device diagnostics information was on oscilloscope camera film. So instead of trying to keep it underground, we'd put lead foil over film holders to shield it. One of the main leakage sources at the time were diagnostic cables, and instead of trying to block the cables as we do now, or did, they would let it come all the way up to essentially the wall of the trailer and where the connector was, they'd make that a gas-tight connector, so you could allow radioactive gas to come all the way up to the outside of the trailer but not go on in.

Oh my goodness. And did that succeed for the most part, keeping the film from getting—?

Yes, it worked quite well except in a few cases where we actually had a big failure, like **[00:05:00]** Baneberry. There were a few cases when you had a dynamic vent and there was a big cloud and you'd lose virtually all of the data; at least what was on photographic film.

And I bet that didn't make the higher-ups very happy.

No. No, it didn't.

They really wanted to get something for their money.

Yes. Which is why Baneberry was such a millstone, in a way, and also a milestone. We lost a lot of device data and people were very upset so they stopped testing for six or seven months, did a *big* investigation, made containment a *much* more important part of the whole system and reconstituted the TEP as the CEP.

The first few meetings of the CEP were kind of like the TEP because they didn't know what else to do and those were the people they had. But they rapidly got people who were more interested in phenomenology than in getting the event off. They had geologists: Bill Twenhofel from the USGS [United States Geological Survey]. They had hydrologists from DRI [Desert Research Institute], whose names I should remember: George Maxey from DIR in Reno. And some other consultants who were more interested, as I said, in phenomenology and keeping things underground than in simply keeping the schedule going. You know, if you can do a little bit about containment without causing us too much trouble, it's kind of like insurance.

Yes. Well, the containment has been kind of developed through the years. I was interested that this also seemed to be an exercise in having the two labs work together; in the plan presented and then there being a lot of questions to see if the details had been taken care of.

Yes. That was really kind of later on, in a way. Livermore was a little bit ahead and got interested in containment because we were doing line-of-sight-to-the-surface shots for the DNA

[Defense Nuclear Agency] roughly after Baneberry. Actually, before Baneberry also, we did effects type tests, as opposed to device development. Events such as TEE and PACKARD.

What is DNA?

Defense Nuclear Agency. They're now DTRA [Defense Threat Reduction Agency]. They started out as DASA, Defense Atomic Support Agency, and then they went to be DNA, Defense Nuclear Agency.

Well, what's the difference between them and any other agencies?

They're just part of the DoD [Department of Defense] instead of Department of Energy [DOE], so they're military. They were primarily interested in nuclear *effects* rather than design or that kind of thing.

So that's why they would be interested in containment?

Yes.

That seemed to be kind of a step—let's see, yes, it seemed like that was along the way. I took note when I was reading Caging the Dragon *that there were certain tests that seemed to be learning points, learning curves?*

Yes.

You know, like for example, I think Red Hot and Double Play, you know.

Yes.

Now were you part of that at all?

Only peripherally. Those were DNA shots. Well, DASA at the time.

OK, because on that one, according to the book, they began to involve General Atomic and RAND people to help with different calculations.

Yes. The DoD people had a lot more contract support than the AEC [Atomic Energy Commission] laboratories did. We *mostly* did our own. We would get some contractor support, but DoD got a *lot* of it. They had RAND, a little later on s-cubed, Pac Tech, a whole bunch of them if you go through it.

Now this is all again precursor to containment but still kind of concerned about film data. What kind of containment were they thinking about?

[00:10:00] The DoD wasn't so much, because the DoD basically on most of their tests used the device as simply an energy source. You know, they didn't care about device diagnostics; particularly they were looking at effects, so they didn't care so much about that.

So what effects were they looking for, then? On humans? On animals? Was it that kind of effects?

There were some of the early things, you know, the early atmospheric stuff, but in the underground things they were looking at a couple of things. One was ground shock and what that did to things. The other is that they tried to simulate essentially an atmospheric test, only do it underground. You've probably seen pictures of these monster line-of-sight pipes with a lot of exposure stations in them. They would put everything from a complete reentry vehicle to a lot of electronic components and all kinds of things and expose them to different levels of radiation and so forth. They were wanting to keep *those* samples intact, so that was *their* interest in containment. It wasn't as much containment *per se* as it was sample protection. But of course, if you had a containment problem, then it had gone past the samples, so it was sort of automatic that they were interested in containment because if there were a breach in containment, it would've done them in along the way.

Well, even defining containment, it seems like that that kind of changed through the years.

Oh, it did.

So at the beginning it was, don't let the radiation get too far, is that what that was?

Yes. There wasn't even really an official definition of containment until the CEP charter. There was kind of a working definition.

After Baneberry.

Yes. Well, it was before Baneberry. As I was going to say, we had a containment group at Livermore that was formed after Diluted Waters, which was about '65 or so, '65, '66. And we were working on various things there. We had—

Now you were a containment scientist on that, on Diluted Waters, is that—?

No, Diluted Waters was another DoD event in Frenchman Flat. No, we didn't have true containment scientists until after Baneberry.

OK. Because that's probably a brand new field, then, wasn't it?

Yes. As I said, we had a containment group but we didn't have much stature.

So how do you become a containment scientist?

Great question.

Do you have to almost raise your own and train them?

Yes, you do. We had containment scientists. The *best* ones were ones who had kind of grown up through some other part of testing, *usually* either geology or reaction history; the device diagnostics kind of thing where you understood something about how the device worked, the diagnostics that were done, why you had cables coming up to the surface, what you were trying to do in a given test. We had containment scientists who were *very* capable, men and women who were chemists, physicists, geophysicists, geologists, computational modelers. Quite an array. It's a very multidisciplinary kind of thing.

Now this panel acts as an advisory to the manager?

Yes, the CEP is appointed by and reports to the manager. The laboratories will nominate people as their representatives but they have to be approved by the manager. And there are some independents on the panel who don't represent anybody except their own expertise. They were generally recommended by the chairman or could be by the manager directly.

Well, I was really interested that one of the key secrets to the panel being able to work was a certain integrity.

Very much.

And I'm really interested in your explanation of that because, you know, to have confidence in what you were doing, there's certain things that I think are part of the record; that it **[00:15:00]** *will be comforting to understand that. Maybe you would like to just kind of explain anything along the lines of how it had integrity and how it was something that was not just pencil-whipping.*

Yes. The panel, as I said, when it was reconstituted, it became the CEP after Baneberry and replaced the Test Evaluation Panel, brought in outsiders, as I mentioned; the USGS and DRI and others. So it wasn't quite the ingrown good-old-boys thing that the TEP tended to be; it was more open in that sense. And we also kept verbatim transcripts, which was not done during the TEP.

Do you know if those are declassified yet, if they've been declassified?

Oh, no, they're all S/RD [Secret/Restricted Data]. There have been pieces that have been declassified that people have wanted, but basically they're all SR/D.

The panel went through several stages. The first year or so, we had several chairmen, and then Jim Carothers took over at the eleventh meeting, roughly a year after Baneberry. Jim was a very interesting guy. Dead now, unfortunately, fairly recently; within the last two years. But Jim

had a way of letting the panel members essentially do what they wanted and go off on some pretty big tangents. But kept things under control. He did *not* have a vote. All he did was summarize the panel members' statements.

He moderated it, then?

Yes. But he wrote the recommendation to the manager as to whether or not the test that had been considered by the panel should go ahead or not.

Now how often did the panel meet?

It was really at the behest of the laboratories of when they wanted to do an event. There was enough testing during the sixties that we met almost once a month—sometimes a little more than that—and we'd consider maybe three or four events at one meeting. After Baneberry, when the testing level went down, we still continued to meet almost once a month and we might consider one or two events instead of three or four. But until testing was winding down in the early nineties, we met roughly once a month.

How long did it take to do one of those? Was it several hours or it was all day?

Typically an event would take half a day. Some of them would take occasionally as short as an hour, a little more, if it were very simple. A complex event like a long line-of-sight event or one of the DoD big tunnel events could take a full day and sometimes more.

Well, I understand that it could almost be as big a process to get it through the CEP panel as it was to design it in the first place.

I don't think it was *quite* that much but it probably seemed like it to the people who had to get it through the panel. And I was on both sides. I presented a number of events as well as sitting on the panel. Well actually I'm still officially on the panel but I don't represent Livermore anymore. But I represented Livermore for close to twenty years as the senior member.

You were *there for a long time.*

Yes. Part of the integrity thing was that the presenting laboratory didn't want to get up there and have something thrown in their face: `why didn't you think of this?` So the presenting laboratory would work very diligently to make sure they didn't overlook something.

[00:20:00] *They'd have a pre-meeting.*

Oh, yes. At least one, usually two or three.

Pre-CEP?

Yes.

Was that just practice at their own lab?

The last one was essentially a dry run. It was practice for the CEP. The earlier ones were technical review kinds of things.

Wow, they really took that seriously, didn't they?

Oh, yes. Oh, yes, we did.

Practicing up for it and trying to cover all the loopholes before they actually went before the official body.

Yes. And we would send copies of the prospectus. Every event had a prospectus, and we would send copies to the other laboratory—well, in fact, to all of the CEP members, as well as the other laboratories. Between Livermore and Los Alamos, we would exchange questions and comments, which was very good for several reasons. One is it would point out things in the prospectus that might even just be a typo, but if people read through a document and see a lot of typos, they kind of get this mindset of, `Gee, was this done carefully or not?` And also if you got a question back from Los Alamos, say, that said, `We're not quite sure what you mean by`

this. Please explain it, you could be pretty certain that that same question would be asked at the CEP. So it gave you a chance to prepare so that you had your ducks in order, too.

Now was this almost an exercise in helping to overcome some of the competition of these two labs with each other?

Later on it was. There was a time in the late seventies that there was considerable rancor between the two labs; the panel members on both sides at the time were pretty strong-willed and not necessarily cooperative.

Yes, there's some unnamed leaders of each lab that gave them some problems.

Yes. I could give you some names but there's probably no point in it. And things got pretty nasty on occasion where it was not cooperative. It was torpedo management.

Were you present for any of this?

Oh, all of it, yes.

So did you feel like some of the rancoring was more pettiness than it was sincere differences, then?

Yes, a lot of it was. It was kind of one-upsmanship; in some cases, really petty. That started to fade away a little bit, partly because of the chairman. But as I said, he didn't like to get in to making it look as though he was trying to control panel members or impress any member more than anybody else. So he gave the panel members quite a bit of latitude, but he did a little bit behind the scenes. What *really*, and I think this is true, what really got it straightened out and had us working cooperatively was when I became the associate program leader for containment evaluation, which meant all of the CEP stuff at Livermore. I got together with Jack House, who was the program manager in Los Alamos for containment, and we got along pretty well personally. We worked *very* difficult problems in the early eighties, getting all of this stuff

straightened out and getting people to cooperate. So by ’84 or so, Jack and I had things working in a pretty friendly fashion. And for a while we even sent people, not just a copy of the prospectus but people back and forth to pre-CEP meetings and things like that.

You mean you have natural political talent, is that what you’re saying?

Well, I don’t know about that; I don’t consider myself a politician.

Well, you know, sometimes political talent is getting people with diverse opinions to come to a middle ground. I can’t help it, to think about this, if it was important for this to be almost in place with regard to helping to bring the Soviet Union [USSR] and the United States together, to help resolve a gap, you know, former enemies, rancor, whatever, and can we find a middle ground, can we come together, can we work together?

Sure. That’s true.

[00:25:00] *And it’s just an idea that’s forming in my mind that maybe some of the things that were learned in getting along with two very, very different laboratories may have been helpful. I don’t know. Have you ever thought about that?*

Not in that way, no, but you know, you have a point.

That there has to be kind of a certain principles of cooperation, of unity, agreement, differences that can transfer over to diplomacy. I don’t know. That’s been on my mind a lot.

Yes, it’s not a bad thought.

But that was one thing I noticed in the book and it talked a little bit about that, and I just thought that competition of the laboratories, coming together for a purpose higher than their egos, you know. That’s, I think, a really marvelous thing about the Containment Evaluation Panel.

Yes. One other thing. Toward the end of the eighties when budgets in particular—well, from the middle eighties. budgets had always been a problem but from the middle eighties on it got really

tight—there were a lot of political pressures back and forth, and there was pressure on the laboratories to try and do things the same. Not so much the same as to try and minimize. [The questions was raised] Why do you do it that way and you do it that way? Can you do it more or less the same and then we can save some money so we don't have to support two separate infrastructures? So there was pressure there on the laboratories. It was not because of anybody doing anything wrong or ego. It was just a—

Well, yes, it seemed like one used drills and the other one used another method, and it would be more efficient if they agreed on using certain similarity things.

Yes. And there were some fairly logical reasons why they developed the way they did. But because of that, then we tried to get back together basically to save money, and that's when around 1990 or so, the JTO, the Joint Test Organization, came about just because of that, to try to simplify and coordinate things on the test site.

Now was that an agreement between the labs?

It was an agreement between the labs but it was essentially a mandate from DOE saying, You will.

OK. We are going to be more efficient here. *Up till that time, they'd had more freedom with budgeting and everything else.*

More autonomous.

Now there seemed like there was also kind of room for learning.

Oh, yes.

You know, room for making some mistakes and not quickly firing people for things.

Yes.

Has that attitude changed through the years? Because it seems like, you know, if you're too quick to pass blame and not give them that little bit of learning time, that you can eliminate an awful lot of people.

Yes. The test programs, especially in the early part of the sixties were probably the best example, but it went further on. There was an awful lot going on and you couldn't— unless there was some horrendous screw-up, which was rare—there wasn't much point in trying to point blame. It was much more productive to go ahead than to look back. You'd say, `Yes, we have a lesson learned here. Now let's move on.` And that's the way it was. The whole thing in the test program in the sixties; very positive, very can-do, very `let's do the best we can, do whatever it takes to get it done,` and both labs were pretty much that way.

Did it stay that way or has there become more rancor, more blaming through the years?

Well, there—

Maybe that's not—that might not be a fair question.

Not really. Like I said, there was that period in the CEP, but that didn't really cover all of the test program either.

The blaming probably came more from the outside, wasn't it? Not really from the inside.

Yes, there was finger-pointing and, `Do we really need to do this?`

But like with some of them, when there was some escaping, like there was one that went to

[00:30:00] *Mexico; Pike went to Mexico.*

Pike, yes.

But it seemed like even when there were escapes, you know, inside the organization there was more problem-solving.

Oh, yeah.

OK, how can we prevent this, you know. I noticed that when—one of the things, cultural differences between the Russians and the Americans, was that the Russians were very, very quick to find fault, blame, and to humiliate.

Oh. Yes. They were very much that way.

And they were very, very surprised that Americans were more problem-solving. That was a stark contrast in cultures. The Communist culture, the American culture. Did you see any of that, too?

Not a lot. A bit. It was more secondhand than direct observation. There were a few things when I was in Semipalatinsk where we kind of heard or inferred that, Gee, you know, why haven't we seen him lately? But we weren't privy to why somebody was no longer around and we didn't know if it's because he had been planning on leaving anyway or if he made somebody unhappy.

Oh, you're saying that there was kind of a sudden disappearance, as if someone made someone higher up unhappy and was—

Yes. But we never knew. All we had was kind of a secondhand of, Gee, have you seen So-and-so lately? And even that was rare. I only personally know of one instance like that and I don't even remember a name. But the Soviets, as you said earlier, tended to be very secretive about things, but they were almost to the point of being comical except *they* didn't look at it that way. One of the stories—I wasn't there at the time—in the beginning of our group that went to Semipalatinsk, they had us in what they called the hotel, which was not a bad two-story building, at least for them it wasn't bad. They tried to spruce it up and they put in wallpaper that looked like it was thirty years old, if not more, and they'd done a little painting and all that. Somebody mentioned in one of the closed meetings that they couldn't get the darn window open; it was sealed with paint. A couple of days later, the window was opened. None of us, none of the

Americans, had said anything to them, and of course they weren't at the meeting, but somehow they had heard that this window wouldn't open, and it just miraculously suddenly would open.

Well, it sounds like they knew what was going on. They had ears on the walls, huh?

Yes. Exactly. And the hotels that they put us in, in Moscow when we were going in and out, we were always next to an elevator because those were the rooms that probably had been pre-bugged. Also at that time, and I think this was in eventually *all* of the hotels in Russia, or the Soviet Union, you didn't keep the key to your room and it was rarely at the front desk. At the top of the stairs or the elevator, there was usually some grumpy-looking little old lady who sat at a desk and gave you your key when you came in. She could see, usually she could see, everybody who came in, knew which room they went into, and was—

Don't keep records. It was just all—

Yes. So it was a funny kind way, very obvious but still at the same time subtle way, of keeping track of things. And they were obsessed with that kind of thing. At the Soviet test site, it was interesting. There were really three different groups. Semipalatinsk actually, you probably know, is a big city. Semipalatinsk was simply not another post office zone; in fact it was their test site, quite a ways away from the city. And the main thing there was in fact **[00:35:00]** a military base. They had troops out and you'd see them marching in the mornings and all this stuff, a lot of them *very* young kids. There were a few real soldiers, but a lot of them were very young and kind of looking around. But they were there and they were across the fence. Then there was the group that *we* dealt with in a technical sense. And then probably the most interesting and the smallest group were the interpreters, and the interpreters were mostly senior students. I don't mean necessarily senior class, but higher up students from the University of Moscow who knew

English. They were there to be interpreters, and they apparently had not been told, you know, `You will not discuss politics`.

So they were very friendly.

Yes, they'd go for walks with us in the evening and they were fairly candid. Probably the thing they were *most* candid about, at least a couple of them, is they didn't like being hauled away from their studies and sent out here to this godforsaken place.

They weren't too happy to be there in Kazakhstan.

No.

Kazakhstan was not prestigious, huh?

No, not really.

Well, do you remember anything else that they told you about what life was like for them at that time?

They didn't go into a lot of it in that sense, but probably if anything they were more interested in what *we* could tell *them*. But the students, which they mostly were, were generally fairly happy. You know, that's a nice time of life. They didn't like in general being hauled off, but because they were where they were, they were going to be in the upper level of Soviet society, and they were probably a little happier than you might have thought they would be. Moscow was the dirtiest place I ever saw in my life.

Really. Did you get to go along the back streets? I know there's some parts that was fancier than others.

No, not much. When we went in, I was with two other guys and we spent two nights in Moscow before we went on to Semey [Semipalatinsk]—a night and a half because we left very early in the morning to go out. Have you seen pictures of the monster radio tower in Moscow? It's been

there for quite a while. It's just a huge tower. It looks something like the tower downtown; the Stratosphere here in Las Vegas. It had television and radio, and they were very sensitive about it. Ordinary tourists, and there weren't many of them then, but ordinary tourists usually couldn't even get very close to it. We went out walking late one afternoon or early evening, and got fairly close to it. I think Willy Cooper may even have taken a picture, but I'm not sure. We left the hotel and when we—oh, if I can remember—were sort of going one direction, the hotel was here [demonstrating] and we'd start down the street here that it was on, and the tower was kind of out that way, so we turned left and started going that way. After we started walking toward the tower, we noticed there was a guy walking behind us. Not close, but he just kind of appeared, and never got very close. We didn't do anything. You know, we'd been warned not to do anything stupid anyway. So we just kind of wandered around and walked back to the hotel and when we got near the hotel, he disappeared again.

So you were watched.

Yes. At Semey, as I said, we had what we called the hotel. There was a road that came off the main road, if you want to call it that, that came in from offsite, and it was maybe a mile or maybe a little more long. It was a dirt road but very well graded. There was a left turn as you were coming in, and it went several hundred yards, and then there was a little shack that, oh, I doubt that the floor area could've been as big as this table, which was their guard shack. Usually there was nobody even there that you **[00:40:00]** could see. And then we went on in. Well, Paul Orkild who was one of the geologists from the USGS and was a good friend of mine, was one of the early guys who went there because they were looking at the geology of the site and that was one of the first things. Paul used to like to jog. He went out one morning and he said again there was nobody there, and he went past this little guard shack and got down about to where the turn was,

and suddenly there was a guy behind him. Paul kept going, and the further he got the closer this guy got, and when he got down almost to the road, so he'd gone a mile or maybe a little more, this guy finally caught up with him before he got to the other one and told him, `You really shouldn't be out there because there are snakes.` And the fact is there are venomous snakes. There's an asp that's out there. There really are apparently venomous snakes out there, but the thought that, you know, that was why he shouldn't be out there on the road was kind of, `Gee, you're so nice to me to tell me that.` But Paul being Paul said that he didn't ever go quite so far, but every time he got down to about where the bend in the road was, somebody would appear behind him.

Well, Americans are just so used to being able to go wherever they want to go without worrying about who's watching. So you were among a very select group of Americans who got to see the closed city, even got to get into the interior of the Soviet Union.

Yes, there were fewer than a hundred of us on the whole list that went over there.

Yes. And you were there for two weeks. Did you go back again?

Just short of two weeks and I did not return.

It was just that one two-week period?

Yes.

Well, can you tell me how the Soviet Union's nuclear program compared to what you saw in the United States? Because you would be doing containment, isn't that what you were—?

Yes.

To kind of analyze—?

Well, there's several parts of it. As far as nuclear design, I am not a designer; I couldn't design a bomb but I know a fair amount about it and how they work. I don't know a lot about the Soviet

bomb, and what I do know I can't really discuss anyway. But technically they were pretty adept. They had some good people. Their testing was different, and for containment in particular, I'm glad I didn't have to work there because the Nevada Test Site is a dream for underground testing because of the geology. Their test site for underground testing is horrendous. It's a wonder that they *ever* contained anything.

Now they have a higher water table. Isn't that one of the problems?

Yes, it's virtually at the surface.

So any tests that they had, they had to deal with water?

Yes. Well, it wasn't water. We have a lot of gas-filled porosity in the soil—the top several hundred to even a couple of thousand feet deep—so there's a lot of sponge, so to speak, in the alluvium and in some of the tuffs. So we can generate a lot of gas and it'll just kind of seep out and stay there. Well, the Soviet test site was a lot of hard rock. They didn't have alluvium with a lot of porosity. What they had was fractured hard rock, and the fractures would take stuff *that* way instead of just diffusing it like alluvium. And then it was filled with water, so there was no place for it to go and the pressure would just go out through these cracks and then, well, most of their events seeped. And once we got to appreciate the problems their containment people had, I have great sympathy for them because I wouldn't have wanted to work there either.

Now tell me why. Was it more hazardous? Was it more dangerous with flying particles?

No, just volatile radionuclides as opposed to particulate like you'd get in a cloud that would blow out. They just nearly all seeped. Are you aware of the difference between a seep and a vent?

No. Well, a vent is kind of when it comes up from the surface, isn't it?

Yes. Well, a vent is something you can see. It's a cloud. You don't need instruments to see it. You *know* there's something coming out of there.

Yes, because I have *seen pictures where it says, This is venting, and I thought, OK.*

[00:45:00] Yes, that's venting. A seep, you wouldn't even know it was there unless you had radiation detection equipment. And they didn't have much in the way of venting. Before Baneberry, roughly 30 percent of our events would have some kind of detectable seepage. And after Baneberry, we had four in over twenty years.

That's really good.

Oh, yes, we did very well.

It seems like I remember a chart and the volume wasn't very much, even with the four that were there.

No. But they continued to have a lot of seeps. Not massive venting, but seeping. And the funny thing about it is that they didn't consider that to be a violation of the treaty. The treaty—

It would've been by American standards.

Yes. Have you run across that, the subtle difference in the wording? The English version of the treaty essentially says, Any radioactive effluent, which would mean gaseous, you know, anything. Their version of it translated back into English means fallout and not just effluent.

So it would be the air.

Yes. Well, fallout is particulate, so they could have radioactive *gas* coming out and wafting across the countryside, but if nothing fell out on the ground, then it wasn't a violation of the treaty.

Then you're OK.

Yes. And they *knew* it was likely to happen, so they just kind of stayed upwind. They weren't so concerned about a little bit of radiation on people anyway, as we were. And out where their test

site is, it is a pretty remote place, too. So they didn't really care much, they didn't think they were violating the treaty and in general; as far as they were concerned, they weren't.

Well, were you able to get a sense of how the Russians felt about their own nuclear program?

Well, that was the other thing. The third group was the people who actually worked at the test site and the equipment they had, if we used that OSHA [Occupational Safety and Health Administration] would have shut us down in the twinkle of an eye. The equipment they had was poorly maintained, at least it appeared to be. It worked but it was old and rusty and—

Needed to be updated and just the money wasn't there for that.

Apparently. Well, they have a thing: if it works, don't fix it. Put your money into something that you *don't* have rather than replacing something that you already have. So this is why they could continue to have some *really* pretty high tech stuff, but the everyday equipment was on the edge of being a shambles. But it worked, so they just kept going until it quit. And it was really weird. One of the things that amazed me: you mentioned the high water table. Coaxial cables—the kind that has a braided outer jacket—gas will go through it. In fact, water will seep through it, too, through this braid. And with the high water table, they'd get water into their electrical cables, and even into their device firing cables. What *we* would've done is say, `Whoa! How are we going to keep water out of the cables?` Well, they didn't do that. They brought the cables up at the top of the well head, ran them up over a sawhorse, made a loop up over another sawhorse, cut the outer jacket on the bottom. The water came up, dripped out the bottom, went back up, and then it was dry and then it went into the device system.

So they probably came up with more low-cost solutions.

Yes. They were pretty inventive. So there were things like that that we *never* would've done, but it worked. So once they found something that worked, they went on to the next problem.

Well, I understand that their technology wasn't actually all that far behind our own.

That's my understanding.

Except for when it came to drilling technology. That was where we were further ahead.

[00:50:00] Yes. And again, we had easier conditions. We didn't have all hard rock. We wanted bigger holes, too, which is why we had the advanced technology. They were happy with smaller diameter holes.

Now one of the differences, I believe, between the CEP and the TEP was that the CEP began to evaluate the difference between the bomb and the earth? Is that right? The conditions, the geological conditions, and things?

Well, yes, the geology was stressed at the CEP as compared with the TEP. The TEP was more interested in the yield of the device and the hardware.

Now they were more interested in using pipes, too, weren't they, and how the bomb responded to the pipes, or inside the pipes?

Well, no, that wasn't the CEP or the TEP. That's simply what was presented *to* the TEP. That's what the laboratories wanted to do at the time, so that both the TEP and the CEP simply reviewed what was given *to* them. No, it wasn't a matter that they set any policy.

Oh, OK. It seems like in the book it said something about bombs inside of the pipe and that there was a couple of tests that were successfully contained with the bomb being inside the pipe. And I didn't know how significant that was or how that was related to the TEP.

Well, as I said, both panels really just reviewed what was given to them and they didn't have anything to do with what *was* presented to them.

Now another thing that I seem to kind of pick up from Caging the Dragon *was that the CEP could kind of have an independent mind, no matter what the administration's policy was?*

Oh, yes, they were charged with that.

Maybe the good example is Star Wars. Maybe it was that there was a difference—they could differ from the administration in maybe their optimism.

Yes, the CEP was *charged* with, Thou shalt not worry about schedule or cost or what the device designers want to find out or the diagnosticians.

Money is not a consideration. Inconvenience is not a consideration.

All your job is, is to decide whether or not it is adequately designed from a containment standpoint. And if somebody else doesn't like it, that's not your problem. And it worked pretty much that way. From a practical standpoint, of course, you can't just say, Well, we're going to ignore cost. But the containment programs at the laboratories were constantly trying to find out ways to do things in a more efficient or a more cost-effective way. But once it got to the CEP, we hoped that it had been designed to the point where there wasn't going to be any problem on those lines.

The ceasing of testing is starting to create a vacuum of some of this expertise, isn't it?

Oh, yes, very much.

And so if the time ever came that it would start up again, there are no homegrown experts ready to step in.

Yes. There are a few at each laboratory, and by that I include DTRA. They still have a few people who haven't totally disappeared who know about *their* kind of containment in the tunnels. Both Livermore and Los Alamos have a *few* people but not many. The panel has lost several people. Well, just in the last few years we've lost the chairman who's died and a couple of other *very* knowledgeable members. A lot of the people who are *very* active in the panel are retired, and I'm one of them. And a few of them, not necessarily the panel but just people who were

active and knowledgeable in the test program, have retired and have said they're not interested in coming back.

Does that concern you? The future of—?

[00:55:00] Oh, yes, very much. Containment is one of the things where you can't really learn it from a book. Maybe it doesn't make sense because I'm writing a book hopefully to change that, but I know full well that you can read my book or read anything else you want and it won't really make you an expert in containment. I think nobody can be a good containment scientist—

Maybe for the record you should say what the name of the book is going to be.

Probably it's just going to be *Containment of Underground Nuclear Explosions: A Source Book,* tentatively.

And it's going to be, you said, it was a government issue—?

Yes, this was contracted by DOE.

Just for the record for, you know, to put that in, get access to it for more information.

Sure. And as I said, I hope to have the draft, certainly before the end of the calendar year and hopefully even by the end of October, have the draft to DOE.

That's a lot of effort. You said it's several years in the making.

Oh, yes. And it's three hundred-plus pages.

But it distills all that, all the knowledge that you've acquired over forty years.

It is that long. One thing that I was going to say is I think you can't be a *really* good containment scientist until you've been involved with a containment failure.

You do learn more from your failures, don't you?

Yes. And that doesn't mean it has to be a Baneberry or a Hupmobile or something, but just something where it's a matter of, `Hey, what did we do wrong?` And something you have to

go back and look at in a different fashion from an event where nothing untoward happened and you can simply say, Yeah, OK, let's move on.

Well, I think, you know, sometimes we forget that the development of the nuclear field was a learning curve, that there was so little known.

Oh, very—that's the name of one of the chapters in the book: "The Learning Curve."

Is it? Well, why don't you maybe just kind of summarize what your thoughts were on that idea?

Well, underground testing actually started in the late fifties. People even at the level of Bill Ogle and Edward Teller and people like that recognized that we can't continue atmospheric testing on continent and get what we need because all the surface radiation does give you a problem with your own diagnostics. People in Utah were beginning to grumble a little bit, and then the moratorium came along. But before the moratorium, there were several underground tests. The first one was Pascal-A which was in the bottom of a drill hole and it wasn't even filled up. You just had a little dirt dumped in on top of it.

Stemming was something that came along gradually.

Yes. And Pascal-A had virtually no yield but it had enough that it was fired early in the morning and the people who were there said that it was the biggest damn Roman candle they ever saw. This big ionized—

Went straight up.

Yes, and it was gorgeous. The first real containment test, other than a, Gee, let's put it underground and see what happens, was the Rainier test, and that happened fairly soon before the moratorium, which was in a sense kind of a blessing to containment because it gave a period of a couple of years, really, to reenter Rainier and do a lot of the study.

Yes, it said that there was more research gained from that time of stopping because they could *go back and they could do some things that if you're testing too rapidly you don't have the time to do.*

Exactly, and if we continued testing, we never could have done all of that reentry and spent the time doing all the analysis of Rainier. Then after the moratorium there was a rush to go bang, bang, bang to catch up with the Soviets. And several of those were—

A lot of tests in a short amount of time.

[01:00:00] Yes. And we didn't know much about containment or even care much because we didn't have the treaties or anything like that. It was again a matter of not messing up our own house by getting radiation on our own equipment and that kind of thing.

Now can you describe that Cold War feeling of competition with the Soviets? This is something that this generation coming up is not quite understanding.

Yes, that's funny. Once in a while we would discuss that in the evening over a beer or thirty or something. It's difficult because everybody had a slightly different approach, and in a way it was simply assumed that we were doing the right thing. It was not a matter of `Gee, are we doing the right thing?` Or, you know, `Should we be doing it differently?` We assumed that the guys in Washington, for example, knew what they wanted, the military knew what they wanted.

We were the good guys.

Yes, and that the Soviets in particular after they violated the moratorium in '61, that yes, we were the guys with the white hats. And it wasn't something that had to be discussed that much, at least among us. It was all pretty much assumed that we were doing the right thing.

Making the world safe.

Yes, and if we hadn't, we would have regretted it in the long run.

Well, describe what the Soviet Union—if the Soviet Union had taken over the United States, that was the actual fear, you know, because they had taken over much of Eastern Europe after World War II—describe what would [have] happened if your *efforts had failed.*

Oh boy.

Your perception.

Yeah. I think our feeling was that we probably would have been kind of an equivalent of East Germany.

The wall?

Yes. That we would've not had the freedoms that we're so used to. They would've thrown us some crumbs but we simply wouldn't have been what we consider the United States to be.

Yes. The Soviets had oppressed civil liberties of speech and freedom of the press, freedom of religion.

Oh, yes.

Freedom of religion was a big thing, you know, because at least they claimed to be a godless society.

Oh, yes.

And also property, you know, freedom to do with our property, that was something that they did not accept.

No. In fact, there was not much that *was* private property.

Yes. And most of the people you knew, that you worked with, that was, without even hardly discussing it, that was your common understanding.

Yes.

I really think that, you know, for the next generation, unless that foundation is laid of what we were fighting, the ideology that we felt we were defending, unless they understand that, that the testing itself doesn't make sense, you know, because you have to know who *the enemy was. The Evil Empire, whatever you want.*

Oh, yes. They were there.

And kids today can identify with terrorists a little bit, you know, but anyway, I just wanted to step in and get you to kind of mention that.

Oh, and one thing about the Soviet Union, too, is as much as they've claimed to be the great classless society, they had a *distinct* upper class and they had followers of the upper class. Probably the thing that got me the most is when we first went in to Sheremetevo Airport in Moscow on the way in, we were met by Sergei and Sergei just *loved* to lord it over the ordinary **[01:05:00]** people. All these other people were standing in line to get visas checked and to get luggage and all this, and Sergei just loved being one of the guys who could wave something and take us around the other way.

The privileges of royalty. Their own class royalty.

Yes. Right. And he was nothing more than a glorified chauffeur really, but he was working for the class guys and he just loved to lord it over the people who had to stand in line. And he was taking VIPs.

Yes. Well, let me go ahead and stop this.

[01:05:38] End Track 2, Disc 1.

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

OK, we were talking about the future of testing. I think that was something that we were onto. Oh, I know what we were talking about. We were talking about the Cold War. Now, is there any other thoughts you would like to give on that?

Not really. I guess one of the things that, you know, just sort of popped into my mind occasionally, but after having been, even though only for a few days in Moscow and for just short of two weeks out in Kazakhstan, I'm sure glad we don't have to live like that, or didn't. It's so totally different. As I said earlier, Moscow was one of the dirtiest places I've ever seen. The old part downtown around the Kremlin was still like St. Basil's and they kept up then. Even though it wasn't a church, they knew it was something worth preserving, so that was kind of pretty. But the further you got from the center of town, the worse it got. It must've been five, six, seven miles maybe out from the middle of the old town, there's this ring of twenty-five-story apartment buildings. And it's like, I don't know what—

Oh, wow. That's higher than I thought it would be.

Oh, yes, they were big. They're like three or four buildings in this ring around town, and they were this terrible gray. I guess they were cement or some kind of rock, but they were gray, there was no color; *absolutely* identical buildings.

Is it like almost stepping back into a hundred years ago?

No, it's not even a hundred years ago. It's a matter of being just so dreary. There was *nothing* to distinguish one building from another. It was mechanized living, in a way, there was nothing individual about any of it.

I bet Las Vegas would really be kind of a shock, wouldn't it?

Oh, yes, Las Vegas is the antithesis of what that part of Moscow was like.

Yeah, because every building has a different personality, almost, you know—

Yes, these had no personality at all. They were *all* identical.

Now did you feel like the people, I mean did they seem to be depressed? I mean did you get any impressions about that?

We didn't get, at least I didn't get, to see much of the people in Moscow. They kept us pretty much in one place because we couldn't go anywhere without them, other than for a short walk, as I had mentioned. So we kind of stayed together and we ate together at the hotel because we didn't know anywhere else to go and they were paying for it if we stayed there. So we didn't have much interaction with the Muscovites.

Well, do you have any thoughts or opinions about how the nuclear program helped to end the Cold War?

It certainly helped. I think it was one of the things that put the fear into the Soviet Union that they had to keep up, which put them in such an economic bind, which was the primary reason that they collapsed. I think they were truly afraid of our nuclear capability, and well they should've been. Without that, they could've redirected their resources and I think they could've lasted quite a bit longer.

Yes, because that was another thing that during the Depression, compared to the United States, the Soviet Union had some good reports coming out of it, that their system was in some ways stronger than ours, at least at that particular time.

In some aspects, yes.

And so another part of the Cold War feeling was that it was possible that they could **[00:05:00]** *surpass us economically because that was their theory.*

Yes.

But in fact, and in hindsight, we know it didn't happen.

No.

OK. Now did you do anything with Shagan?

Oh, yes, I was out there.

OK. Were you part of the CEP with that?

No. There was no review with Shagan. That was their test.

Oh, OK. Do you remember the review with Kearsarge at our—?

Oh, yes, I presented it. I was the containment scientist on Kearsarge.

Can you go ahead and share what you can about that? Especially since that's the event that I'm personally following.

Yes. Well, in fact, from our standpoint, meaning the containment program, the fact that Kearsarge was the JVE [Joint Verification Experiment] *didn't* make much difference, with one exception that I'll get to in a minute. By then we were pretty well developed; it was pretty far down the line in testing, of the work we did geologically and how we presented things, and also higher yield tests in a sense are easier to contain. So it was, from a containment standpoint, with the exception I was going to mention, which is the stemming plan, there was nothing really unusual about Kearsarge. The stemming was different because the protocol requires that stemming close in what they called a hydrodynamic region specially designed so that you get the best possible hydrodynamic yield measurement.

Now they were also wanting to take samples, weren't they?

Yes. Oh, you mean geologic samples or post-shot? Oh, yes, get the geologic samples and the logs which measures density and things like that.

Now were they to be sent to the Russians?

Yes. Well, they were here and they got their own samples, just like we got samples over at Shagan. Oh, I mentioned Paul Orkild, the geologist; that's why he was over *there*, to get the geologic samples and oversee that part.

Did you deal with the Soviets at all here?

Just a little bit, not much.

What'd you think of them?

The ones who were here that I dealt with were really pretty nice guys.

Viktor Mikhailov. Did you—?

Oh, yes, Mikhailov was—

Yes, and there was Il'enko, was another one.

Yes, Il'enko .

What about Mr. Alex? Did you meet Mr. Alex [Alex Shamtov] at all?

Rings a bell but I can't bring up a face.

He was a KGB agent.

OK. Probably heard about him.

They said he was obviously not a scientist.

OK, I do know who you mean. But from a containment standpoint, it was pretty much routine. As I said, the stemming, however, had to be designed according to the protocol and for hydrodynamic yield because the Russians, or the Soviets, were *much* less interested in the details of how their nuclear explosives worked as in how much bang for the buck. One of their primary measurements was simply the yield of the thing, and the cheapest way to measure yield is hydrodynamically. You just measure the shock front going out as a function of time and you can calculate yield from it. But to do that, you need a uniform medium that the shock wave is

traveling through during the first few hundred feet, depending on the yield itself. So the stemming was designed to have a very uniform medium, which is not what we would've had. But except for that change, which didn't really cause a problem for containment, it was just more expensive. It's the kind of thing we probably would've preferred to have, but more expensive than our normal stemming plan. So from that standpoint, other than the stemming in the bottom quarter of the hole, it didn't make any—

Now how long did it take from beginning to end to put that thing together and to implement it? I mean it had to have been done fairly quickly.

[00:10:00] Yes. Well, the hole essentially existed. We had to do an exploratory hole, or an instrument slash exploratory hole, that the Soviets got to instrument and got samples from. But that was done after the main emplacement hole was drilled. But the whole thing was done fairly quickly compared with some of our tests.

Now Joe [Joseph] Behne was the test director.

Yes, he was the test director.

Do you remember working with him, then?

Oh, yes. Well, I worked with him on so many events. I knew Joe for so long, they all kind of run together.

Yes, he's done a lot. I got to interview him and he had such a nice perspective from the beginning, you know, to pushing the button. It was good to get that overall view.

Oh, yes. You know, that's what the test director does.

Yes. He said it was like building a building, you know; that it's that *complicated.*

Oh, it is.

And so you presented the Kearsarge event for the Containment Evaluation Panel.

Yes. And actually then my alternate on the panel categorized it for Livermore because I could hardly categorize my own presentation.

Now it was one lab's test but the other one implemented it, is that right?

It was primarily a Livermore test, but it was in Area 19 which had routinely been Los Alamos, and because it was the JVE, there were some things in it. In particular, Los Alamos had been more involved in developing hydrodynamic yield stuff for JVE kinds of things. Don Eilers and those people.

Yes, I remember his name.

Yes. So they were more involved in the Livermore test because of that kind of thing, but it was still basically a Livermore test. We had the test director and we did the containment.

Is there anything else that you remember about Kearsarge that was noteworthy, memorable, or anything?

Nothing very profound. I guess probably the only thing that I thought amusing was when you went up near ground zero, they have a van up there with Cyrillic on the side of it, but other than that—

When you knew the Russians were coming, did you have a reaction yourself? I mean did it take you some to get used to that?

A little bit, but I didn't interact directly with them very much, unlike the people who were at the test site twenty-four hours a day. So not so much as some people, but it was sort of an interesting thought.

It was a big deal, though.

Oh, it was, yes.

It was the first time they'd ever come to our test site and the first time that Americans had come to their test site.

Yes.

Now have you done anything afterwards with regard to weapons inspections or anything like that? Or has it mostly been Containment Evaluation Panel?

Mostly still containment. And as I said, I'm still on the CEP. I've done a little bit; I went through the Defense Information Agency training to be an escort, which I can't really go into any more. So yes, I've done more than simply containment. Actually, I've been prepared to do more. I haven't really *done* much more.

Well, a lot of the lab people, they were needed. That's almost been a next step, is weapons reductions and inspections, especially when there was no more testing, you know, that expertise needed to be used in other areas.

Yes, especially the device engineering people.

Yes. OK, let's see. I took note of some of the tests at least that were mentioned in there. Neptune formed a crater. Logan, Platte, Des Moines. You know, these were some of the **[00:15:00]** *ones that I guess with each one there was something that the containment evolved into a next step of, OK, we'll change this because we've learned—*

Yes, although with *those* in particular, those were very early and they weren't even looked at as containment. They became important in containment later on. You know, part of the scientific method is that you can do a controlled experiment. Well, very soon it became obvious that we can't do a *controlled* containment experiment in the sense of, you know, we go bang, bang, bang, oops, that's close enough and it blew out. We can't do that. So we went back in history to the cratering shots and these that you mentioned, like Logan and Neptune and Blanca, some of those

became our failure database. They became important after the fact; they weren't considered to be containment at the time.

So it's just knowledge gleaned almost as hindsight, then, because they were there.

Yes.

Now I read where there was some concern that at the test site, there was still a lot of knowledge that needed to be gained from these tests that have already been done.

Oh, yes.

And there's kind of a reluctance to pursue that?

I don't know that *I* would call it reluctance. Well, things have changed with time, too. A lot of it was *because* of so much that we were doing and you didn't have time, unless you had a real disaster, to go back and do anything. Probably the *best* example is December of 1970; we did Carpetbag which was a *big* event, big in yield, in Yucca Flat. We did an event called Avens which had several devices fired simultaneously. And there was a seep, a release, on Avens that was—we still don't know quite what happened and it should've been investigated. The problem is we did Baneberry the next day, so Avens just went *pfsst!* You know, forget all about it. So that's one that in an ordinary operation, we could've learned a lot from it. Turned out we *didn't* because of Baneberry. All the resources went there.

Is it too late to go back and learn some of that stuff by excavating and things?

Actually, we *did* learn *some* more some months later. We were drilling some new drill holes in the area near Avens and found radioactivity underground in this new drill hole. We went back and tried to reconstruct how it got there, but because at the time of Avens we didn't do any more investigation. By then except for a few things, all of the radioactive material had decayed or it

was so low level that you couldn't really track it, we never really got a decent explanation of what happened.

So there's a problem with going too fast, then.

Yes, in that case it was.

Now the tests have changed quite a bit in complexity over the years, too.

Oh, yes.

Now would you like to make a comment on that? I understood that in the early years they could be put together, you know, six weeks, a couple of months, and in the later years it would take several years to put together a test which would actually be the equivalent, at least as far as yielding information, of a lot more of the earlier tests.

Yes, some of them could take that long. There were a few. Probably the so-called Star Wars things were the most complex and they had *very* complex diagnostics. Livermore was looking into doing a long line-of-sight event which we hadn't done for twenty years.

Did they actually do some Star Wars testing? I know there was talk about—I don't know who it was. Or did it shut down quickly?

[00:20:00] Well, there was a lot of work done on it. I don't—

Design level, you're saying.

Yes. I don't think I should—without knowing the current guidance, I don't think we ought to discuss it anymore.

OK.

But there was a lot of work done.

OK. Well, that's interesting. Let's see, we were talking about complexities. Would that make a presentation more complicated, then?

Sometimes. The problem with the diagnostics canister and all that stuff was relative to the yield. When a bomb went off, an explosive, it would very promptly vaporize material out to a distance that was actually like two meters times the cube root of the yield in kilotons. So a one-kiloton explosive would promptly vaporize out to two meters and eight kilotons, where the cube root is two, would promptly vaporize out to about a four-meter radius. And then more than that, out to about four or five times the cube root of the yield, it would promptly melt it from depositing energy as the shock wave went out. Well, if the canister were within that melt radius of, say, five meters per kiloton to the one-third, then it was moot because there was nothing there to affect event behavior. If the canister went on past that radius, then you started having to look at it because then it survived the initial explosion. Then you sort of had to start looking, and in some cases there were line-of-sight pipes that went to the final cavity radius, which was even further than that by quite a bit. So the longer the pipes were with respect to the size of the cavity, which was dependent on yield, the more concern there was to contain it. But we had enough experience from earlier events in the sixties and early seventies, that unless it was *really* an unusual configuration, it didn't cause a problem. But we did have to look at it, and the bigger these canisters got, the more we had to pay attention. They never *really* caused us any serious problem. There was one event called Dianthus that behaved in an almost amusing way *because* it had a big canister and the canister was big compared with the explosive. It ended up with the hole almost filled still with canister and the cavity growing down here [demonstrating]. The emplacement pipe was very strong because it was a heavy can, so it didn't just crumple the way they normally would. So to make a long story short, within a second or so after zero time, the emplacement pipe rose out of the ground forty, fifty feet and it was known either as the Dianthus Dipstick or the Dianthus Flagpole. And this thing just came right up out of the ground. It was fascinating.

Instead of exploding. Oh, that is funny.

Yes, that was about it.

Well, do you have any other memorable shots or even of things that—lessons learned from—I know Baneberry, there's lots of lessons from Baneberry.

Oh, yes, Baneberry. There was an awful lot done. As I said, I was there at Baneberry and I was what *would* have been the containment scientist if we had had one at the time. I was primarily involved then with the containment diagnostics.

That was really alarming, wasn't it? That just kind of almost set things back for a while.

Oh, it did, you know. I worked Christmas Day that year doing data analysis down hole; pressure and radiation and so forth data for Baneberry.

[00:25:00] Some others that were important to containment: Hupmobile was one. That was another one that vented; that was a line-of-sight to the surface which didn't close properly.

Yes, there was a note there that a containment group was formed as a result of that.

Actually it was formed just before that; I was in it. The group leader was a guy named Phil Randolph who was actually an associate division leader. There were about four of us in a fairly fledgling containment group at the time when Hupmobile happened.

Well, you really weren't very old when you began being on the containment either, were you?

Well, in containment at the lab, I was about thirty, or actually twenty-eight, twenty-nine.

So a lot of career people that started out really young in the early—in this work stayed on and matured and gave the program the benefit of their maturing.

Yes, and there were a number of guys who started even younger—especially engineers who went there with a bachelor's degree who didn't spend time in graduate school that started there when they were twenty-two, twenty-three.

There was a lot of action there, wasn't it?

Oh, yes, very much so.

A lot of problem-solving. Was it exciting for you?

Oh, it was, yes.

I mean was it something that, you know—?

Yes, the lab was a great place to work, especially in the sixties and even after Baneberry, but it wasn't quite so almost frantic as it was in the sixties. Nice thing about the sixties is that there was basically no budget concern. If you needed it, you got it.

You're a top priority.

Yes. And we did some wild things, in retrospect, not nutty but almost humorous in a way. One of them that comes to mind was an event called Hutch. We were trying to measure the pressure in the cavity itself, which turns out to be extremely difficult to do because of all of the energy; whatever you put down there to try and measure it gets destroyed. Well, we thought, How can we keep a pipe open so that we can measure the pressure up at the top and find out what's down there? The simple thing was, Well, heck, you fill it with water and then you can measure the pressure at the top. And Hutch was a fairly deeply buried event, so we had this long pipe that went down. The pipe itself was like seventeen hundred feet down from the surface. But to make a long story short, the thing started leaking. We put in water and the top started going down, so it was, `What the heck can we do about this? If we just let it drain out, we know we're not going to get any measurement.` This was on a Friday afternoon, so Friday night and Saturday morning, everybody in Las Vegas and Livermore was running around to every car parts place they could find, buying every can of Stop Leak that was available. We flew

it down from Livermore and brought it out from Vegas and dumped all of this in, and it helped some.

Well, that's just an automobile.

Yes. And we didn't get a cavity pressure measurement, I think, not because of that but simply because the yield of the event was high enough that there was nothing we could have done. But we did things like that, and now you'd have to write a proposal. Then it was, `Go buy it.`

Yes, just go out and do it. Well, it seemed like I was reading in Caging the Dragon *where there was some elaborate attempt to make the holes safer, and I think it was Huckabee, Fred Huckabee, who said that,* `My guys don't fall,` *or something to that effect I think that was an idea that came out of the containment panel, I believe. I believe it was and—*

[00:30:00] I don't remember that as being part of the CEP. There were a few accidents, but very few, which was amazing considering the things we did. There were a couple of fatalities: a laborer who did fall into a hole up on Pahute Mesa and a couple of people were hurt on Peninsula, which was an event that was being emplaced and it was part way down hole and some bolts broke. Turns out they were improper bolts that had gotten out to ground zero. All the cables and everything were connected to it going down, so when it broke and everything started whipping around, some people were injured. Actually, we're lucky nobody was killed on that one.

The safety record was kind of marvelous, though, wasn't it?

It was incredible, yes, considering the things we did.

Well, when I was talking to Larry Neese and he had all of his fingers, even though he had dealt with these hundred-thousand-pound weights, you know, that there seemed to be a concern for safety and for their lives, so those are some good things to think about, too.

Oh, yes. One of the things, though, too, is even though it was a great concern, there was considerably less concern about a *little* bit of radiation exposure. Now, people go into orbit at the thought of how much they get from a dental X-ray or something; you go in for a dental X-ray and they cover you up with lead sheets and everything. At that time there was really no great concern on most people's part if you got a dose of a couple R.

Now was it because it just seemed like a low dose amount and we didn't really know what it does to you, therefore…?

Yes, it was. Well, it was partly that and it's partly the evidence is that it was insignificant. There have been a few studies later on that say, `Well, yeah, but it does add up,` and you can find just as capable research that says, `Nah.` But it was considered that a dose of a few R wasn't going to hurt anybody.

Now were you exposed to about that much through the years, then?

Oh, yes, there were a couple of occasions when I got that much in an hour or so. In particular, the reentry of Door Mist. We had gone back in because it *was* a containment failure and DASA then had reentered, re-mined back in to find out what had gone wrong. A couple of us from Livermore who were then in containment, Phil Randolph and I, went into the tunnel to look at what they had found. It was pretty hot, and we got a couple R. It was sort of, `OK, it goes on your record.` I haven't grown another head and no fingers have fallen off.

That's good. So your health has been respectable, then, through the years?

Oh, yes.

It is really curious how the same two people can have the same kind of exposure and one it doesn't—no problem at all, and the other one, you know, ends up with something or other that he says it must've been the radiation that did that.

Yes, and odds are—

It's not a solid, exact science, is it?

It wasn't, but you never know with anything that's probabilistic like that or statistics. You can look at a big population and say, `Well, yeah, one out of umpteen have some effect,` but you don't know what causes it, unless you can do a really controlled study, which you can't. Again, well, it's like containment, we're not going to be allowed to take a bunch of people and do a study and keep giving them bigger and bigger doses of radiation.

No, you have to find people who are already exposed and then just track them.

Yes, and even then you can't do a controlled experiment. You don't know what a population *like* them that didn't get exposed would do, so it's very difficult.

[00:35:00] *Yes, it's been a very interesting industry, and as a scientist it must have been quite exciting to get to do a lot of those experiments and scientific method and have a very large lab.*

Oh, yes.

That's good. Well, OK. Maybe I could just ask you some highlights or special thoughts, just kind of maybe philosophically thinking. What do you consider to be the most difficult time of your life or your career?

It depends almost what you mean by "difficult." Do you mean professionally or personally?

Either one.

Personally, there are two things; one of which is specific and one of which is nebulous. The specific one was when I got passed over for a promotion when I and everybody else in the program thought I should've gotten it. But it was given to a buddy of the guy who made the appointment. And I won't go into any detail on that.

As a disappointment, then.

Yes. And I got over it. Probably the nebulous one is there were times when it was a bit of a strain on the family, especially when the girls—we had two girls—were getting a little older and they were old enough to know that Daddy was gone but not old enough to understand why. And there was some strain in the family.

You were one of those marriages that lasted, though, weren't you?

Actually we were separated for a while. We got back together, but yes.

Because it seems like they're a hardworking group. Really, really hardworking group.

Yes, there were a lot of marital problems, and a fair number of guys who had an extra drink or two.

Had your wife ever worked within the program itself?

No.

So she was one of those that just kind of had to accept that what you did was noble and good and you couldn't talk to her about it.

Yes.

So that difficulty in keeping your work separate from your home life, that's part of the strain of that kind of work, then.

Yes.

I appreciate that because one of our interviewers has been interviewing wives, and there's a difference between interviewing the wives who have participated in the testing program in some way versus *those who have never, and those women have their own story to tell.*

Yes, I'm sure they do.

So it sounds like you were able to step back and—

Yes.

That's commendable.

We managed. Let's see, as far as the program, I suppose the hardest time would have been Baneberry because we hadn't the foggiest idea what had gone wrong in the beginning. After we went back and started looking at it, we got some clues but we didn't even really have a fairly good idea—until now we don't really have a *good* explanation, but we didn't even have a reasonable explanation until a couple of years later when we had done calculations—

And containment itself still isn't always a guaranteed process.

Oh, no. No, not at all.

Which is, you know, for someone who—you hope that you can give absolute answers, perfection, no fail, zero tolerance for failure or escaping anything, and yet it's humanly almost impossible to place those kinds of guarantees.

Oh, it is, yes. And Baneberry was another thing that, at the time, dynamic ventings, you know, the cloud coming out, the [makes gasping sound], almost invariably started within the first **[00:40:00]** minute, and after about two minutes, your pulse rate started to go down. After three minutes, it was kind of, `Ahhhh, well, we got another one.` Baneberry started venting at three-and-a-half minutes, when everybody had pretty much decided that, OK, we managed another one. We can go home for Christmas. And so that was a real surprise. It wasn't supposed to happen at all. And if it had to, why didn't it do it at thirty seconds, because we could've understood that more. We still don't understand why it took three-and-a-half minutes.

Now wasn't it a fault line? Wasn't that what the problem was?

No. Well, that was *a* contributor, but there are—well, depending on how you look at it—three or four different factors, all of which had to be there and not one of which caused it.

What were the factors?

Clay alteration, which gives you something that's very weak when it's wet, the water that was there, the fault, and the material below the working the point. Well, the entire geologic structure, the fault and the other materials in the layering that gave reflections in the shock wave just the right way that the material around it failed. What we *still* don't understand is why it took three-and-a-half minutes, because our modeling said it could've just as readily done it in twenty seconds. Fifteen seconds. So we don't know why it was sitting there cooking for three minutes before it came out.

Boy, there are a lot of answers, it sounds like, still yet to be figured out, then.

Oh, yes.

Oh my goodness. You're making that learning curve chapter more fascinating all the time. And it was funny, I think there was a quote in here, something about like `We, still don't know anything about containment.`

Somebody may've said that, yes.

Who was that? Anyway. Final analysis is we still don't know. We still don't know everything about it.

No, not at all.

It think it was in the last chapter. [Reading] "Billy Hudson's closing words perhaps make a suitable summary and ending for this book. I guess the upshot of all that is we still don't really understand containment very well."

Yes.

And you know this seven-hundred-plus-page book explaining that. If you had to do it over again, would you make any changes in your life?

Strangely enough, I don't think so. I think by and large we did the best we could at the time and to try and second guess yourself, knowing what you know later, isn't productive. I think we did the best we could with what we had at the time and I wouldn't change that.

OK. What do you consider to be the best time of your life?

With respect to containment, there are two things. One is the time in the early and middle eighties when I was the Livermore CEP guy and Jack House from Los Alamos *really* worked to try and get the laboratories back on the same track.

Yes. That's when you were bringing them together.

Yes. That was rewarding.

A very positive—yes.

The other time would've been in the sixties, which was more hands-on in the test site; when it was simply such an exciting place to work. A lot was going on. You had a lot of very dedicated people you were working with. It was just a great place to work; very interesting, exciting.

Meaningful work.

[00:45:00] Good science, meaningful, you know.

Yes, and really as a scientist, just having a huge laboratory with a lot of bang for.

Yes.

Who or what do you think has been the most influential in forming your way of life, your way of thinking, your guide?

Again, on a professional level, I'd have to say my graduate advisor, Charlie Nash, at Davis. He was young; I was his first Ph.D. student. But he was an *extremely* bright guy and had a way of conveying how neat experimental science was. He wasn't a theoretician; he was experimental.

But had a wonderful way of just conveying how necessary and how much just plain fun experimental science could be.

That's wonderful if you find somebody like that who gets you headed in a direction, or even who helps you discover what you *are strong in.*

Yes And he also, as I mentioned earlier, is the one who got me connected with what was then the Lawrence Radiation Lab, the LRL.

Well, it is nice, the way some things kind of, you know, roads open up for you and lead you to where you are.

Yes.

Well, you've answered my questions. Had you for over two hours.

Great. Oh, has it been that long?

It has. Is there anything else you would like to add for the record? I really appreciate your sharing this with us.

Oh, I appreciate the chance to *get* it on the record somewhere. I think there's been so much that is in danger of just kind of disappearing through the cracks that I think that somebody who is making the conscious effort to preserve it is just wonderful.

It'll be available for scholars; we're hoping for the younger generation. You know, the questions that I *had growing up, knowing the test site was there, and now there's children of test site workers that now will have a chance to see what exactly was going on and judge for themselves if it was done in an honorable way, you know, and I think if they find those answers, it'll be good.*

Yes. What are you going to do with this? I assume there'll be a transcript or something.

Yes, there will be—

Is it going to go beyond that, or just be a transcript? The reason I ask is because I have read literally thousands of pages of transcripts of the CEP; the CEP guys are bright guys by and large and almost all of them, if you read a verbatim transcript, sound like congenital idiots. There's never a complete sentence. There's a bunch of *ah*, *uh*.

Actually that's human.

I know.

And there are ways to eliminate the false starts, to kind of smooth things a little, but all of us humanly don't talk the way we write.

Oh. Thank heavens, yes.

So we will go over this. We will do some polishing.

OK. That's a lot of work. I was just curious if anybody had the time or not.

Yes, that's part of it. There'll be the CD record. There's a couple of other organizations that are interested in archiving it in theirs. If there's information that we can coordinate and use to get the story out into the public, into the schools, I mean there'll be educators who will have access to this. So our hope is that you put enough stories together, it will tell the different pieces and parts to it.

Good. Good.

[00:50:00] End Track 2, Disc 2.

[End of interview]