

**Phillip Morrison Interview**  
**November 30, 1999**

**What was your initial reaction to Los Alamos?**

**01:13** I arrived very late in the day, sometime in August of '44, with the big expansion that went on in the Lab in the middle of 44. So I heard a lot about it. My reaction that I remember is absolute wonder at the beauty and extraordinary quality of the physical surrounding of the mountains. I had not been in New Mexico before as I recall. Of course I had driven there, so I had some idea. I'd heard about the Mesa and the rest. That was overwhelming, was the sense of the sense of the amazing place I was going to. But, of course, very concerned at what we were going to do there...what could happen, how it could be done and so on. I was devoted, I was enlisted for the duration for as long it was going on. I had been on the project for three years in Chicago, and recruited from Chicago to Los Alamos, at the time Los Alamos crisis by Robert Bacher.

**Did Los Alamos strike you as kind of a boom-town?**

**02:26** It was wartime, it struck me as being a military camp. There was an influx of University people, many of whom I knew. I felt right at home and of course famous European Physicists whom I'd never met were quite common and walked about.

**I've heard Los Alamos described as being to scientists, like Hollywood was to starlets.**

**02:52** Well I wouldn't put it that way because starlets are publicly known, whereas the others are not. It was the inner secret, probably most of the people at Los Alamos, uh soldiers and other people at the Laboratory didn't know these people and had never heard of these people before; finally learned about them by having them pointed out on the street. It was a specialized thing, it was not like celebrity. That really backs the present back into the past. Nobody ever heard of those people before in the United States except for their Physicist colleagues who studied and used their works.

**When you first got there where did they put you to live?**

**03:29** Oh, a nice...I'm sure, but I'm pretty sure it was the same house I ended up in. A little duplex, one couple on one side and one couple on the other side. A little three or four room house. Can't remember the name of the guy that was, but it was pretty close to the tech area.

(Sundt home?)

It was probably a Sundt home, yes.

**Do you remember who your neighbors were?**

**03:53** Yes, he was a very well known person. He was not a scientist but he was a lawyer. He was the son of the speechwriter of FD Roosevelt, a mister Rosenman. Didn't have much to do with him, but I knew his name and we were friendly, casually friendly. There were so many people we knew. I always remembered I walked to work, I was not far from it and there were thirty houses I would imagine. I knew somebody in fifteen or twenty of them. You know, that's not an ordinary city, even a University town doesn't have it like that. So it was impressive. We were a close community.

### **What was the mood like living there?**

**04:31** Intense. Intense concern, intensity of work, intensity of hope, intensity of wonder...didn't know what was going to happen next. I felt very much, and I expect most people that came in that '44 crisis felt like soldiers. We were being enlisted to win this battle...everything would have to go.

### **Was it difficult to live there?**

**04:58** Well, it was difficult more for the people who came there earlier because they came from America which was functioning rather normally and is it went downhill...it was hard to get you cleaning done and et cetera and whatever...they felt it was all the fault of living in Los Alamos. But in fact it was better off in Los Alamos than we were in Chicago, because the army was taking care of us better than the people in Chicago. But, gas was short and meat was short and rubber was short for tires and everything else and so on. So all these small impediments of wartime, travel was very difficult, they all became easier for people at Los Alamos, we thought, than the outside world. Whereas they who had been there as it slowly worsened and more people caught up in the war, 15 million people in the service at that time, population half of our present population, it was a big effect. I thought it was OK.

### **The first place you checked in was East Palace.**

**06:00** Of course, 109 East Palace, Dorothy Kckibben took care of us, yes. Oh wonderful person, absolutely one of the most dearly from Los Alamos. Knew everything that had been born and raised in that region. Knew the city very well, knew the people very well, the places...understood quickly the relationships of the people of Los Alamos, and was devoted to each person who came in as a new person to try and make that one happy. Was a wonderful reader and organizer. Outspokenly cheerful, and able to say what was wrong when things were wrong, and point out what was right when things were right. Couldn't say too much about her.

### **@ 109 E. Palace.**

It was a flat, courtyard kind of place. I can tell you this. I went back to Los Alamos a couple of times. One of the times I was staying downtown a

couple of days and I was drawing a bit of my own and sat in front of 109, the real one, and drew it. In the 50's or 60's....

### **What did you do there?**

**07:46** I joined a group of physicists headed by Robert Frisch, already well known to me by reputation. I'd never seen him. He was with Lise Meitner, the co-discoverer of fission, explained how it worked, how it would release energy, how it would make neutrons all in the first paper that came out in February 1940. That was the beginning of the whole thing.

### **What was your job at Los Alamos?**

**08:18** I was working in his group, we were called the Critical Assemblies group. And, it was remotely like something we had done in Chicago with Fermi. We were making the measurements of the reactivity of mockups, small models of the big reactors that were eventually built at Hanford. It was our job to measure that in detail. We learned a lot about that kind of neutron physics, very straightforward. And then we were doing the same thing here only not for a big reactor but a little thing like that...the core of the bomb. Much more dangerous, fast neutrons instead of slow, but we understood the differences.

### **At what point did you recall that fission became a prospect for a weapon?**

**09:06** Well that's a wonderful story. I wanted to tell that story to begin with and I'm glad you asked it. In the last part of January 1940 I was a graduate student...24-years-old at Berkeley, my thesis supervisor was Robert Oppenheimer who became the Director...the wartime director of the Laboratory. There were about a dozen of us. We were young theorists. I was about the third year, people the second year, people the fourth year around me, people quite friendly; spend a lot of time together doing our work. Calculating, trying to follow Oppenheimer's very rapid delivery and so on. Shared a great deal of enthusiasm about work. We were nuclear physicists and electrodynamic students, that sort of thing. A meeting was held in the east at that time in Princeton and Washington, I believe and during one day in the middle of that week in January whenever it was...some one of our group from Berkeley phone up and said: the most amazing thing has been told us here. And he told the story, brought in by Neils Bohr from Europe, not yet published, the same material Frisch and Meitner would publish, they'd already sent it in, it took six weeks to publish. It only took days to go across the Atlantic even then. And so they beat the news, they told us all about it. We were astonished, we could understand was unmistakably true, you know, what they said. And so we talked about nothing else for days and people in the Lab who were experimenters began to set up the equipment to demonstrate it. And within a day or two...even I who was not close to this at all, I was not a experimenter. I had no laboratory, just paper, but my friends had and they said

come see this we've set up and it's working in the lab. There'd be three or four of these demonstrations a day. All you need was a quarters worth of uranium you'd get from the chem stores and put it there with a neutron source, turn on you amplifier and oscilloscope and the green spikes would appear on the screen. Those big green spikes were the fission product...track. And they were a hundred times stronger than the alpha particle tracks which came with them in the same sample. So you knew this was a huge amount of energy being released. And that, I'll never forget that. It was the first thing I saw. But once we saw that we very rapidly, we knew very little neutron physics, we were graduate students, we were not up to that level. But in the next week, most of our conversations and chats, and you know...out of work discussions over the table, was talking over fission...how it might work, what you could do and so on. And by the end of that week, maybe the next week, we'd drawn on the blackboard, jointly...all of us...what I've always called an exorable drawing of an atomic bomb.

That's how fateful it was. You realize we were at war. The war just began four months earlier. So we knew it was going to develop into a terrible World War and this coming at that time seemed a fateful move, it was. And we immediately saw, no one's mind was on anything but...how could this be used for war. Gradually it became clear...it's quite possible to make an explosion with this. We didn't know how, we didn't know what, but we used key words we knew something about it...it was deuterium, it was uranium you could see how it would go. And that was amazing and I think it happened all over the world. And I found out one piece of evidence for it. Later on the letters of Robert Oppenheimer were published...oh in the 60's maybe, and he had written a letter in the same days we were doing this to his old friend at the University of Michigan...Ullenberg, and said I've just heard about fission and what do you think, it is the most amazing thing. It seems very likely that a kilogram of uranium deuteride might blow itself to hell. So that's how it was. That's why there's no mystery in the...in the details there's everything. So, I don't say it was real then but it was a potential so obvious we understood it as graduate students in Berkeley and I'm quite sure...I know at the same time...you know I got the years wrong, I said 40, it was 39. The war had not yet come.

**The information you all had had come from the German experiment?**

**13:33** No, it was information that Meitner and Frisch did out of an earlier German paper where they discovered the effect, but didn't understand it. But Meitner and Frisch made order out of it, showed what it was, made it quite clear what the physics behind it was in a broad way, not yet showing the chain reaction but showing the potential of such a thing. And that was published in Nature in February 39, I had the dates of the year wrong before. They were both German immigrants...one working in Britain, one working in Sweden.

**And because they achieved fission is spread round the world.**

**14:19** Yeah, but you put it the wrong way. It was not achieving fission. Nobody knew about fission. What we have here, this mysterious thing, is fission. They named it; they understood it. Frisch and Meitner. So...as I say if six rather energetic grad students in Berkeley can in a week do something foolish in the right direction, you can be sure it happened everywhere else. And I looked into the history a bit and in 1940, at least five or six countries had official committees looking into it...including Japan. Not much, I was there and looked into it...little to do, but they tried. Germany, Japan, Soviet Union, USA, France...

**The Russians were able to tell we were looking into it by the disappearance of papers in international journals?**

**15:15** Yes, but that was quite late. That didn't happen till late 39 –early 40. Yes by that time all such publications stopped in the US. Everyone quite knew that would make the signal, but it was something interesting, and it was something already known.

**Who else did you work with?**

**15:33** Well my boss was Frisch, I worked with, in Chicago, Fermi and Vigner. And in Los Alamos I worked almost exclusively with the Frisch group. We shared a laboratory building with Fermi's group so we saw fairly quite often.

I came to the Met Lab, I was asked to come to the Met Lab to interview for a job and they didn't tell me that, but they said come see me. A friend said come see me, so I had some idea about that. A few days after. I was infused with excitement, I don't know why.

**What was the impact of Trinity and the end of the war like for you?**

**16:24** Well, of course, it was an extraordinary experience. We'd been working on this thing for a long – long time. The whole context had changed. The war was over in Germany. The war was blazing in the Pacific. And we knew the Pacific War was the only thing it was going to be used for and it would probably be used that way but we didn't know that for sure. And...at that time, I had been removed from the group which I had mentioned, otherwise I was still working. But two of us, another physicist at Los Alamos you might know, Marshall Holloway, and I were made, jointly, what were called G Engineers in April of 45, and our task over the next few months was to become responsible, you know give a technical and procurement...test procurement to us for making sure that all of our division was doing, that means the whole nuclear assembly that surrounded it, would be ready and working, and tested with the auxiliary support apparatus that people do and everything else ready to go as soon as we could. That was our task, so I knew a lot about that.

**What was your choice after the war?**

**17:42** Groves and Farrell asked me to go to Japan from Tinian where I was. I went to Tinian...I guess I was the leader of the group that assembled the plutonium core. Nothing to do with the Hiroshima bomb. All our attention was focused on the plutonium one...so we made that ready. Maybe half a dozen of us. You know there was a party of about 60 or 70 people from Los Alamos to Tinian, which was the air base from which the bombs were delivered and these people set everything up...made everything work. There were no manuals or military that knew about it. We had to do it...we came right out of the place, there was nothing written down, we had to do it.

They asked me to go to Japan. I went there essentially with two missions. Originally more as a public relations expedient for the general if anything else to go to...for me it was Hiroshima others it was Nagasaki to go and look at the radioactivity on the ground and make confirmatory measurements to show the Japanese had it right and to tell the people it was not blazingly dangerous on the ground, it was terrible to be there, but afterwards there was not much left. And that's what I did for a week or so. And then I went around visiting all the physicists I could, partly to see what they were doing, partly because we knew many of them were friendly trying to rehabilitate and bring them into the new regime in Japan.

So we went around and toured the whole place.

**19:17** I came back after then just before the big typhoon, must have been early October, late September and came back to Los Alamos. By that time it was too late to go back to University campus, as many people were doing and I had a program. I wanted to make a peacetime application of plutonium. We did it, it was a pilot effort. The whole effort collapsed down, nobody wants to do it, the economic are not in favor of it. But it worked, we had a plutonium reactor, the very first one which I and a group working with me designed and built. And it operated between 46 and 54 or something. It was interesting, it was the only one of its kind....

The Americans, not the British, the French and the Japanese have all had big projects in this direction. All were failures. The Japanese just gave up about a month or two ago. They went much further, of course. But, its dangerous and difficult to run so no one has ever done it. The main problem is economical. It would save a lot in uranium, but uranium is not cheap or as available. Someday it will become important, yes.

**What kind of feelings did you have as you took a look around Hiroshima?**

**20:53** Well, of course to be honest I was quite afraid of the whole thing, really scared cause we went ahead of the American occupation even, a little bit and we lived in Japanese military camps. Everyone knew who we were, so I was afraid of some hostility. But, no, nothing like that ever occurred.

(The damage) is a very interesting point. You understand I was in Japan for a couple weeks before I even saw Hiroshima, but I saw plenty of burned-out cities.

So I was...when I got to Hiroshima I realized, I've said this very, very often since...the difference between Hiroshima and Tokyo, and Osaka or 50 or 60 other cities or smaller ones is not on the ground, it's in the air. The ground looks ruined in every case where a firestorm, everything was burned out in all the Japanese flammable buildings and the whole town was ruined for square miles, but it was done in Hiroshima with one plane and one bomb and a few escort planes. And it was done in Tokyo, the same thing by a thousand bombers. But nobody has ever been able to make a thousand, two-thousand big bombers, right? Even after fifty years. But you can make...we have made tens of thousands of bombs. What does that mean? It's an enormous difference in warfare. And that was the thing that got me...the effect on the ground. If you asked somebody who went through the bombings of Tokyo what he says, it's the same thing survivors of Hiroshima said: The whole place was exploding there was a bomb everywhere. That's what they thought in Hiroshima. And that's what they had in Tokyo. So, on the ground, people saw it very much the same way. There is one important difference that has caught the imagination of the world, I don't think its really intrinsically that important, not from a hard-boiled point of view anyhow, an objective point of view and that's radiation. With thousands of people I saw the most wrenching sight. Hundreds of people lying on the railroad platform in Hiroshima being treated with palliatives, hot water mostly of their radiation. Most of those people are dead by now, truly. They died in 30 or 40 days. But it was a small number compared to the 150-thousand who were killed there, by all means, mostly by fire. So, as I say, on the ground, there's much less difference most people were killed by fire in all the Japanese cities. And in Hiroshima another five percent by radiation.

### **Tell me about Robert Oppenheimer.**

**23:38** That's very hard to do because I first saw Robert Oppenheimer when I became a graduate student at Berkeley. I had to decide whether to go to Harvard or Berkeley. I never was in California. I was excited about the prospect. I heard, I heard Oppenheimer was a brilliant person. I'll go to work with him, I said, better than going to Boston. Never been to Boston either, for that matter. I was a Pittsburger. So we went to Berkeley, I went to Berkeley and there I met him and he had undergone some kind of a change as far as we could tell. His reputation for brilliance and for clear explanation and the rest was already strong. But he had a reputation for being very quick and easily able to quash a question or an objection or anything of that sort. He was very difficult to detract with and that change was not true when I got there. Everybody agreed that was the case. He had changed over a year, year and a half. His whole style of teaching and demeanor to the younger students had become different. (Why?) Probably because of the young woman he was associated with. That's what everyone said. He was falling in love and this was very good for him. So it evened him out in many ways. When we got there we were just entranced by him. Of course he was still breathing, he was still challenging, he was still

demanding. We worked hard every night all night to complete the problems to keep up and try to understand, But, it was worth doing. Every once and a while he would take a few of us out to dinner at a good restaurant. We couldn't afford that, he could, it was very nice too.

**There were some people who were surprised that he was named head of the lab.**

**25:20** Yes, yes I was surprised. Everyone was surprised. No one thought he would undertake such a task and it was amazing that General Groves would have done that. When I met Groves I began to realize they were very different persons, very different views of the world. But they both had an intensity and determination, and I think that's what won over Groves. Once he could see Oppenheimer was a man who understood every part of the job and was determined to get it done as best as he could.

**What do you think General Groves saw in him?**

**25:51** Just what I said: wide knowledge, quick learning, articulate...all that was characteristic and a real burning determination to end the war and prevent the Germans from getting this first, which we all had at one time. He made it very expressive and his energy was tremendous, that's what General Groves liked.

**Scientists were surprised because he was a theoretician and not an experimentalist.**

**26:28** Yeah, but he was smart. Every smart theoretician knows experiments are very important. And Robert also had the understanding of people. When anything important was done in an experimental program, you know step by step by step by step and then finally at three o'clock in the morning some Saturday its ready to test and you get it going...if it was a biggish program, more than three or four people involved...he would be there. That's got nothing to do with experimental physics, but it has to do with management. Setting an example of leadership in a laboratory.

**How about General Groves?**

**27:05** General Groves was a very difficult man to sum up. But again, the same thing appealed to General Groves that I think appealed to Groves about Oppenheimer. Enormous devotion, determination to get the war over...to do what he could. It would give up his own views for doing that. Though his views were so strange, so different from mine, I would say so bigoted, so difficult, so narrow-minded that we could hardly talk about it together. We didn't have to because we had a joint enterprise. And on that basis we could work together very, very well...on the mission.

And General Groves, there's no doubt he would give everything to the success of that mission. That was the kind of guy he was, and he was...a bulwark for the project, too much...once I was in the office and I heard him arguing with

someone else about a legitimate claim on his resources, but he wouldn't give them up. So, he was the boss. So I think many people feel he slowed up the project or they say things like that. That's quite wrong in my opinion. It took leadership like that, it took devotion, it took someone who understood his role his Washington, understood the army. He did these things very well. I can't imagine anyone else who could've done a better job than Groves. He was a bred General and he was willing to do this and once he did it, he got hold of it. Of course he had many of the faults that I think go with generalship. I've known quite a few of them. They're a bit arrogant and they're waited on hand and foot and they don't quite understand those issues, and they tend to sneeze at small matters to exert authority. General Groves was reeking of respect, which he did at Los Alamos every once and a while. He would look at these millions of dollars of experimental equipment all...and he would pick out a wasted matchbox or something like that, point it out how foolish that was. Well I understood what he was trying to do, still there was a strange impression on these people...thought he would emphasize the things he thought were not important. In fact we understood very well, I had the same responsibility. I had to clean up where General Groves went through. I finally realized, it took me some time...that's the way he came. So we would all clean up and straighten out and getting everything working right again. It wasn't what he said. It was his presence.

**Who are some of the lesser-known individuals who should get recognition in the Manhattan Project?**

**29:35** Well, I think the young people that worked with me, my age essentially...25 to 30 to 35 should be mentioned more. Charlie Baker was a sensationally famous one, Schobe, Robert Fish was one who was very well known...extremely original contributor to many things at Los Alamos, Ray Scriber did get quite some promise and so did Marshall Holloway. Stan Ulam, of course the famous figure by now.

**What are some of the experiments and work that should get recognition?**

**30:24** Well the most interesting experiment, the most dangerous one, one of the last one's we ever did which didn't do any too well we named it, it was named by Richard Feynman...Tickling the Dragon's Tail  
Didn't break the ground, we thought it might. It was making a fast reaction, gradually approaching, faster and faster reaction to simulate the very fast reaction in the bomb. And of course you stayed short of that, if we could, and we didn't assemble an explosion, we just did it by dropping it down a smooth way.

**TAPE #2**

**31:12** Well, the first critical reaction of plutonium. First time plutonium was ever made critical...was done late one Saturday night as I recall in the spring of 45, by Slotin and me.

**What was the setup like?**

Never terribly well, it was supposed to be secret at the time. It was just done with, uh, with the sphere and solid materials for tamper simulation and various hydrogenic paraffin blocks and so on, far away to represent the explosive, and we just, we had done a lot of these things and we just carefully added material and put, and made it denser and denser until you got a reaction. I guess we actually did it even before that with a solution. We had a double or triple-walled plastic container of plutonium nitrate in the solution and we dipped it into water, and we gradually increased the water level around the outside of it, measuring as we went.

It was a very, draining time for us. We started at ten o'clock in the morning and weren't ready to go until around 2 AM. It was scary (There was an intensity of the work) It was, this was very close to the end, don't forget.

**Did it tend to be that way working, not only for you all, but for everyone?**

**32:56** Generally yes. It was a time of great intensity as you pointed out, our group in the end, suffered about as many casualties as a ten-man infantry unit on the Italian Front somewhere. We lost two people out of ten or nine. That's quite a loss.

**What did you do for fun up in Los Alamos?**

**33:38** Well, for me, well we had lots and lots of dinners and sessions with our friends and I told you every house was a friend, practically. The people was, just full of people you knew well and knew their families. You knew their parents, you knew all about them.

(What was Saturday night like?)

Well I wasn't a very Saturday night organized person. There were the young people who had many parties and so on. We would tend to go to a dinner with six people. That's what you would do in any university town.

Sundays was more for outdoors. Sundays went on picnics, went to the mountains, to the Indian pueblos, went to the ruins, sometimes even went to Santa Fe if we could afford the gas...and so on. It was a good time, it was an intense time. We'd all worked....I think it fair to say 60 hour weeks and worked on Saturday by rule so to speak, by routine. Sunday was the only day off.

**Had you ever been to the Southwest before?**

**34:43** I never had...superbly beautiful that's what I told you first impression. I love the desert, I'd seen the desert in California, but never New Mexico.

**Were there any doubts that you all had about what you were doing?**

**35:18** Well many, two kinds of doubts first...whether anything would ever work, of which we were never certain until the final tests and...what it would be, what it would mean for warfare, what would it be for that war and so on. So we didn't know how it would be used or when or how or anything else. So we had

ideas about that but we found pretty sound they're not going to be listened to. I had very minimal expectations of what could be done. I served on a couple, as a technical advisor on a couple of meetings...what are called target committees. Confusing thing to talk about because there's more than one and most people don't remember which one it was that they were on. But there were several different organizations. The project itself as the Manhattan Project, the Air Force as a whole, the 21<sup>st</sup> bomber command all these people had, all these groups had people to check which cities to, be should be attacked. So I would be there to answer questions. And I was always trying to get the committee to talk about what the responsibility was, and I always claimed we should really make a good warning about this, explain it, to display it and so on. But nobody would hear that, especially the military who said you can't make a warning. That'll just mark with a big bullseye spot...every aircraft, every ship involved.

They were wrong about that because they didn't do it until the Japanese were almost incapable of putting up resistance in the air.

(...one reason was they wanted to reduce losses from invasion)

Yeah, that's what the leadership thought. Whether that's true or not, I don't know...very hard to know. They had a very hard problem, they saw an enemy that seemed remarkably formidable, and tougher and tougher only rapidly beginning to lose. Okinawa was a disaster of the American forces. Tremendous losses. I was there on the way to Japan after the end of the war...days after the end of the war, and I was there the famous "Iron Bottom Bay" where indeed the ships in the harbor were visible because their tops of their masts protruded above the water, that was all...there were dozens of them. Destroyers, Cruisers, supply ships...hit by Kamakaze aircraft.

(Norman Ramsey had mentioned the same thing about a determined foe)

**38:10** Yes that's why a landing seemed difficult. I'm not sure all this is really so. It rests on a somewhat superficial view of what was going on in Japan. Cause we saw it afterwards. It was pretty clear that they were coming very close to the end of their rope. I mean they didn't have gas, they didn't have anything.

**I was surprised to find out you rode down to Trinity site with the core of the weapon.**

**38:44** Yes, true...it wasn't a weapon yet it was only a test bomb. (how'd it feel to ride down with the majority of the supply of plutonium the earth?)

Well, I explained to you, we were the people who put that together for the first time. So we were familiar with it by that time. It was the previous one, but we were...but it was the first one. (Remember anything about the ride?)

Oh sure, not a great deal, but I remember being rather afraid of the fast, driving young woman who was the...who drove us down there with the convoy, who was a really high-speed...pedal to the floor all the way. Driver, that was the scariest thing. But I did, had the special carrying case which an ensign of the navy and I had designed for the thing. So we watched that a lot. It had a lot of safety

measures that told you what was going on inside, that sort of thing...kept an eye on that.

**What was the sequence of events when you got there.**

**39:50** Sure, we went through the gate and in a half-hour or so we were at McDonald's Ranch house and turned it over to...this was the place which also our group had designed and supplied so we knew every box was every counter was more or less...and we brought the thing to that place.

**Once the core got to McDonald Ranch, what happened next?**

**40:48** Well I think we took the day off, it was late in the afternoon, uh yes, it was Thursday and we assembled it on Friday. SO we went there on Friday and went through the procedures. Couple people came in who were not part of our group and helped us, especially Cyril Smith the metallurgist who brought along...I'm not sure how classified this is...brought along various materials to add to it, to make things work well.

**What did you think of Trinity site?**

**41:39** That was too much desert, even for me. I think it was a great place to make a test explosion. I don't know, it was an empty place, as you know. It just had a few things in it. The Trinity base camp was there, and so it had a dozen buildings or so.

**Did you spend time at the base camp?**

**42:02** Well yes I came in on Thursday, Friday we assembled the thing. I guess we didn't put it up in the tower until Saturday, I'm not dead sure of that. Then it went to the tower Friday evening, I think it did, and stayed up in the tower on Saturday and I came by a few times because we had some ongoing custodial responsibilities. We made measurements of that thing every few hours to see that it was behaving properly because it was the first one...left out of the laboratory for any length of time, and so somebody was there, somebody from my group had to climb up and measure something and come back down again every few hours. And so we did that all the time until finally locked up and sealed which I guess was a Saturday evening, Saturday afternoon. And after that they went up still to do their measurements remotely. Sunday was a day off....it was also rather rainy.

**Was it raining all day?**

**43:13** Not all day that I can recall, but it was threatening to rain....and it cleared up, yes. It was the monsoon season, so rain wasn't unexpected

**How would you describe the tension in the air?**

**43:34** extraordinary, I mean very hard to sleep, very hard to get your minds off all the things that might of gone wrong, very hard to think about the

implications. But you know, I think we were all consumed in this job, especially this crucial one...a test fire to see if this whole idea would work. And that was in everyone's mind, I think.

#### **Was there doubt it would work?**

**43:54** Of course. There was a pool, you must have heard about that, organized by I.I. Rabi, and some people entered that with just the high-explosive went off...two tons or something. They would give the number of tons equivalent and I guessed a number too, something like five thousand. And I think Rabi came very close and guessed the design number...about 18-thousand.

**44:59** I don't think I ever felt the first shot was sure to work. Almost nobody did. They thought it was a good chance of working. (?) was quite far along. What was thought of during the war was, and very often we kept saying...maybe we'll come across something that's an assumable physical obstacle which prevents it from working. You could easily imagine those things. For example a little delay in the emission of fast neutrons after fission would have ended the whole thing.

(We're talking microseconds)

Oh no, no, no, no, no much shorter than that...pico-seconds.

#### **Where were you when the countdown was begun?**

**45:41** I was at base camp, and I actually was the person with the microphone and a short-wave set listening to the people reporting, and I was supposed to read out the countdown which I remember repeating when I hear...McKibben...I think it was...into the microphone saying we're now getting this ready, we're starting on the timer, now we're on automatic and I'll count with it, then I started to pick up their count. Before that I had to tune out the night stations that were coming in so strongly because the sunspot cycle which made the signals much stronger than they were normally thought to be. So we had a tough time getting our own local radio going.

#### **When it went of...would you describe it?**

**46:29** Well of course I knew a lot about that. I had a very elaborate eye filtering arrangement. I had goggles and sunglasses and cardboard...two or three different things to pick up. So, as I thought I could adjust them to begin to see more and more as it got dimmer and dimmer cut out the main first flash, first tenth of a second, then go to the next ones and then the eyes were pretty free to look.

#### **What did you think**

**46:58** Well, I'll tell you this. The most important memory of the experience is before I got my hand up to start adjusting the goggles, I felt something and I didn't know, I hadn't been smart enough to interpret and figure out what was going to happen and no one thought of it, I think. It was a cool desert morning, the sun had not quite come up, the air was still, it had that curious chill of a hot

place which is the coolest hour of the day. And suddenly on that cold background the heat of the sun came to me before the sun rose. It was the heat of the bomb...not the light...but the heat was the first thing that I could feel.

(It was intense?)

Of course, like sun. As though the sun had suddenly risen. And then, you know, the same moment, but I couldn't see it that fast the light came. The light shown all right, I could see peripheral vision quite well, but I couldn't see the direct light for a half a second or so. But that was an unforgettable experience, because what you feel I think is deeper in the memory than what you just see. A light after we do see bright lights...the only thing about this bright light was that it was far away, but the thing about this heat was it was far away as well. And so the notion that it was...some way, in the most elementary human way, competitive with the full sun, that was the time I got the sense of the power of the bomb more than anything else. It was unforgettable.

### **How about the sound it made?**

**48:40** Well that took 45 seconds to get there or 50. It was an anticlimax. ...a great rumble of thunder bouncing off all the hills....at 18-thousand yards it was ten miles...ten miles away. It was 50 seconds for the sound. In fact the famous journalist Bill Lawrence, who wasn't all that secure on the physics yet asked someone when he heard the sound "What is That?"...he no longer associated with the light he had seen, because it came nearly a minute before. He waited, he was disappointed, there was no sound, he breathed relief...suddenly a great sound "WHAT WAS THAT."

### **Were there a lot of people around you?**

**49:53** Maybe a hundred, all lying down as according to regulations and once it was over, began to stand up. Fermi stood up and I watched him...I knew he was going to do this...he was only 20 or 30 feet away and he began dropping those pieces, those famous pieces of paper, so we all watched to see how far they would move which, understood, would measure the...integrated motion of the air and thus the intensity of the explosion.

### **What was everybody's reaction?**

**50:22** Well, a mixture of elation and awe. As I say, like feeling the heat on you face changes in a moment all the attitudes you might have. No longer a commonplace thing, no longer something we all understood perfectly. We now knew it was a completely new phase of the whole thing, the whole world. So that was there, but also the sense that it worked. We had done what we promised to do, done it on time, no particular disaster.

### **Were there second thoughts?**

**51:07** Well yes, I don't think there was such a second thought. It was generally felt that we didn't know what was going to happen. We knew what was

going to happen, we knew...and we knew definitively one week later when Petty gave his famous lecture on the effects of the bomb at the colloquium on the Thursday after the Monday.

(What came out of that colloquium?)

Again with the same mixture...this is clearly going to end a city and probably the war.

(camera battery change)

**When did you go back to Los Alamos after the test?**

**51:50** Noon, I think. Early in the afternoon, probably, everybody, most people had something to disassemble.

(film of Oppenheimer @zero- when...a month later)

We went up, back up to Los Alamos and the most interesting thing about that was the collapse of security in the dining halls, that evening because everybody was exchanging experiences about the explosion...where they saw it from, what it was and so on. A general, not just a few people, but a roar of such discussion.

You realize then I was engaged...committed to go to Japan, not to Japan. To go to the islands, which I did about ten days after Trinity so I was getting very busy with shots, passes and papers and God knows what all. So I went over there.

**Describe the work you did on Tinian.**

**53:29** Well Tinian was a remarkable place. It was the chief base of the 21<sup>st</sup> Air Force...20th Air Force, 21<sup>st</sup> Bomber Command. The B-29 attack on Japan was carried out mostly from Tinian a little bit from Saipan, and adjoining island...a mile away across the water, but smaller than Tinian. And Tinian was said to be the largest airfield in the world, I think it was. They had three or four 2 or 3 mile-long runways that ran the whole length of the island, and 50 or 60-thousand people. There were 800 4-engine bombers, then the biggest regular aircraft in the world based on that field.

These bombers would use the entire length of the runway to get off because they were over gross weight)

Oh yes, They had...graded the top of the island, cut of n feet. So it was a flat mesa-like structure but it had a berm which went down to the sea, and you just lifted off that and had...the ground fell away and you had 50 feet or so...a hundred feet of foreshore, maybe more, before you came over the water. And we were there on Air Force day, maybe corps day it's called when they made a maximum effort. They were full of things like that, and they tried to get all the aircraft off they could and so they started early and they rushed them out. And, a plane went down into flames...burst into flames...didn't take off, fell over the berm and, you know...crashed a hundred yards out or something like that and

went tail up and you could see the crewmen trying to jump out into the flames. It was full of incendiaries and gasoline. And then on one runway...meanwhile they were going off every minute and a half, and sure enough a minute and a half, two minutes later, maybe less, another one did the same thing...the second runway over so two of them were burning at once. They cancelled the day...couldn't do anything else. Couldn't have had another 500 pilots take off with that.

**56:11**...so that was a terrible experience, but it gave a flavor to the place. Otherwise it has all of the qualities that you read in, nowadays, many of the...nowadays no...30 years ago in many of the novels and experiences and that in the Pacific war. Great many people, not much to do. I remember one interesting thing...the base hospital...Big, Splendid hospital very well staffed, with physicians, nurses, surgeons, everything...no patients. They had planned on a kind of sickness rate and a higher accident rate that such a busy airport, airfield was expected to generate back home in training conditions. Nothing like it...several times better. And it was quite clear, they explained it the people had thought about it a lot. In the Air Force in training, you know every, in those days at least in the regulations we had, the crew chief would be called to account. He would get up and say...the airplanes are ready to go or he'd say they're not ready to go, and what's not there...he would give the number of things that are not there, and then some external person would say OK, you don't go, or no you should fix those and see if those are important and take off without them. So this was the way you determined the readiness of the field. And the captain would be there, the commander of the aircraft and his officers, and so on and on that basis each day they compiled a readiness record for the aircraft, now right at the side of the runway, so its very prompt an appropriate. They were twice as good at Tinian as they were back home in Texas or Wyoming or wherever it be. Why? They believed it was meaningful. Training is not meaningful. Nobody, no group...maybe some people who were devoted, they would do it...the captains do and so on. But other people in the flight crew don't regard each day as a vital test of their ability and their devotion. But this was what every day was...gonna fly off and strike Japan. It was war. And those who are getting ready for war, doesn't have the same intensity of import. And that showed me at once what morale really means. These people, of course, they were doing their best trying to make liqueur in the barracks and everything else, but they worked, they knew it meant business, they didn't goof off, they didn't relax, they didn't stop thinking about the work. They were there, they did it and the record of readiness was way ahead of projections.

**Did you notice a change or attitude of the Nagasaki crew after they came back?**

**59:00** In the first place, before that, before Hiroshima. That's three days before that one, our group, 509<sup>th</sup> Composite Group, was pretty clearly regarded with suspicion by the rest. Because we never did anything. And we never got

any big supply of materials. You understand, huge amounts of gasoline flowed into that island and huge amounts of bombs, mostly incendiaries. Some were high explosives. Well they could see we didn't get any of those. Said...what's going on here? Here's this airplane, they go out, they train, but they don't do much. They don't get our ordinance. And so people would begin making fun of the 509<sup>th</sup>...in the papers, you know, that sort of thing, those screeds that were mimeographed that went out from each unit. So it made a big difference when they finally did something. This caused a lot of stir among the other Air Force people, but as far as attitude of the crew, I have no way of knowing that because you have to realize after they landed, there was a phalanx of brass there. All the commanding officers that could get their own air transport from anywhere in the Pacific were there. The commanders were there, Twining was there...name the other man Spetz was there, LeMay was there. Many others whom I don't remember anymore, but all these people remained prominent in the Air Force for a long time. And when that crew brought the plane to a stop, of course in front of the delegation of reception officers, they jumped out of the plane and as they hit the ground and straightened up, Spetz who I think was the senior general...pinned an Air Force Medal on each one. As his feet, so to speak, hit the runway.

By the morning it was in the New York Times.

### **Tape #3**

#### **How much more weapons work did you do?**

**1:02:46**                   Essentially I would say none. But we kept the same responsibilities. Slotin, in fact, took over the group and I started a new group to build a plutonium reactor, I've told you, which used the same expertise, but of course was a different proposition and I spent some time at that.

#### **How soon after the war did you notice things turning from the original purpose to science?**

**1:03:14**                   I didn't see it at all. I left in June of 46, I guess and went to Cornell. That's wrong, it was August, the end of summer. I came back in summers. I kept in touch with the reactor project. But I didn't work there full time. So I came back and talked to people and I really remembered the summers very pleasantly. The people who were doing the work then were...under Jane and Dave Hall, whom I'd known from the Chicago days.

#### **After you came back from the Pacific, did you notice any change of mood at Los Alamos.**

**1:04:18**                   Oh of course it was completely different. The war was over, it was a completely different United States and whole world. It was a completely different place and the scientists especially, especially, well quite a few of us were determined, you know the things that we'd seen one nuclear war, an

embryonic one, right...only that size and we knew that we couldn't go through another one. A big one, once you got better at this. We always felt, I always felt, anyway I kept saying so...one nuclear war, one small nuclear war was all that anyone could tolerate. We can't have a second one. And I think beginning the week I got back we were talking and writing about that. The Association of Los Alamos Scientists was formed, similar places around the country, Congress was busy investigating. First setting up the new direction for atomic energy...would it be civil or military, second what is going to happen to the weapons and so on. And we all became very much engaged in that. I'm sure I spent as much time in Washington in late 1945 as I did at Los Alamos. So that was quite different from the wartime experience. We were as public then as we were as private before. From one month afterwards, yes. It was the blazing talk of the day. You should look at the newspaper. There was a headline every day.

**Was there a tendency you think, after the war, for scientists to head in that direction...we can't have this.**

**1:05:58** Oh I wouldn't say it was a general tendency, but most of the people I knew, and I myself took that view. So it was a little unfair to say it was general. No it wasn't general. Most people were concerned about rejoining civil life. Some felt they had found a fine place to work and they would stay there and make a career of this, facing the prospect that would probably engage them in preparing for a bigger war. But there was no...at that point there an obvious enemy. Maybe it was obvious, but it wasn't guaranteed.

**Was it a surprise to find out Los Alamos had been infiltrated?**

**1:06:38** Well infiltrated is a strong word. I don't think it was infiltrated by Klaus Fuchs. I worked with Fuchs a little bit at the strange event of the radiation death of Louis Slotin. Fuchs and I wrote, studied the matter and wrote the technical account of what had happened.. How much radiation, why, how long it took and so on. So I worked with him.

(What kind of guy was he)

We all knew him. Utterly reserved, taciturn, very, you know, the kind of guy you think of...nearsighted, peering person. Thinking his work into the book and calculator. No interest in hand skills. Not very social. Cheerful enough fellow, but very restrictive, very...confined. It certainly was an astonishment to me that, what his history was and he was extremely well informed and nobody could have been better informed than he was. But he was not infiltrated in any sense. I mean, he was a volunteer.

**Did anyone think that Los Alamos would continue after the war?**

**1:08:05** I think after 46 we began to have that thought, but I didn't want to stay. I knew I couldn't be compatible with this...future aims if it did continue. But many people did think it would continue saw themselves as having a career in it. That was the bad sign, the men that came towards the end of the

war, those were the most likely people who were to do it, who came in 46 or late 45 cause they already could see that it was going to be an institution of some sort. Once the big road was built, I think its future was determined. When we only had the old road, no. But in '45 the old road...the new road was completed, I think. And after that you could haul anything up there I think.

**How do you view Los Alamos today?**

**1:09:48** I know little about it, I've slowly become more and more, you know all my friends are gone, practically. There's nobody there I know. It's easier to find Los Alamos people in Cambridge than in Los Alamos, for me and so I really have been not in touch with it for some time. I gave a couple public talks. I gave one of the memorial lectures for Robert Oppenheimer, years ago, and uh, that's probably the last time I've been there.

**Do you think it has a good or a bad reputation?**

**1:10:18** No, I think there are two things to it. It has among the professionals quite a good reputation among physicist for what it does and the kind of people that are there, and in the public eye it's all dominated by the myth. Nobody knows anything about its present situation. They can't find themselves to separate that.

I blame that mostly on the media (spy scandal)

Media loves myths and they do because the people like myths. So you put Los Alamos in a story, and associate it with something like that. It's a sure-fire seller. And the Congress have plenty of people who are tendencious enough to want to exploit it on that basis. As I understand it the present case on Mr. Lee, whom I don't know at all from Adam is disappearing. Which I imagine was the case all the time from what they describe.

**Is there something you would like to talk about that you think hasn't been completely told?**

**1:12:02** One of them is I think that a myth has arisen, partly due to circumstances, which is how difficult it was, what a feat, what an intellectual feat it was and so on. Some of that is self-serving, the scientists like to say it was difficult, and it looked difficult. It wasn't very difficult. In fact it was much easier than you thought. That's the trouble. You could see who does it nowadays. The Iraqi came might close. And you should read, you should think of looking over and reprinting some of the interesting pieces of the report from the Security Council that Swedish diplomat issued when he quit his job. He made a summary of the whole thing because it quotes the technical things they were working on. And there's such a variety of interesting specialties that you'd be surprised. But

one...(?) That reminds me exactly of the technical, the monthly technical reports that came out of Los Alamos in 1945. For example, one of the biggest things I saw when I read this...BIG thick, only a little bit of it was the effort of the metallurgists there and the chemists to make a crucible that was suitable for melting plutonium, and not diluting it, not reacting with it. For which you have to use cadmium sulfide. That's what they got from Los Alamos declassified literature 20-years later. But do you think that's the end of the story? No, can you make a cadmium sulfide crucible? No way, I don't know what it even looks like. But, somebody has to do that, refine the material, purify it, study how it melts, figure it out and that's what they're doing. And there's a hundred things like that to do. And that's what's not realized. Still to this day it's despite many, many decades of talking about the same thing. It's a huge technical affair. It's not written on a little piece of paper.

**The work of making that first bomb wasn't that hard, but it was complex 1:14:14**

Everything that you make that is new is very complex. The first Chevrolet was very complex. Very hard thing to do. The first airplane, God knows how hard that was for the Wrights to do that. They had to, after figuring out how to fly, how to control it with wind tunnels and calculations as well. They then had to make an engine that would work. They couldn't go out and buy an engine. And that's the same thing with the atomic bomb only it's a much higher technology, a thousand times more. And all those people, all those groups at Los Alamos probably had an important say in the final product. That's what nobody remembers, they remember Fermi, they remember...I'm not saying these aren't great people. I'm not saying they don't have great ideas, they do...I'm not saying they're not essential, but they wouldn't have completed the task. The task is completed only when there's a substantial, unified body free to work on it some time with a lot of resources. That's what makes it. That's why it cost them a billion dollars or a few billion dollars.

**(and the free collaboration)**

...Is important, is very important, yes.

(Reference the spy scandal and foreign scientists)

You know that's partly why Los Alamos was set up if you look back, even...I think it's in the literature quite fully. It was an isolated place; it was easily controlled. Within Los Alamos you could have a certain amount of security, but the people should be able to communicate, at least the people who had to communicate and they did well. And the brilliant idea, and I don't think anything has ever been said against it, of having this weekly meeting where everybody with a white badge, every scientifically trained person could come, and hundred came to listen to this account not just of their own work, but of somebody else's work. And that was very important, it preserved a kind of attitude which was, in spite of compartmentalization, in spite of all those things made for a kind of cooperation which was really indispensable for the whole project.

The reinforcement of motive is very important. I always say there's no such thing as one physicist. He's got to have someone to learn from or teach or do something. He's got to get engaged to learn understand he is doing. Physics is a sense of understanding the world by understanding what you're missing, and that's what you've got to find out. You can always find out those things by yourself. Occasionally that can be done, but mostly it's that interrelationship that counts..

**How do you feel when you look back at those years at Los Alamos?**

**1:17:03** Well, it was probably one of the most important experiences of my life...the most significant for the world. I think it opened the door to a dreadful corridor down which we never finally went, despite being very close to it. I think the main thing I want to say is it has to stop, and its not stopping yet. I don't know if that's good to hear at Los Alamos, but they have plenty of other things to do. There are a lot of good people out there. But, you know, we can't get along with 30-thousand weapons. We don't have them any more. Even a thousand is a lot, even a hundred is quite a lot. I don't know what is a small number, but it is certainly very small, and that's what I say. That's not understood everywhere. The people don't want new weapons, but they think they're gone. Except in Congress where they keep talking about it. And the notion that you can sell secrets in this simple way is completely wrong. I'm not saying it's of some importance, of course it is, but it's not the decisive thing as I was pointing out. The decisive thing is getting a lot of people together who know how to make cadmium sulfide.

**How big a job do those in non-proliferation and international security got?**

**1:18:25** I think the job is better is better than we hoped at this time, but its not yet final. Far from it, and its slightly declining in the last couple of years mostly due, I think, to the difficult time in the present American administration, which knows better, has in getting its will done, especially with the respect of the military, especially the respect of the most conservative and the most warlike of the military supporters, not so much the military themselves as their congressional backers who feel a bigger bang for the buck is the best thing to have...when its so clear it endangers us more than anybody else. So, we have the most to lose.

