

# Physics genius showed Oak Ridge how to be safe

(As published in *The Oak Ridger's Historically Speaking* column on November 3, 2014)

One of my favorite characters of the Manhattan Project era is Richard Feynman. When asked by Sam Shaw and Lily Byock, producer and writer as well as husband and wife team, who created the *Manhattan* television series now showing on cable WGN and set for a second season, which of the Manhattan Project scientists they should consider including in the series, I immediately suggested Richard Feynman.

If you have followed the TV series, you know that they did indeed use the history of Feynman's visit to Oak Ridge in the earliest months of the Manhattan Project in their series.

I was most pleased when Carolyn Krause offered to write a *Historically Speaking* column on him. Enjoy what Carolyn has dug up in her research.

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At the age of 26 he may have saved Oak Ridge from a nuclear disaster.

As a junior physicist but experienced safecracker (for fun) at Los Alamos, N.M., he demonstrated that two safes in Oak Ridge weren't safe.

It was in Oak Ridge that he first wept over his young wife's death in Albuquerque in July 1945.

He won the Nobel Prize in Physics in 1965 for developing quantum electrodynamics, which describes how light interacts with matter. This New York City native and son of Jewish parents with Russian and Polish ancestries was ranked as one of the 10 greatest physicists of all time.

When Richard Feynman (1918-88) first came to Oak Ridge in April 1944, he had taken his first airplane flight. He found that Army officials and company managers needed an education on how the atomic bomb, to be fueled with neutron-releasing and neutron-absorbing uranium-235 from Oak Ridge, was supposed to work.

Feynman convinced Army officials that key leaders needed to know the latest information on how to prevent a terrible criticality accident caused by runaway, explosive chain reactions. As he put it, "I really grew up fast."

It started when a letter from a plant superintendent with Tennessee Eastman Corporation in Oak Ridge reached Los Alamos. The writer asked this question: should Oak Ridge have advanced fire-fighting equipment and special chemicals because "no provisions have been made in the 9207 Area for stopping reactions resulting from the bringing together by accident of an unsafe quantity of material"?

Robert Oppenheimer, scientific director of the Manhattan Project who was in charge of the weapons laboratory at Los Alamos, sent Emilio Segrè to Oak Ridge to inspect the Y-12 Plant, which was producing uranium fuel for the atomic bomb. Segrè was astonished by the Army's "compartmentalization of information" that kept secret the findings Oak Ridge managers needed to know to ensure plant safety. He had seen workers wheeling around large bottles of a greenish, water-based solution of uranium nitrate.

According to "Genius: The Life and Science of Richard Feynman," by James Gleick, the Oak Ridge officials "lacked knowledge that had become second nature to the experts at Los Alamos: that the presence of hydrogen, as in water, slowed neutrons to dangerously effective speeds and so reduced the amount of uranium-235 needed to sustain a reaction."

Oppenheimer then transferred Feynman to Oak Ridge as a safety supervisor. The Los Alamos director told him what to say when he arrived: "Los Alamos cannot accept the responsibility for the safety of the Oak Ridge plant unless . . ."

"You mean me, little Richard, is going to go in there and say . . ."

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"Yes, little Richard, you go in there and do that," Oppenheimer said. (The entire dialogue appears in "Surely You're Joking, Mr. Feynman: Adventures of a Curious Character.")

As an expert in making critical-mass calculations at Los Alamos, Feynman worried about the possibility in Oak Ridge of reactions that could release dangerous, potentially fatal amounts of radioactivity and heat at near-explosive speed, as the atomic bomb was being designed to do.

Segrè had visited just one Y-12 storage room. Feynman discovered that uranium nitrate solution enriched in U-235 was stored in drums holding 300 to 3,000 gallons. His drawings and calculations showed that the drums were placed in potentially unsafe arrangements on brick or wooden floors in dozens of rooms in several buildings.

According to Gleick, Feynman "met with engineers to study blueprints for plants under construction. He realized that the plant was headed toward a catastrophe . . . The nightmare was that two batches, individually safe, might accidentally be combined. He asked what each possible stuck valve or missing supervisor might mean. . .

"Eventually, meeting with senior Army officers and company managers, he laid out a detailed program for ensuring safety. He also invented a practical method . . . that would let engineers make a conservative approximation, on the spot, of the safe levels of bomb material stored in various geometrical layouts. A few people, long afterward, thought he had saved lives."

Ted Welton, who worked at Oak Ridge National Laboratory starting in 1950, interacted with Feynman when both were undergraduates at MIT and when Welton worked in Feynman's theoretical physics group at Los Alamos during the war. Welton wrote an article on Feynman published in "Physics Today."

At Los Alamos, Feynman befriended Klaus Fuchs, who lived in an adjacent room. Fuchs, a German Communist who became a British physicist, contributed to the bomb project. He also worked as a spy, driving secret documents on how to build an atomic bomb to Santa Fe, where a courier took and transferred them to the Soviet Union. Feynman sometimes borrowed Fuchs' blue Buick so he could drive to the Albuquerque sanitarium where his wife Arline was dying from tuberculosis.

Feynman didn't know Fuchs was a spy until World War II ended. But Feynman, who had taught himself to crack safes, was capable of accessing locked-up atomic secrets. To make the isolation of Los Alamos bearable, he played bongo drums and enjoyed learning how to pick combination locks.

Feynman knew that people tend to leave safes unlocked, factory-set combinations unchanged, and written-down combinations inside desk drawers. Many choose birthdays and other easily remembered numbers. "By fiddling with his own safe," Gleick wrote, "he learned that when a door was open he could find the last number of a combination by turning the dial and feeling when the bolt came down."

One time in Oak Ridge, Feynman and others gathered in a VIP's office on a Sunday to discuss a secret report locked in a safe. The VIP couldn't recall the combination, and his secretary was away on a picnic in the mountains. Feynman got permission "to fiddle with the safe" and in 10 minutes opened it.

On another weekend when Feynman was visiting a colonel in his Oak Ridge office, he waited for the colonel to review Feynman's report that had been locked up in a fancy safe with big handles and brass doors. Feynman obtained permission to examine the open safe while the colonel read his report.

After the report was approved, returned to the safe, and locked up, Feynman told him a skillful safecracker could open his safe in 30 minutes but he could do it in 45 minutes. The colonel doubted his claim, saying he would wait to see if Feynman could crack his safe. In 12 minutes, Feynman opened the combination lock. "The colonel's jaw dropped and his eyes bugged out," Feynman later wrote.

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The next time he came to Oak Ridge, secretaries told him “not to come through here.” The colonel had told them that if Feynman had been present in their offices, they should change the combination of their safes. “That was his solution,” Feynman wrote. “I was the danger.”

Despite his mother’s objection, Feynman married his high school sweetheart Arline Greenbaum in 1938 even though she had contracted TB. After he obtained his Ph.D. from Princeton and got the Los Alamos job, he took Arline to the Albuquerque sanitarium. By driving or hitchhiking, he visited her almost every weekend. (Their story is told in the 1996 movie “Infinity.”)

After she died, he wrote: “I didn’t feel terribly upset, perhaps because I had known for seven years that something like this is going to happen. . . I didn’t cry until later when I was in Oak Ridge. I was walking past a department store with dresses in the window, and I thought Arline would like one of them. That was too much for me.”

Richard Feynman was an energetic, ingenious man who believed that the best prizes in his life were the “pleasure in finding things out” and the observation that his findings are useful to others.

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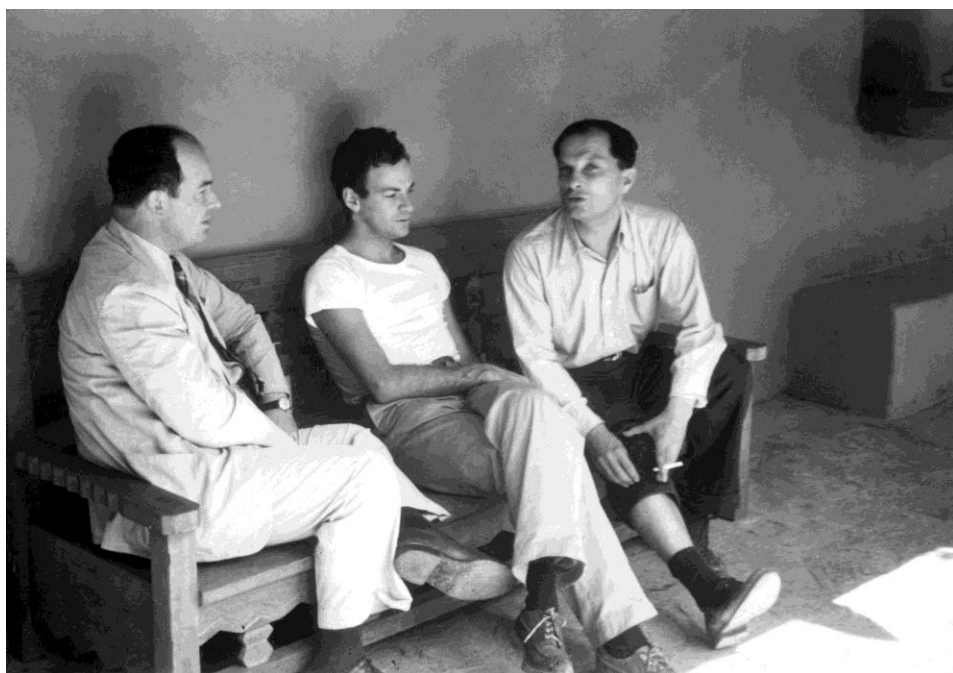
See why I admire Richard Feynman? Thanks to Carolyn for bringing us the story of this complex yet quite likeable scientist.



Richard Feynman’s Los Alamos badge photo

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von Neumann, Feynman and Ulam, three of the scientists involved in atomic bomb design



Richard Feynman in suit talking with Robert Oppenheimer and others