

SEDs at Los Alamos: A Personal Memoir

Benjamin Bederson*

I have written this personal memoir approximately 55 years after the events I describe. It is based almost exclusively on memory, since apart from the diary I kept while on Tinian, I have few documents concerning it. It covers my service in the U.S. Army's Special Engineering Detachment (SED) in Oak Ridge and Los Alamos in 1944–45, on Tinian island, the launching pad for the bombing raids on Japan, in the summer and fall of 1945, and my return to Los Alamos until my discharge in January 1946.

Key words: U.S. Army; Special Engineering Detachment; Manhattan Project; Oak Ridge; Los Alamos; atomic bomb; implosion mechanism; Trinity test; Soviet spies; Tinian; Japan.

Introduction

The role played by the common U.S. soldier in the development of atomic weapons during World War II is not generally appreciated. Early in the history of the Manhattan Project, the U.S. Army decided to tap the vast pool of GIs possessing scientific and technical backgrounds who were serving in it, mostly as draftees. These soldiers were assigned to an entity called the Special Engineering Detachment, and hence were known as “SEDs.”** Their ranks also included skilled mechanics, machinists, and electronic technicians. At its peak in 1945 about 1800 SEDs were working, mainly at the principal Manhattan Project sites at Los Alamos and Oak Ridge. The main role of the SEDs (figure 1) was to act as assistants – something like graduate students – to the senior scientists who by then were arriving at Los Alamos and Oak Ridge in large numbers. They were assigned to the many individual research projects that would eventually culminate in the successful design and construction of the two atomic bombs, the “Little Boy” and the “Fat Man,” as well as to the various technical shops. Often little distinction was made between people in and out of uniform, although the former were subject to army regulations and discipline, as well as to army salaries rather than civilian ones.

As work progressed, many of these soldiers assumed positions of considerable importance while still being subject to normal army routines, tempered somewhat by the rather loose discipline that prevailed, particularly toward the end of the war.

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** Officially, the 9812th Special Engineering Detachment of the Manhattan Engineering District, created October 1943.

Several sources exist where the reader can learn more about the SEDs and the roles they played in developing the bomb.* Here I limit myself primarily to my own personal experiences as an SED, which were fairly typical in most respects, give or take a few singular events. Since I am writing this memoir approximately 55 years after the events I describe, mostly from memory, I cannot claim absolute accuracy, although to my surprise many of the events that occurred between 1944 and 1946 remain sharply etched into my mind.

Los Alamos before Tinian

I entered the army through the draft in 1942, possessed of $2\frac{1}{2}$ years of college (City College of New York) as a physics major. At some time in 1943 I had found myself happily back in college, at Ohio State University, taking an electrical engineering course courtesy of the Army Specialized Training Program (ASTP). This program was intended to teach technical skills to soldiers for an army that was experiencing ever-increasing demands on such skills in fighting a modern war. Just as I was completing this course in January 1944, the Army announced that it was going to abandon the ASTP because of the increasing demand for combat troops in Europe and the Pacific. Coincidentally, at that moment my commanding officer asked me if I would be interested in being interviewed for a new project, called the Manhattan Project, where my physics and engineering training, such as they were at the time, might come in handy. And, he remarked, this might get me back to my beloved Manhattan, of whose affection I had made no secret in Columbus, Ohio. Needless to say, I jumped at the opportunity, and shortly thereafter was interviewed by a visiting board of three civilians. They asked rather peculiar questions, I thought at the time, consisting mainly of elementary physics questions, for example about Newton's laws, and about my career interests.

A few days later I received orders, marked Secret, along with a train ticket, to proceed to a town called Knoxville, Tennessee, to be met there by a car that would take me to another town called Oak Ridge. On the train I met several other GIs who also had received the same orders. We arrived in Oak Ridge to discover a city in the throes of heavy construction. There was orange-red mud everywhere, and a number of tall buildings with a peculiar look – if I hadn't known better I would have sworn they were moonshine factories, and in view of their location in the hills of Tennessee, I first thought that the government was secretly manufacturing Tennessee sour mash on a huge scale – perhaps to drop huge vats of it over Europe

* An "official" review of SEDs at Los Alamos can be found at < www.lanl.gov/worldview/history/23_engineers.html >. For a personal and very readable report written by the former SED and Nobel Prize winner, see Val Fitch, "The view from the bottom," *Bulletin of the Atomic Scientists* **31** (February 1975), 43-46. A definitive history of the SEDs at Los Alamos is now being written by John Coster-Mullen, who can be reached at < coster@execpc.com >. William Spindel and Henry Linchitz are quoted extensively in Stu Borman, "Chemists Reminiscences on 50th anniversary of the atomic bomb," *Chemical and Engineering News* **100** (July 17 1995, 340-352). See also the personal memoir by Phyllis K. Fisher, *Los Alamos Experience* (Tokyo and New York: Japan Publications, 1985), for some sidelights on SED life at Los Alamos.



Fig. 1. SED shoulder patch, issued after August 6, 1945.

to disable German troops. It turned out that the plants were indeed distillers, only not for whiskey but rather for the gaseous diffusion separation of U235 from U238. Of course, I didn't discover this until later. I was assigned to the Special Engineering Detachment – the SED, and I remained in it until my discharge in January 1946.

Something unusual was obviously going on at Oak Ridge (figure 2), since among other reasons, while we were quartered in barracks they were cleaned, and our beds made, by local young girls! No KP,* latrine duty, or even drill – not a typical army experience. Instead, we were given a series of tests and interviews. After about a week I received new shipping orders, this time to report to an address in Santa Fe, New Mexico. Again I traveled by civilian train, to a town called Lamy. That was

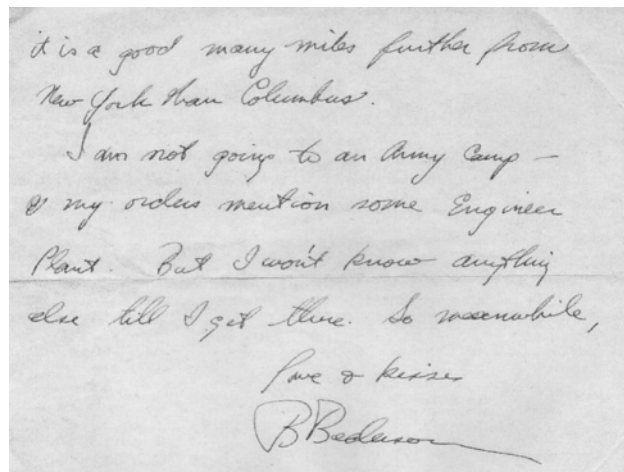


Fig. 2. A letter of the author to his parents from Columbus, on his way to Oak Ridge, Tennessee.

* Kitchen Police, that is, peeling potatoes, washing dishes, scrubbing floors, and other despised duties in assisting Army cooks.

when I discovered that the Atchison, Topeka and Santa Fe railroad did not (and still doesn't) go to Santa Fe. At Lamy I was met by an army sedan and taken to an address in Santa Fe – the now famous 109 E. Palace Avenue. It was a store front on the main Plaza, where just about everyone going to Los Alamos reported (to Dorothy McKibbin) before heading up the “hill.” Before long I found myself in another army sedan, which drove me north, then west, up a tortuous road along the side of a mesa, without guard rails at the time. I was assigned to a barracks, and then to a project. As for army life, we did indeed partake of this during the time when we weren't actually working. We had to undergo hated calisthenics in the early morning, and traditional Saturday morning inspection, for example – but no KP! Comparing notes we discovered that most of us had something in common – our educational or training backgrounds in science, particularly in physics and chemistry. Also scattered among us were machinists, including my neighbor in the next bunk, David Greenglass.

My first supervisor turned out to be a British physicist by the name of Philip B. Moon.* He arrived at Los Alamos just weeks after I did, as one member of the group of British scientists who had by agreement joined forces with American scientists to work on the Manhattan Project, rather than working independently in Great Britain. He was the first practicing physicist I had ever met (apart from my City College professors), and what an introduction it was! Phil, as he insisted on being called, was an amazingly sloppy dresser. The first thing I noticed about him was that he wore a tie for a belt. And he perpetually had a cigarette dangling from his lips, with one eye closed to keep the smoke out, and with ashes forever falling randomly about him. Much later I learned that he was one of the scientists who had performed very early work on the neutron, after its discovery by Chadwick. We became good friends – I was greatly taken by his wry sense of humor, and we corresponded with each other for a while after the war. He had a wife, Winfred, who was the quintessential English matron, very tall and broad, with an accent I could never understand, but warm and friendly. Much later, when I had helped organize the so-called “Mushroom Society,” a club consisting of myself, Norman Greenspan, and occasionally Ted Hall,** Winfred and Phil would on occasion come as invited guests to listen to our classical record collection in a small office where we had installed a homemade hi-fidelity system (more on this later).

My first assignment at Los Alamos, under Professor Moon, involved the testing of “strain gauges.” These are thin wires attached to a sample whose ability to withstand stress is determined by monitoring the change in resistance of the wires as the sample is stretched.*** My job consisted mainly of attaching these gauges to cylindrical hollow tubes containing explosives, which were attached at first to

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** Ted Hall was exposed recently as a Soviet spy; see Joseph Albright and Marcia Kunstel, *Bombshell: The Secret Story of America's Unknown Atomic Spy Conspiracy* (New York: Times Books, 1997).

*** The *New York Times* (April 15, 2000) just published a lengthy obituary of Arthur C. Ruge, the inventor of what he called the stress gauge. The *Times* states it “revolutionized the way things are weighed and tested for stress.”

“primacord.” Primacord consists of ropes of explosives, very handy for use by sappers to blow up bridges and railroad lines. A bit later I was given electrically activated detonators to use in the tests. These were very tricky since they tended to go off without warning owing to static electricity, which was easy to create if the electrical connections were not properly grounded. And in fact such a detonator did explode in the hand of my army buddy working next to me on an experiment – John (?) McNamara, a cheerful bulky fellow from Wagoner, Oklahoma. He was severely injured, although he fortunately recovered.

In a month or two I was called to a small meeting of SEDs who like myself were working on various aspects of explosives. At the meeting we were greeted by the head of the Explosives Division, George B. Kistiakowsky. “Kisty” was a professor of chemistry at Harvard, one of the most distinguished chemists in the world, as I was to find out later. He had a strong Russian accent, and was very approachable and good-natured. The purpose of the meeting was to let the GIs know what was going on at Los Alamos. He laid it all out, from beginning to end. The story that circulated later about how security was so tight on the Manhattan Project that people only knew exactly what they needed to know to do their job was simply untrue. He explained nuclear fission, critical mass, and the implosion concept among other things. None of this was needed for my job, which, it turned out, was to help create something called Jumbo. Jumbo was a huge cylindrical container into which was to be placed the first “Fat Man” to be tested. Fat Man was the name of the implosion bomb (generally referred to as the “gadget”), and Jumbo was intended to contain the radioactive material if the nuclear explosion failed, but if the TNT explosive lenses would do enough damage to spread deadly radioactivity from the unfissioned plutonium. Jumbo was to prevent this radioactivity from spreading all over the landscape – and, incidentally, making it possible to recover the unspent plutonium for another try. That was why I was testing containers! Everything fell into place with Kistiakowsky’s revelations, from the mysterious distillation plants in Oak Ridge to the overwhelming secrecy of the entire project. The only thing I had cause to be miffed about was my faded hope that the Manhattan project would get me back to New York. Still, the thought that somehow I had landed in the middle of what was certainly a historic enterprise was exhilarating and inspiring.

At this time I had what was called a “blue badge” – a sort of second-class admission ticket. It allowed me to wander around all of Los Alamos except the “Tech Area” – the collection of buildings guarded by MPs (Military Police) where the main work on the bomb was clearly taking place. I could drive out to “Two Mile Mesa,” where the strain-gauge tests were being performed, clearly an assignment that did not possess the highest priority.*

I did not know it at the time but during this period I was being given a security check. Army security people (not the FBI) went to my neighborhood in the Bronx, Allerton Avenue, and interviewed people who knew me there. These included the superintendent of my apartment house as well as my two closest friends at the time,

* Up to this time I had never driven a car. This was easily remedied, however. I simply signed out a car from the motor pool and taught myself how to drive.

both of whom gave me sterling recommendations and assured the investigators that my politics was above reproach. I am eternally grateful to them for telling those small white lies, particularly the one in response to the question about the “Coops” – the communist cooperative houses where I did indeed hang out, and where my early political beliefs were formed. Apparently the investigators also did not view my stay in the U.S.S.R. in 1932 at age 12 with my family for about eight months as being particularly sinister. In any case, it wasn’t very long before I received word that my security investigation had been completed. I was given a white badge – the prestigious symbol of complete acceptance into Los Alamos society, which allowed me almost unlimited access to the Tech Area. I immediately was permitted to attend the general Tuesday evening talks, during which various leaders gave progress reports on their work. Thus I was able to gain a pretty complete picture of most of the important aspects of the bomb work.

The most memorable of these talks was also the first one I attended, not more than two or three days after receiving my white badge. The talk was given by Enrico Fermi. Fermi was an affable, obviously brilliant physicist with a strong Italian accent. He sounded just like some of the store owners on Allerton Avenue. But what he spoke about was a far cry from salamis and mozzarella cheese. He didn’t even speak about the fission project. In his mind he had already assumed that the project would be successful, and he was thinking ahead, to the hydrogen bomb. He gave a fully developed talk on the expected yield of the fusion reaction designed as a bomb, and he offered some thoughts on how it might be designed. This was probably in March or early April of 1944.

Later talks were given by various Los Alamos luminaries, including Edward Teller, Philip Morrison, “Nicholas Baker” – that is, Niels Bohr – and many others. Simply attending these talks as a low-ranking GI (I was a “T/5” – the equivalent of a Corporal at the time) was an incredible piece of luck and a wonderful privilege that helped me define my later career.

Because I now had access to the Tech Area I also was given a new assignment. This was fortunate because Jumbo was later abandoned as being unnecessary because of the increasing belief that the Fat Man bomb would work. My new assignment was somewhat more interesting and important. One of the challenges of the implosion concept, which relied upon a number of shaped charges (“lenses”) placed around a spherical plutonium core, was to ensure that all of the lenses would ignite at the same time. These lenses were shaped somewhat like solid cones, with explosive detonators at their apexes, so that the explosion would travel inward until it ended at the base of the charge, which was to be placed against the hollow spherically shaped plutonium core. There were to be 32 lenses, and therefore 32 detonators. The detonators had to fire within a few microseconds of each other. While microsecond times offer no great hurdles to today’s electronics technology, that was not true in 1944. It was necessary to design reliable switches that all fired within this time frame, to ensure that all of the detonators were activated at the same time. It was necessary to design and develop such switches, and at the same time develop a technique for actually measuring the times at which the detonations took place, to within a resolution of a fraction of a microsecond.

My boss became Donald Hornig, a professor of chemistry at Harvard, later to become Science Advisor to President Lyndon Johnson. The problem was, first, to develop reliable, fast, and powerful switches that could be triggered simultaneously, and then, to have the simultaneously fired switches ignite detonation fuses, set at the apexes of the implosive lenses, which would compress the plutonium. And a test system had to be developed that would be accurate and reliable enough to be used in diagnostics' tests.

I could be characterized at this time as being a "research assistant" to help Hornig both in the design and in the testing of apparatus. Design of the switches themselves was the responsibility of another group (in which my civilian friend and later Ph.D. thesis advisor Leon Fisher worked). These switches of course could not be mechanical because of the severe requirements on speed and simultaneity. After a number of false starts they took the shape of Pyrex "vacuum" tubes containing a rare gas at low pressure in which two tungsten electrodes sat at opposite ends with a third, small trigger electrode inserted close to one of the electrodes. A high voltage, not large enough to cause an electrical arc, would be applied to the two large electrodes, while a fast, high-voltage short pulse applied to the trigger electrode would cause the breakdown – i.e., function as an electronic switch. This assembly, after successful testing, was farmed out to Raytheon for manufacture.*

We were given some switches, not of the final design, and told to test them. But how? More knowledgeable heads than mine quickly came up with the idea of using a "streak camera." And Hornig had a particular streak camera in mind – the very one or a twin of the one used by Michelson in his measurements at Cal Tech of the speed of light. It was no difficult task for Los Alamos to requisition this camera, which I believe was sitting out the war on the Cal Tech campus. The camera was set up on Two Mile Mesa, away from the Tech Area because of the disruptions that could be caused by high current sparks.

The camera arrived, and I helped to assemble it. It was really a very simple though ingenious device. Perhaps three or four feet long at its base, it was shaped like half a cylinder, maybe two feet high. At the front end of the camera was a lens that would focus a distant object, after being reflected by a mirror placed at the center of the base, onto the circular surface of the half-cylinder. The mirror was actually an eight-sided coated prism, mounted onto a low-friction axis and made to rotate swiftly by a stream of compressed air. Thus, a light beam would travel from the opening lens, get reflected off one of the sides of the rotating mirror, and end up being focused somewhere along the circular surface. A strip of film was mounted around that surface to record the image. Because of the eight sides of the prism, the onset of a spark would almost always be recorded somewhere on the film even though it was not possible to predict exactly at which point on the film the image would appear. A long flat metal plate could be slipped in ahead of the front side of the film, exactly like the shutter of a focal plane camera, to be removed and replaced just before and just after a shot.

* I understand that Raytheon was slow in delivering these switches, which caused significant delay (and consternation) at Los Alamos.

For these tests we had to devise a spark system to simulate the actual spark device that would later trigger the detonators. It made no sense at this early stage to use actual explosives. Instead we designed a device adequate for the job, cheap and easy to assemble. It consisted of a pair of plain old pins, placed parallel to each other and fixed into position by enclosing them in a plastic envelope, with the heads of the pins bent outward to accommodate wires attached to the electronic switches.

At this time I was working closely with a civilian woman, Margaret “Peggy” Ramsey, who had a bachelor’s degree in chemistry from a New England college. I greatly enjoyed this collaboration – it was the first time I had ever taken part in a joint project with anyone (this is of course the way to have the most fun out of scientific research). After this test system became sufficiently reliable, I myself would set up each test with the streak camera, and operate the entire test, including setting off the sparks, operating the camera, and finally developing the film. On important tests Don Hornig would be present, and it goes without saying that he always was available for consultation, and was careful to oversee my work and ensure that I didn’t do anything stupid.* I would spend long hours wiring the various combinations of spark triggers, eight at first and then gradually increasing to 32, which was the final total number of implosion lenses contained in the Fat Man.** At a later stage in this research, after the triggers were working well, I was placed in charge of what you might call “field testing,” that is, using the streak camera to test assemblies of the final switches that were to be used in the real bomb. That is why I was chosen, among many others, to go to Tinian.

By this time it was the spring of 1945 and the project was approaching its climax with the impending test of Fat Man at Alamogordo, due to take place in mid-July. Our simultaneity tests were essentially completed. The Raytheon switches had arrived and were being used; the actual spark ignition switches, just like the ones that would go into the bomb, also had arrived and were being used instead of my pin assemblies. We were ready for more realistic bomb testing. It was time to bring in the Air Force. The 509th bombardment squadron was given the bomb assignment. It was quartered at an isolated Air Force base at Wendover Field, on the border between Utah and Nevada. The flight crews of the B-29s that were to drop the bombs had to be trained in their operation while in flight, and the wiring and switching also had to be set up by Los Alamos people on site. I was one of the crew that had to travel frequently to Wendover to help in these tasks.

* However, he wasn’t 100 % successful. One crucial shot, which I had worked most of the night assembling, was to have been a final test that all was working well. I fired it off early in the morning, with Hornig present. He jokingly remarked, “wouldn’t it be funny if you forgot to remove the shutter?” – which is exactly what I had forgotten to do. In tribute to Hornig’s equanimity and grace he took this in good stride, and even laughed about it. I spent another five hours setting up a second shot, and this time (and forever after) I remembered to remove the shutter.

** In the December 13, 1999, issue of *The New Yorker* there is an article about Saddam Hussein. I quote in part some of it here. “Recently Iraq ordered half a dozen state-of-the-art machines for getting rid of kidney stones. Such machines require a high-precision electronic switch that triggers a powerful burst of electricity. In addition to these [machines] Iraq wanted to buy a hundred and twenty extra switches.... [Its] strange hankering becomes less mysterious when one reflects that the switch in question has another use: it can trigger an atomic bomb. ...each bomb...requires thirty-two switches....”

One obstacle first had to be overcome. I of course was a plain soldier, as were the other SEDs. Most of the flight crews were officers. It would not do for such soldiers to be supervising officers! Nor could it be revealed that we were enlisted men, *i.e.*, GIs, as this might cause excessive suspicion by the crews, who at this time were not informed of the actual nature of the bombs they were going to drop. Accordingly, the GIs, myself included, had to masquerade as civilians. I was given \$200 in cash and instructed to buy a full wardrobe of civilian clothing in Santa Fe. This I did, with enormous glee. It was quite an outfit – I remember especially the bright green (or was it red?) jacket, which caused great amusement back in the barracks. The only problem I had was that shoes at the time were rationed. I only possessed one pair of high army boots, above the ankle, with inside-out leather.

No civilian would be caught dead in such shoes. Accordingly, I was given permission to have a shoe ration certificate issued to me. The memo with this authorization still survives, reproduced here (figure 3), along with the original secret memo authorizing the wearing of “civies” (figure 4). Properly outfitted I started on a series of trips to Wendover Field. These generally lasted two or three days. My job there was to help the B-29 crew familiarize themselves with the complex set of switches and other gear that was to be connected to Fat Man. We became quite friendly with the crew, which still did not know exactly what was going on, although by this time crew members were beginning to have suspicions. I loved the flights from Albuquerque to Wendover. We would fly directly over the Great Salt Lake, into very barren and empty land where you could still see the trails left by the covered wagons of the pioneers heading west. In the evenings I occasionally would walk across the border into Nevada; the town of Wendover straddled both Nevada and Utah. Thus, by taking a few steps one could gamble legally, which I did. Needless to say, the Wendover gambling establishments did not resemble today’s gambling emporiums – they were very seedy and run down. However, I did enjoy playing blackjack, a game I was convinced at the time could be conquered by counting cards. Once I took an unauthorized leave in Albuquerque and missed the bus back to Los Alamos, although fortunately for me no one had an accurate personnel roster, so I got away with it.

Tinian

It was now May 1945. The war in Europe had just ended, and our attentions were focused totally on Japan. It was clear that we were getting ready to use the bombs in Japan, although the Alamogordo test had not yet taken place. I along with a number of others received orders to go to the South Pacific, although at first we did not know our final destination. I made my preparations. The first thing I did was to assemble a collection of books that I packed in a footlocker for separate shipping (I knew it would have to go by boat). At this late date I remember the title of only one of those books – Thomas Mann’s *The Magic Mountain*. I planned to reread it, partly because of my identification with the protagonist Hans Castorp – I hoped I would stay for only a short time but feared I would end up staying twenty years. The footlocker arrived on Tinian about a month after I did. Fortunately I

not the first one made by the Green Hornet, but it certainly felt like a momentous adventure to me. Since it was obvious that I was in the middle of a historic event I decided to keep a diary (figure 6), which contained entries for almost every day until I returned to the U.S. The flight was reasonably uneventful. We first landed in San Francisco for refueling, then we flew to Hickam Field in Hawaii, where we stayed overnight – no flying in the dark! I was put up in the enlisted men's quarters

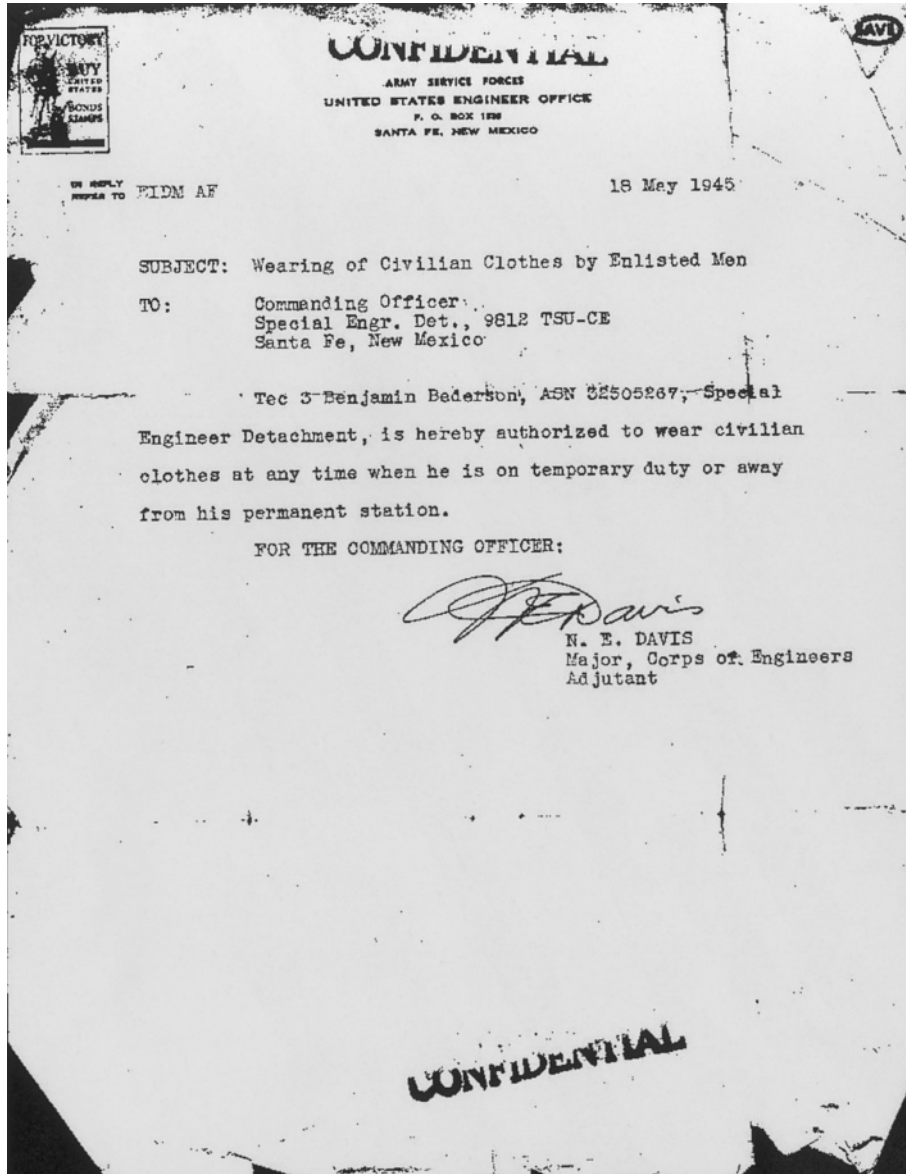


Fig. 4. Authorization for the author to wear civilian clothes.

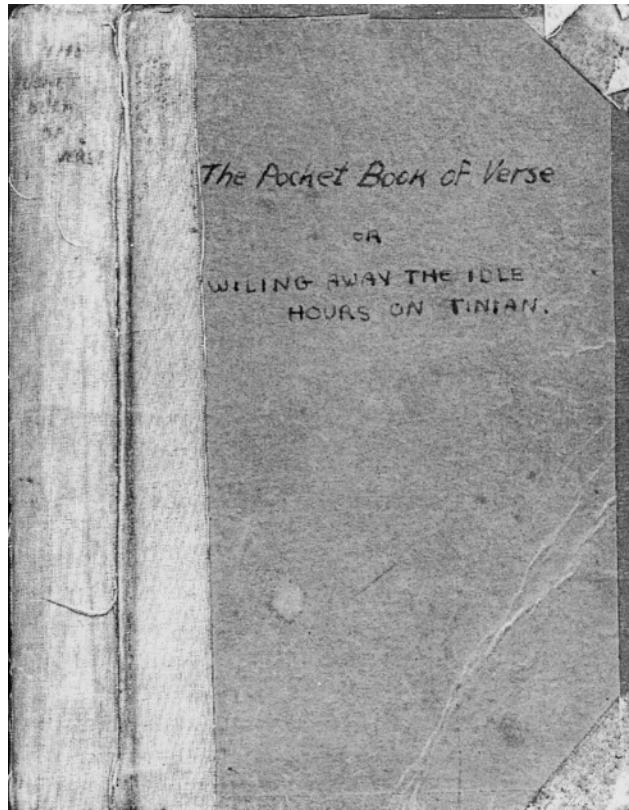


Fig. 5. The only book that the author carried with him personally to Tinian. His spelling ability, he claims, has improved somewhat since that time.

at Hickam Field. I slept in a top bunk. Directly over my head were gouged out bullet holes in the cement ceiling from the Japanese attack on December 7, 1941.

From Hawaii we flew to a tiny speck of an island, called Johnson Island, a convenient refueling stop about halfway between Hawaii and the Marianas, where we again were put up for the night. This was my first experience with true military life, although without any nasty direct dealings with the enemy, but with powdered milk, very soggy corn flakes, and Spam. We received literature describing the island, called by the occupying GIs “no island atoll.” We took off in the morning and after a very long flight landed on Guam in the Mariana Islands. These islands had only been captured recently from the Japanese, at considerable cost in Marine lives. But they were of great strategic value, since they were close enough to Japan to be a Japanese protectorate, not an occupied country, and were within bombing range of Japan by the new B- 29s. The overall strategy of the U.S. Air Force was to use the Marianas as a base for the strategic bombing of the Japanese mainland. A neighboring island, Tinian, was chosen as the best location for a huge Air Force base, and it was to this island that we flew and set up shop. By then Tinian had become the largest airfield in the world, being the launching pad for Air Force raids

directly over the Japanese mainland. There was a continuous roar of engines as hundreds of Boeing B-29s took off with bomb loads and returned many hours later, after having deposited them on Japan. We would watch this show for hours on end. I also watched more than once as new graves were dug for returning fatalities, as airmen were killed by antiaircraft fire and Japanese fighter plane attacks. It was a matter of great pride and satisfaction that I was aware that I was playing a role, however modest, in helping to stop this killing.

By each man in his turn, we know the takeoff time —
 0230 6 August. We know the drop time — 0415 7 August.
 We know it's going to work, and all that remains to
 be determined is its effect on the waves and the target.
 I guessed at Tokyo Bay, though this area will probably
 wait for a later bomb. It is the general opinion that this
 fission will be used as terrifyingly as possible — say,
 dropped in the center of a city not yet bombed. It ought
 to start the Japs for thinking.

The boys are joking, and most of the cracks are
 directed at the Navy photoographers, who have to get up
 at one AM to "take" the takeoff. They were told by
 that this new bomb would have the effect of several
 blockbusters. They were also told, by the same lieutenant,
 that one will destroy a city. Since they are somewhat more
 intelligent than the lieutenant they now doubt everything,
 and believe nothing.

We mentioned the fast camera which will photograph
 the Ball of Fire — the camera that takes 600 frames a
 second. They claimed you couldn't get a picture at 600
 frames a second without strong external light source.
 We astounded them by saying that not only would
 we get a picture but a ^{very} dark filter would be
 used.

Fig. 6.

(36)

Someone suggested that if I didn't make they would take it out of our pay. Someone else remarked that then we would remain in the army for ten million years. No bomb could cost that much, swore the Navy. We said then that this one does.

Then they asked us how long it took us to make the bomb. Four years, we told them. So they left to use up their leave rations. The discussion got livelier. Most of the men in the lab have been with the project over a year. They have worked hard, and the work has been mostly boring and sometimes heart-breaking. Days have been spent on the same experiment - making a change, putting it in a steel chamber, loading a camera, opening the shutter and firing, and the record is out of focus or the sweep was out of kilter and you repeat the motions, take another picture. You get a good record, but things aren't what they should be. ~~Some~~ Yesterday you made the same experiment, get an answer different by tenths of microseconds. Tenths of microseconds! A tenth of a milliwatt of a second, and a simile like "battering an eyelash" becomes obsolete, as ^{out of date} ~~meaningless~~ as saying "going a mile a minute". You search for a reason for the change because though you could swear nothing has changed.

Fig. 6.

The local inhabitants of Tinian apparently were considered to be loyal to Japan. They had been herded into internment camps; they lived in tents and makeshift corrugated tin huts behind barbed wire. Entire families lived in very primitive conditions. Long, narrow, and mostly flat, Tinian roughly resembled the island of Manhattan, and in one of those ironies of fate had been laid out with streets and avenues named after Manhattan main streets and avenues - the Manhattan

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The only way to preserve your sanity is to keep the damned thing logical. You search and find nothing, no differences, until one night at the show you hit it — The first shot was taken in the morning, the second one in the afternoon. The first one was still moist from the night dew, the second had time to dry out. So from then on you take all your shots the same time of day, and one bundle has been humbled, one stumbling block has been stumbled over, you've tripped, caught your balance and kept going.

Aug 6

So the month's past, the snow melts on Two Mile Mesa and the mud gets deep and you can't get anything insulated properly because everything is wet, but you do your best and the mud dries and it gets hot, you make in your sheets, still shooting detonators a leaves and always keeping in mind that you have to wind the shutter, or 4 man days will be lost. Then it gets muddy again and then it snows again and you put ^{spring} wheels on the wheels ^{of your car} and put in the four wheel drive but you still get stuck twice a day — and suddenly what you once thought would go on forever suddenly ends. Without celebration or official notification the experimental set up is over. The more pulse generators or ^{this flop} circuits. Instead

Fig. 6. Several pages of the author's diary kept while on Tinian. In the interest of historical accuracy, the author has not corrected misspellings. The first several pages reproduced here were written August 5, 1945.

project! I and a friend, Henry Linchitz, a civilian Ph.D. chemist,* occasionally would wander around the island, exploring caves and low hills where it was

* Henry Linchitz became professor of chemistry at Brandeis University. He later became deeply involved in disarmament activities, aimed principally at eliminating all nuclear weapons. He became one of the many scientists who felt deeply about their bomb work during the war, although he as most everyone who worked on the bomb felt that within the context of the time its use over Japan was justified.

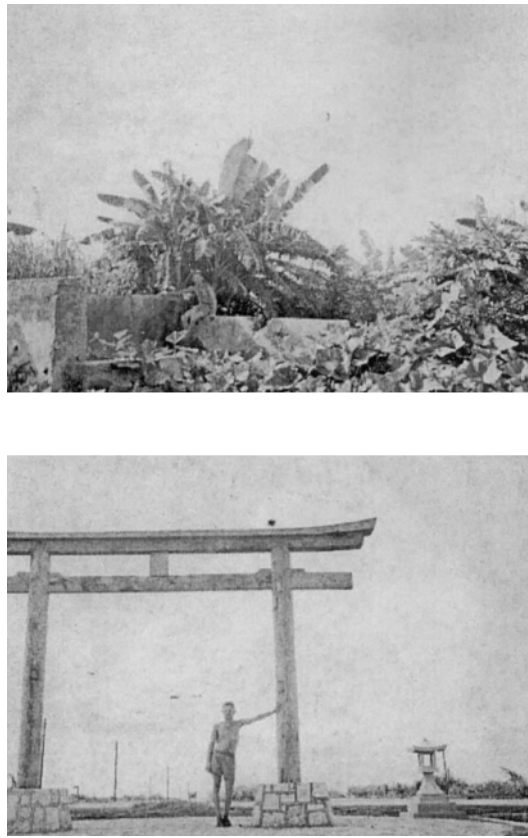


Fig. 7. A bombed-out private home and a Shinto shrine on Tinian.

rumored a few Japanese soldiers were still hiding. Once we came across a family home that had been bombed almost beyond recognition, but which still had the remains of a bedroom in it with children's paintings on the walls. This brought home to me a different picture of the "enemy" than the one I normally had held (figure 7). We also explored some Japanese bunkers along the shore that still contained remnants of bodies.

We worked in a converted Quonset hut, where I assembled the spark igniter testing equipment and ran tests on the igniters, using the same streak camera I had used at Los Alamos. I was to select the best set of triggers, that is, the ones that fired fastest and most closely together, out of the many supplied, and this I did.* We already had heard from recent visitors that the Trinity (Alamogordo) test had

* In later years I had a fantasy that I could have chosen the worst, not the best, triggers for inclusion in the Fat Man. The bomb would therefore have been far less effective, and might even have fizzled. Think of all the Japanese lives I could have saved. But the thought never crossed my mind at the time, and even in hindsight I have no regrets whatever about this.



Fig. 8. The full Tinian crew. Norman Ramsey is in the front row, center, and Luis Alvarez is in the second row, second from the right. The author is in the third row, fifth from left, and his friend and mentor, Edward C. Stevenson, is in the third row, third from right.

been a huge success, so we were very confident that our efforts would not fail. Finally we were finished. We knew on the evening of August 5 that Little Boy, the first bomb, would be used the following morning. We were visited in the enlisted men's tent by a pair of Navy photographers who were to take pictures of the event on the following day and also by the senior *New York Times* science reporter William Lawrence. We felt very important since we were for the first time almost permitted to discuss the bombs, which we did albeit rather circuitously.* We went

* My normal uniform on Tinian, which had a hot and humid climate, consisted mainly of a pair of khaki shorts and GI-issued heavy shoes. One day while I was at work in that hut, dressed as usual, it was announced that there was to be a visit that day by General Curtis LeMay, the commanding Air Force general. General LeMay had a reputation, well deserved, of being the most aggressive and effective commander in the Air Force, maybe in the entire military. He was a strong advocate of blanket bombing, and after years of effectively leading air strikes over cities in Germany had recently been directing operations over Japan, with the newly produced B-29 bombers. He had introduced nighttime incendiary bombings of Japanese cities, which were causing great havoc throughout Japan. He was later to be the founder and the Commander-in-Chief of the Strategic Air Command. Naturally everyone hustled to straighten out and clean the rather casually organized Quonset hut. Unfortunately, or fortunately, someone noticed that I was not wearing a shirt. This did not seem appropriate in the presence of that particular officer, but there was no time for me to go back to my tent to grab one. Someone quickly shoved me into the darkroom, closed the door, and instructed me to turn on the red light that indicated that film was being developed, in case he might want to peek in. I caught a glimpse of the general, big cigar and all, as I closed and locked the darkroom door. When the visit was over, in about half an hour, I was allowed to leave. Everyone was all abuzz with the General's reactions to what he had been told about the bomb. My army buddies gleefully described to me these reactions. He expressed complete skepticism over the claim about its likely destructive power, clearly believing that he was in the presence of a bunch of high-brow nuts. The thought that one B-29, delivering one bomb, could do the work of his entire fleet of B-29s carrying incendiaries, was naturally a pretty difficult dose for him to swallow. Later, after the bombs had been dropped, General LeMay became a strong advocate of maintaining a nuclear arsenal, and even on occasion offered the opinion that the use of nuclear weapons under some circumstances could be justified. [This incident is also described in a short note in the magazine *American Heritage* – in press.]



Fig. 9. Close-up of the author (center) and his friend, Henry Linchitz (to the author's right).

to bed late. It didn't take long the next morning for the radio to report the explosion. The secret was out. It was a truly awesome feeling to have participated in this historic project and to have been at the site of its dramatic denouement. A group photo of the entire Los Alamos staff and the top brass of the operation was taken (figures 8 and 9).

My work was essentially completed with the testing of the triggers for Fat Man,* which was used three days later. A few days after that we heard of the Japanese surrender, and had a minor celebration, realizing how our own efforts had so strongly influenced this early, welcome end to the war.**

There really was nothing left to do except to pack up and await a flight back to Los Alamos, which didn't occur for about three or four weeks. I basically just killed time, doing a few crazy things. I studied the habits of the huge Tinian ants (described in my diary). Once in sheer desperation for something to do I decided to study the relative importance of reflex *versus* conscious action. I borrowed a jeep and attempted to drive it with my feet reversed, that is, with my right foot on the clutch and left foot on the brake. This worked fine for about five minutes, until I had to make a sudden stop. So I stepped on the clutch instead of the brake, and crashed right into a small water tower mounted on some scaffolding. The tower tipped over crazily, although it did not crash completely to the ground. Standing there at about a 30-degree tilt, it and I were observed by a passing Lieutenant. Perhaps he was just as delirious as I was – he simply admonished me and moved on, as I did, using the correct feet positions this time.

* At just about the same time as the bombs received their famous nicknames, *The Maltese Falcon* appeared in Hollywood with Sidney Greenstreet and Peter Lorre playing sinister but fascinating roles. They became known in studio lots as the "fat man" and "little man." Coincidence? Who can tell?

** When I was growing up in the Bronx we had a favorite expression, "wake up, the war's over," left over no doubt from World War I. When the Japanese surrendered I went to the "officers" tent, which also housed civilian scientists. I happily awoke one of my senior mentors, Edward C. Stevenson, a professor of physics at the University of Virginia, using those exact words. I had been planning to do this to someone, anyone, for three years.

Finally we received our orders to return to Los Alamos, and flew back, again on the Green Hornet. On the flight home I had an important conversation with Professor Edward C. Stevenson of the University of Virginia. This was the first time I actually had an opportunity to discuss my future with a real scientist. He advised me to go to graduate school after finishing college. I had not thought of this before.

Returning to Los Alamos I was given a new assignment, nowhere nearly as interesting or important as the earlier one. I became a nuclear reactor inspector. I worked an eight-hour shift, just like a civilian employee, and had to make the rounds of a research reactor, recording meter readings, watching for problems, and in general keeping an eye on things. The rest of my time was free. In the next section I describe in part how I managed to spend this free time while waiting for my Army discharge, which was not forthcoming until late January of 1946.

Army Life at Los Alamos

All SEDs were assigned to a special barracks; other soldiers such as MPs and guards were quartered elsewhere. (When I arrived there was only one SED barracks, although a second was soon built.) There was an interesting dichotomy in our daily lives. While working in the Tech Area or elsewhere we were treated like the civilian workers, with privileges compatible to our jobs and responsibilities. However, at other times we were simply soldiers like all other soldiers, with a lieutenant in charge of the SEDs and a major in charge of all soldiers. Our officer in charge did not have access to bomb information, and this caused significant tension, since his authority was strictly limited. For example, if a soldier had to work at night, or was traveling, he could easily get out of normal routine. This did not prevent the lieutenant from imposing Army discipline to the extent he could. At first we had to submit to early morning drill and calisthenics, before going to work. This was exceedingly unpopular among the SEDs, and was eventually done away with. We had to abide by normal barracks' discipline, which mainly meant Saturday morning inspections. Depending on who happened to be the commanding officer, these were either cursory or strict. We of course took these impositions as lightly as possible. We had to keep our footlockers in prime shape, clothing and toilet articles clean and neat, and shoes highly shined.*

I have to admit that the Army and I were never really meant for each other. Looking back, I am quite aware that my own free-wheeling bringing up in the Bronx and Brighton Beach (Brooklyn) was poor preparation for Army life. I now believe that painful as it was at the time the discipline and routines of this life were crucial in helping me later to complete graduate school and develop a career in physics. Many aspects of Army discipline at Los Alamos did not sit well with me, and, need I add, *vice versa*. I was not a spit-and-polish soldier, and I was

* At one particular inspection, to show our contempt for this kind of treatment, my bunkmate and I polished the soles of our shoes and exhibited them bottom side up. Unfortunately, the CO took no notice. Cigarettes were also required to be neatly stacked. On another occasion I put a box in my footlocker labeled "opium for smoking," but again this elicited no reaction.

continually getting into hot water with my commanding officer about my dress and appearance. Many other SEDs had similar problems. One of my close friends and barracks neighbor was Dick Davisson, son of the famous physicist C.J. Davisson of Davisson and Germer fame. Dick was as bad as I was. He devised a method that would not require him to ever make his bed. He simply made it once, and then slept on top of it, with a thin blanket to cover him. He bragged that that was the only time he made his bed during his entire residence at Los Alamos.

I was always homesick for New York, and on one occasion was so homesick that I tied a bagel to the overhead light string next to my bunk. (The bagel was given to me by Peter Lax, later to become a most distinguished mathematician, who had received it in a package from home.) Val Fitch, a fellow SED, wrote about this incident in his own memoir of SED days called "A view from the bottom," published in the *Bulletin of the Atomic Scientists* in 1975. My bunkmate (he had the upper one) was William Spindel, a chemist with a degree from Brooklyn College, later to become an officer of the National Academy of Sciences-National Research Council, who worked on gaseous diffusion, that is, isotope separation. He originally had introduced himself to me because he had heard of my presence at Los Alamos from a mutual New York friend. At first the double-decker next to ours was occupied by a New York machinist, David Greenglass, along with a New York friend of his, also a machinist, whose name I do not recall.* It did not take long for them to reveal their political sympathies, which were nothing but those of communists, plain and simple. Bill and I, however, had long shed our earlier pro-Soviet sympathies, and political arguments among the four of us gradually grew more intemperate. Eventually they became so unpleasant that Bill and I asked for and received permission to transfer to the second, newly constructed barracks.

At first security was so tight that we were not permitted to leave the post. Some time in late 1945 we were allowed to visit Santa Fe. Eventually we even were permitted to go to Albuquerque,** where wives of GIs also were permitted to live. A number of my New York friends were married and soon a virtual colony of SED wives was established there. Among them were the wives of Richard Bellman and David Greenglass. Bellman was a mathematician of considerable talent and later fame.*** He was a close friend of another SED, Norman Greenspan – they went to Brooklyn College together. When Norman, who worked for Luiz Alvarez, heard that Richard was about to be drafted, he informed Alvarez

* I have always wondered, after the Greenglass case broke, why his buddy was never mentioned in the press or elsewhere.

** On weekends I would often take a bus from Santa Fe to Albuquerque. Occasionally I would ride with Richard Feynman, who was already by this time an acknowledged genius, and a luminous star of the theoretical division (he was a very young civilian--not an SED). He would travel to Albuquerque every weekend to visit his wife, extremely ill, dying of tuberculosis. He had no compunctions about complaining about Los Alamos security and bureaucracy, which he expressed in a loud voice, unafraid. I was not so bold, being in uniform, and cringed from time to time in hearing him sound off. Of course he never got into any trouble about this.

*** For Bellman's own take on Los Alamos see his autobiography *Eye of the Hurricane*, World Scientific, Singapore 1984. It stars among others, Greenspan, Peshkin, and "Bedeson."

of Richard's abilities. Alvarez recalled Bellman as a graduate student and he soon found himself drafted right into Los Alamos. And indeed his talents were quickly recognized. He even received a private office in the theoretical division, a luxury not accorded to the experimentalists, like myself. This office was to come in very handy later. I inadvertently got Richard Bellman into a heap of trouble after the war, related to David Greenglass. I introduced them to each other, and Bellman sublet his Albuquerque apartment to the Greenglasses – but fortunately he survived this without damage to his career.

Greenspan constructed a state-of-the-art hi-fidelity system, consisting mainly of a powerful amplifier using parts requisitioned from the electronics stock room. His system was very sophisticated for the time – he designed a circuit that could be adjusted so that the two push-pull 6L6 amplifying tubes could yield exactly balanced outputs, greatly minimizing distortion. Using this amplifier we would play classical records, using a record player that we had somehow scrounged. The amplifier was installed in Bellman's office, the only private place we could commandeer. Of course we could not play music during working hours. Instead, Norman and I formed a club, called the Mushroom Society, which often met at night, when we could play records loudly without disturbing others very much. The name was particularly appropriate because our favorite music consisted of recordings of Mahler symphonies, which were not difficult to identify with darkness and gloom. We occasionally had a third member of the club, a very quiet and introverted young SED named Ted Hall. He would show up from time to time; like the other club members he loved Mahler. However, we never became very friendly, simply because he did not talk much. Later, after I had returned from Tinian, and was waiting for my discharge, I built my own amplifier, which I labeled the Bederson Belchmaster. It was an improved version of Greenspan's first effort, a beauty with maybe 50 watts of audio power. When I left Los Alamos I shipped it back home, hoping that it would get through Army inspection, which it did. I used it in New York for years afterward. I also laid my hands on a record transcriber, used mostly for recording data. I made a number of records that I mailed to my folks back in the Bronx. One or two of these survive.

Barracks' life was not unlike the experiences of millions of other GIs during the war. As already noted, we had neither latrine duty nor KP – these were performed by hired local women, Mexican and Indian. But living in one large room with 49 other soldiers was hardly a pleasant experience. The latrines were public, as were the showers. Heat was supplied by two or three coal stoves per barracks, and these had to be stoked by volunteers, especially in the early morning when it tended to be very cold. I had to perform my share of this onerous chore. Of course none of us, including me, really resented our lot. We were all too well aware that there were soldiers fighting and dying while we had to suffer relatively unimportant inconveniences, while performing exciting and important work. Thus, our gripes were not taken very seriously, either by the Army or by ourselves. Probably the most serious complaint the SEDs had concerned relative rather than absolute treatment. Young civilians and SEDs (and even some Navy Ensigns) often worked side by side with comparable responsibilities, sometimes with SEDs ranking higher than civilians. But the civilians not only did not have to put up with Army discipline, they also

were far better paid. This did not make very good sense to the GIs whose monthly checks often did not reach higher than two digits. In late spring of 1945 I received a letter from my father framed in black ink. He informed me that my close friend Irving Yusin, who had shared living quarters with me in Philadelphia for six months before I was drafted in 1942, had been killed in the Battle of the Bulge. This essentially trivialized my so-called hardships, putting them into the proper perspective of the year 1944.

SEDs would sometimes be called upon to perform other duties, notably helping to put out forest fires. The dry New Mexico climate resulted in frequent small fires in the pine forests surrounding Los Alamos.* From time to time we would be "recruited" to go on forest fire duty. I didn't object to this very much, except on occasion when after a hard day (and night) stint doing timing tests we would be awakened to help put one out. I developed a strategy to avoid such duty after particularly long hours – I would hike from Two Mile Mesa to the back entrance to Los Alamos, slip through a rickety barbed-wire barrier, and seek out an ancient Indian cave in what is now the Bandolier National Monument. There I would luxuriate in a good night's sleep under a ceiling covered with the smoke of ancient cooking fires, with walls sometimes marked with equally ancient glyphs.

And speaking of fires, there was a very serious fire in the Los Alamos machine shop, likely around April 1945. That time I grabbed a hose and entered the shop, becoming a *bona fide* fireman, braving the smoke and fire to help preserve the much-needed shop.

Furloughs, when they were given at all, were given grudgingly – not surprising in view of the Army's nervousness about security. I believe that in all I had maybe three furloughs, taking that interminable train ride from Lamy to New York. Of course I was not able to talk about my work to anyone, although surprisingly one or two of my friends made some pretty accurate guesses about what I was doing. In one case a friend told me of an experiment at the University of Chicago, even naming the football stadium as the location, where some hush-hush experiments concerning atomic bombs were taking place. This was long before I knew anything about Enrico Fermi's reactor experiments. I have a letter from another artist friend who actually drew a picture of an atomic explosion for me, kidding me about what I was doing. Mail was censored both coming and going, although only the mail sent to me bore a censorship seal. Outgoing mail had to be unsealed, and passed by the censor. I had one censor assigned to me throughout my stay at Los Alamos, and after a while we developed a kind of friendship. To this day I have no idea who he (or she) was, though of course he (or she) knew all about me.

In all of the time I was at Los Alamos I met its two principal leaders exactly once each. Shortly before Christmas 1944, I, along with a handful of other SEDs, were invited to meet with General Leslie R. Groves. Expecting something a bit more worldshaking at this momentous event (for a corporal), General Groves revealed his purpose in arranging the meeting. It was, he said, to urge us to write home to our parents at Christmas time. You have no idea, he said, how much this would

* Forest fires at Los Alamos are obviously not new!

mean to them. At the meeting he also asked whether we had any complaints or suggestions on how life could be made better for us. Only one SED spoke up – he was very unhappy that the Army did not supply us with adequate baseball equipment. We needed more balls, gloves, and bats. General Groves promised to look into it, and we adjourned.*

The day before I was to take off for Tinian the group that was to travel on the Green Hornet assembled in Dr. Oppenheimer's office. He gave us a rousing speech, telling us how important our mission was, he shook our hands, wished us the best of luck, and we adjourned.

When I returned from Tinian, in late August 1945, I simply marked time waiting for my discharge. The Army had established a point system based upon length of service, duty in combat areas, and other factors, for determining the order of priority in getting out. My designated time of discharge was late January 1946. Thus, I had a lot of time to kill (apart from my reactor-inspection duties, which were hardly onerous). I spent much of this time listening to music, traveling to Santa Fe and Albuquerque, and mainly playing Chinese Checkers with Richard Bellman. Living up to his brilliant reputation, he was a formidable adversary, although I did manage to beat him about a third of the time. We also had an ongoing game of hearts – a cutthroat game in the best of circumstances, with Bellman, Greenspan, myself, and Murray Peshkin as regular participants. (Peshkin is now a highly regarded Argonne physicist.) Greenspan reminds me that on one occasion after a particularly offensive play Peshkin chased him around the Tech Area late at night with a jagged tin can, but I can't personally vouch for this. More importantly, the administration had decided that it would be a good idea to have some of the many luminaries on the site offer "courses" – actually, lecture series, on topics in pure physics. I happily sat in on many of these, including ones by Edward Teller, Philip Morrison, Robert Serber (of "Serber Says" fame), and also some guest lectures by Hans Bethe, among others. Needless to say, these were wonderful preparation for my future graduate school studies.

A final temptation was put in my path. Just before my discharge I was approached by one of my former group leaders who invited me to participate in the planned nuclear tests to take place in the South Pacific in 1946 and later. I was offered what to me seemed like an amazingly high salary – \$6000 for six months. This was over sixty times what I was then earning as a soldier. Pleased with the flattery, I had no trouble turning it down, and instead proceeded with my plan to finish college at CCNY, and then go on to graduate school.

Eventually my number came up, I traveled to Fort Bliss, Texas, aptly named, and received my discharge.

It is virtually obligatory for any atom bomb memoir to include a discussion on the merits of President Harry S. Truman's decision to drop the bomb. I can take care of this obligation here by simply describing what I have told students at New York University whenever they would confront me with this question. I would point out that had the bombs not been used many of the men and women in the

* Val Fitch in his article notes that General Groves never mentioned the SEDs, even in passing, in his autobiography.

class would not be there, since one of their parents or grandparents would not have survived the inevitable invasion of Japan. This was, and is, a very compelling argument.

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Strong Opinions

Rudolf Peierls painted a vivid picture of J. Robert Oppenheimer's likes and dislikes:

He had strong views on questions of style in food and drink. Martinis had to be strong. Coffee had to be black. When coffee was served in their house, there was never any cream or sugar on the table. They would be provided on request, but the hosts started from the assumption that the guests would want to have their coffee the proper way.

Steak had to be rare (underdone), and this brings a story to mind. Oppenheimer took the members of a committee to a steak house after a meeting. Everybody ordered steak, and the waiter took orders on how it should be cooked. Oppenheimer said "rare", and this was echoed by everybody in turn, until the waiter came to Robert's neighbour on the other side, who said "well done". Robert looked at him and said, "Why don't you have fish?"

Rudolf Peierls, *Bird of Passage: Recollections of a Physicist* (Princeton: Princeton University Press, 1985), pp. 189–190.