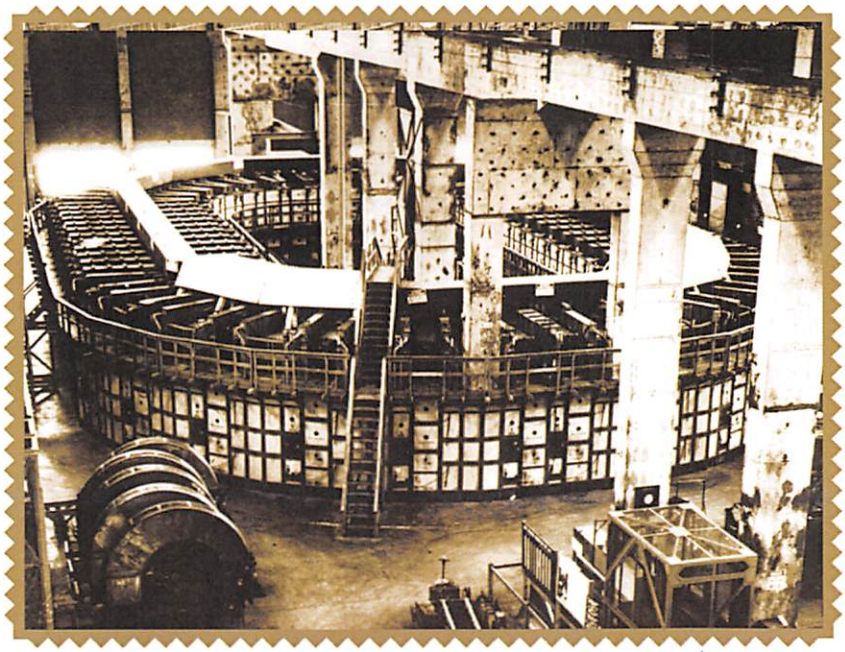
What is a Calutron?

The calutrons (California University Cyclotron) built at Y-12 were the brainchild of Noble Laureate E. O. Lawrence. At its peak of production in World War II, Y-12 had 1,152 calutrons in operation in five Alpha buildings and four Beta buildings.



A calutron is a mass spectrometer used for separating the isotopes of uranium developed by Ernest O. Lawrence during the Manhattan Project. Its name is a concatenation of Cal. U.-tron, in tribute to the University of California, Lawrence's institution and the contractor of the Los Alamos laboratory. They were implemented for industrial-scale uranium enrichment at the Oak Ridge, Tennessee Y-12 plant established during the war and provided much of the uranium used for the "Little Boy" nuclear weapon, which was dropped onto Hiroshima in 1945.

In a mass spectrometer, a vaporized quantity of a sample has each atom stripped of an electron by an electric arc changing the atom into positively charged ions. There are then accelerated and subsequently deflected by magnetic fields. They then collide with a plate, producing a measurable electric current.

To maximize the separation and the use of the large electromagnet required, multiple calutrons were arranged around the magnet in a massive oval, which resembled (and were called) race tracks. Two types of calutrons were created, known as Alpha and Beta, as the technology was improved. Magnetic separation was later abandoned in favor of the more complicated, but more effective, gaseous diffusion method.

GLOSSARY OF TERMS

- Mass Spectrometer—A mass spectroscope that records its data electronically
- Isotope—One of two or more atoms having the same atomic number but different mass numbers.
- Uranium—A heavy silvery-white metallic element, radioactive and toxic, easily oxidized, and having 14 known isotopes of which U 238 is the most abundant in nature. The element occurs in several minerals, including uraninite and carnotite, from which it is extracted and processed for use in research, nuclear fuels, and nuclear weapons. Atomic number 92; atomic weight 238.03; melting point 1,132°C; boiling point 3,818°C; specific gravity 18.95; valence 2, 3, 4, 5, 6.
- Lawrence, Ernest Orlando (1901–1958)—American physicist. He won a 1939 Nobel Prize for the development of the cyclotron.
- Manhattan Project—The wartime effort to design and build the first nuclear weapons (atomic bombs). With the discovery of fission in 1939, it became clear to scientists that certain radioactive materials could be used to make a bomb of unprecedented

power. U.S. President Franklin Delano Roosevelt responded by creating the Uranium Committee to investigate this possibility. Progress was slow until Aug. 1942, when the project was placed under U.S. Army control and totally reorganized. The Manhattan Engineer District was the official name of the project. The MED's commanding officer, Gen. Leslie R. Groves, was given almost unlimited powers to call upon the military, industrial and scientific resources of the nation.

- A $2-billion effort was required to obtain sufficient amounts of the two necessary isotopes, uranium-235 and plutonium-239. At Oak Ridge, Tenn., the desired uranium-235 was separated from the much more abundant uranium-238 by electromagnetic separation at the Y-12 Plant using calutrons designed by Ernest O. Lawrence at the radiation laboratory of the University of California at Berkley. There were 1152 calutrons in nine major buildings at Y-12. At the Hanford (Wash.) installation, huge nuclear reactors were built to transmute nonfissionable uranium-238 into plutonium-239. This method was based on the principle of the self-sustaining nuclear reaction (nuclear pile) that had first been achieved under the leadership of Enrico Fermi at the metallurgical laboratory of the Univ. of Chicago. The actual design and building of the plutonium and uranium bombs took place at Los Alamos, N.M., under the leadership of J. Robert Oppenheimer. Gathered at this desert laboratory was an extraordinary group of American and European-refugee scientists.

Control panels and operators for calutrons at the Y-12 plant.

- The only nuclear test explosion, code-named Trinity, was of a plutonium device; it took place on July 16, 1945, near Alamogordo, N.M. The first uranium bomb ("Little Boy") was delivered untested to the army and was dropped on Hiroshima on Aug. 6, 1945. On Aug. 9, 1945, a plutonium bomb, virtually identical to the Trinity device, was dropped on Nagasaki.

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Y-12

NNSA National Nuclear Security Administration