The Isotope of Uranium That Changed History

(As published in The Oak Ridger's Historically Speaking column the week of December 7, 2026)

When people talk about Oak Ridge's role in the Manhattan Project, one of the most remarkable accomplishments was the work carried out at Y-12, with feed from K-25 and S-50, to separate uranium 235 from uranium 238. Great Britian had come to the United States and said, "We know you can make a bomb out of uranium 235, but we do not have the resources to separate it. You do, so you make the bomb and we will send our scientists over to help."

The objective was simple to state but extraordinarily difficult to accomplish! It was to produce enough uranium enriched in uranium 235 to make an atomic bomb. In 1,000 pounds of uranium ore there is only seven pounds of uranium 235. And it is distributed through the ore.

Y-12 accomplished that mission through the electromagnetic separation process that separated the isotopes according to their mass using machines called calutrons, named for the California University Cyclotrons and invented by Ernest Lawrence. The K-25 Gaseous Diffusion process and the S-50 Thermal Diffusion process both created feed material that helped make the process work faster.

By the summer of 1945, Y-12 had produced uranium enriched to levels suitable for the uranium bomb known as Little Boy, the first atomic bomb ever used in warfare. The enriched uranium had been shipped as a powder nine times from October 7, 1944, to July 17, 1945, in small gold-lined coffee cup sized containers placed in a briefcase, strapped to an Army Lieutenant's arm who was dressed like a salesman and who caught a passenger train in Knoxville to take the shipment to Chicago where it was transferred to another Army officer to take it to Los Alamos.

By the July 17, 1945, shipment, the cumulative shipments at an average enrichment of approximately 81.6 percent, represented about 64 kilograms of enriched uranium. Enough for Little Boy and a small amount left over. This amount is less than a gallon in volume.

In other words, by the time the first atomic bomb was being prepared for use against Japan, Oak Ridge had accomplished one of the most important, and technically demanding, tasks of the entire Manhattan Project, producing enough highly enriched uranium for the uranium bomb. This was a vital effort and one on which General Groves and Colonel Nichols focused much attention.

The achievement becomes even more impressive when we remember what the situation looked like in 1942. There was no established uranium enrichment industry in the United States. There was no existing facility capable of producing significant quantities of highly enriched uranium. Within only two years and nine months, Oak Ridge had become the center of the nation's effort to produce it. At the same time the world's first industrial size nuclear reactor proved that plutonium could be produced.

Another way to look at the accomplishment is to examine the advancement of the production quantities of uranium 235. In October 1944, the production output was measured in tens of grams per day. By March 1945, it was approaching 200 grams per day. By July, it was approximately 340 grams per day.

Thousands of workers operated and maintained the calutrons at Y-12, while engineers, scientists and technicians continually improved the process. Many of the operators were young women right out of high school. Gladys Owens was one such "cubicle operator," later known as "Calutron Girls," because when she returned to Oak Ridge in 2004 after having worked at Y-12 only from January to August in 1945, she noticed herself in the famous Ed Westcott image of the young women sitting on stools in the Calutron control room of Beta 1.

Gladys told Steve Stowe, the director of the American Museum of Science and Energy, "that's me in that picture there…" Steve called me and said, "Ray, I have found you a Calutron Girl!" Now, that is where that term started to be used and now it is commonly thought to have been what the young women were called.

Denise Kiernan's book, *The Girls of Atomic City,* also helped call attention to the women who worked in Oak Ridge during the Manhattan Project. I believe her book did much to make people aware of Oak Ridge history who would not have otherwise known about it.

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The same thing can be said about the operation and maintenance of the K-25 Gaseous Diffusion process and the S-50 Thermal Diffusion process as well as the X-10 Graphite Reactor. While each of these required far less personnel than Y-12, the same progress was being made with each of these newly developing technologies.

The uranium produced at Oak Ridge was ultimately transported to Los Alamos, where it became the fissile material for the uranium bomb. Little Boy was dropped on Hiroshima, Japan on August 6, 1945, resulting in devastation like had never been seen before.

The story of Oak Ridge during the Manhattan Project is therefore not simply the story of large magnets and tons of equipment. It is the story of producing a relatively small quantity of an extraordinarily difficult-to-obtain isotope. It is the story of young people who did not know what they were producing but knowing they were doing something to help end the war.

And that distinction matters. From the 3,000 people who had to move off the land to the 75,000 who were living in Oak Ridge by August 1945 and to the 80,000 who were working in Oak Ridge in August 1945, all these people were doing what they could to help stop the awful war and the killing of 70,000,000 – 85,000,000 people, making World War II the deadliest conflict in human history!

The numbers can be confusing unless we remember the difference between **uranium ore**, **uranium 235**, and cumulative shipments. When those distinctions are made, the achievement of the people who built and operated the Oak Ridge facilities becomes even more remarkable.

Oak Ridge did not have to produce thousands of tons of enriched uranium to make the atomic bomb. It had to produce enough uranium 235 enriched sufficiently to make the mission possible. This accomplishment proved the British were correct. The United States may well have been the only place in the world that could accomplish the task of ushering in the nuclear age.

Both Germany and Japan have been proven to have attempted to create atomic bombs during World War II. Keith McDaniel and I have interviewed Dr. Todd Rider about the German nuclear program. https://smithdray1.net/Blog/HiddenHistory.html He has done an enormous amount of research.

While the Manhattan Project is one of the most remarkable chapters in the history of Oak Ridge, Manhattan Project 2.0, as challenged by Chris Wright, Secretary of Energy, is bringing to the forefront the next chapter in the history of Oak Ridge. As our mayor, Warren Gooch, often says, "Great things happen every day in Oak Ridge" and that is surely true for the nuclear renaissance.

It was a delight for me to bring the Tennessee Historical Commission to Oak Ridge recently. I was especially proud to be able to provide them a full afternoon of tours that included Building 9731 at Y-12 (to see the world's only Alpha Calutron magnets), the New Bethel Church and the Graphite Reactor at the Oak Ridge National Laboratory, as well as four of the new nuclear companies (Kairos Power, Radiant Nuclear, Orano, and TRISO-X.)

Oak Ridge is fast becoming the hub for all things nuclear for the nation. Ranging from creating the fuel for nuclear reactors by enriching uranium by Orano, to producing high assay low enriched uranium fuel by TRISO-X, to laser separation by LIS Technologies, to Standard Nuclear's fuel beads, to Nano Nuclear Energy's microreactors and high assay low enriched uranium fuel, to Kairos Power's Hermes reactors, to the Tennessee Valley Authority's five small modular reactors, to BWXT's centrifuge development, to Radiant Nuclear's microreactors, to Oklo's recycling of spent nuclear fuel, to Centrus expansion of their centrifuge capability, to Type 1 Energy's fusion design facility in the closed Bull Run Steam Plant.

It is yet another time of major nuclear related development in Oak Ridge, one of the major birth places of the Nuclear Age with Nuclear Reactors, Nuclear Energy, the Nuclear Navy, Nuclear Medicine, and more such as supercomputers, neutron science, nuclear nonproliferation, and a wide range of work for the National Aeronautics and Space Administration (including the moon box and plutonium 238 for powering deep space probes and much more). I know I have left out a lot of work being done in Oak Ridge for other

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government agencies and even more, but I think I have included enough for you to get the idea of just how significant Oak Ridge is to much of the major technological advances being made in the world today.

Uranium 235 is the isotope that started it all. First an atomic bomb, then all that we know as the nuclear age had its beginnings in the rare isotope uranium 235. Oak Ridge has had a huge role in it all and continues to do so even today with the future leading role seeming well secured!



Two racetracks of Beta Calutrons remain in Building 9204-3 (Beta 3) which is included in the Manhattan Project National Historical Park which are among the most significant artifacts of the Manhattan Project along with the Graphite Reactor, the B Reactor in Hanford, and some facilities in Los Alamos National Laboratory. This building should be on the National Register of Historic Places as a National Historic Landmark. (Courtesy of Ray Smith)

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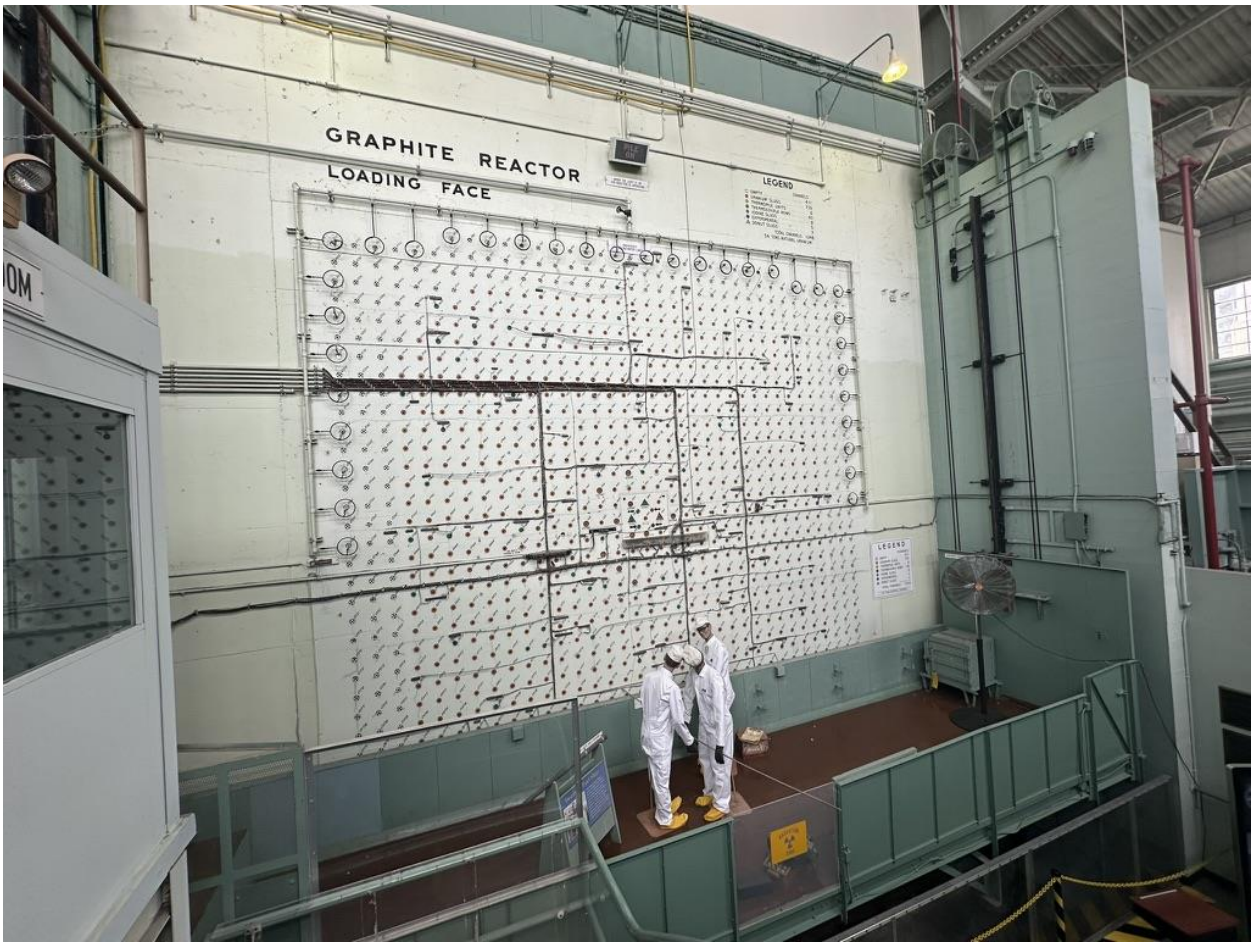
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Young women right out of high school were hired as cubicle operators (later known as Calutron Girls). Gladys Owens is in the front right and Ruth Huddleston is seated third from the front on the left. (Ed Westcott photo courtesy of Ray Smith)

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The Graphite Reactor is the first industrial size nuclear reactor which operated 20 years from November 5, 1943, until November 5, 1963. It was designated as a National Historic Landmark in 1966. Both Beta 3 and Building 9731 should be designated as National Historic Landmarks as well. The Graphite Reactor is a part of the Manhattan Project National Historical Park. (Courtesy of Department of Energy)

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The world's only Alpha Calutron magnets located in Building 9731. This building should also be on the National Register of Historic Places as a National Historic Landmark as well. (Courtesy of Oak Ridge History Museum)

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The K-25 Building which was the largest building under one roof in the world at the time it was constructed covered 44 acres. There is the K-25 History Center and the William J. Wilcox, Jr. K-25 Interpretive Center located in the foreground just at the end of the east wing of the footprint of the K-25 Building. This footprint is a part of the Manhattan Project National Historical Park. (Courtesy of the Department of Energy)