Decisions that led to Y-12

Last week we saw the political and organizational changes that led up to the Manhattan Project being created on August 13, 1942. The S-1 Executive Committee created two sites initially, Site X in Tennessee and Site Y in New Mexico.

While this was happening the technical and scientific experimentation was already well established. As early as 1929, Ernest O. Lawrence had invented the cyclotron, a mass spectrom-eter machine that led to the Calutrons (named so for the **Cal**ifornia **U**niversity cyclo**trons**) used at Y-12 to separate the Uranium 235 for Little Boy, the first atomic bomb used in warfare.

During the period from 1929 to February 1, 1943, Lawrence continually worked on the scientific aspects of his machine and also worked the political system to get his method of electromagnetic separation selected as the process to use to obtain the scarce Uranium 235. His Radiation Lab at the University of California at Berkley, California eventually would design the calutrons installed at Y-12 and would assist in getting them working without a pilot plant.

As early as 1940, John Ray Dunning confirmed German physicists Otto Hahn and Fritz Strassmann's claim that they had achieved nuclear fission. He led a team that included Alfred O. C. Nier who was an expert on mass spectrometry. The team confirmed the German claim of fission and settled the fact that the fissionable isotope of uranium was uranium 235. It was already known that uranium 235 represented only 0.7% of the raw uranium ore with uranium 238 making up the vast majority of 99.3%.

Three methods of obtaining the rare uranium 235, centrifuge, gaseous diffusion, and electromagnetic separation, were given consideration. Thermal diffusion was also a known theory, but was dismissed as being impractical. Engineering studies for centrifuge and gaseous diffusion failed to produce any theoretical methods that would seem likely to produce the amount of uranium 235 needed for a bomb. Literally five months of experiments on centrifuge and gaseous diffusion failed to produce even one usable centrifuge or gaseous diffusion unit of practical size.

Still the method that held the highest hopes for the most scientists seemed to have been gaseous diffusion. It was being worked on by the British at Oxford and by Dunning at Columbia with the British team farther along in the process.

However, Lawrence continued to optimistically report progress on his mass spectrometry approach. As early as March 1941, he had begun converting his 37-inch cyclotron into what he thought of as a super mass spectrograph. Cyclotrons and mass spectrometers of the size he envisioned had many similarities.

Both used large magnets, vacuum chambers and relied upon the same basic physic principles. Separation of isotopes by causing small quantities of material to travel in vacuum chambers under the influence of magnetic fields was well understood by Lawrence. Scaling up the process large enough to handle more than laboratory amounts seemed something that could be done. Yet, he was alone in his optimism and kept working every angle to convince others of the potential of electromagnetic separation.

Simultaneously, Arthur Compton was working hard to prove that the newly discovered element 94, which came to be known as plutonium, could be produced in large enough quantities for a bomb. The new element was named plutonium by Glenn T. Seaborg as it was next in the order of the planets in the solar system. Neptunium having been the name given to element 95 as it was discovered prior to 94 and thus the cause for the odd order in the names). Also it is worthy of note that Pluto has recently lost its standing as a planet…things change, huh.

Another interesting tidbit is that Seaborg assigned "Pu" to the element rather than the standard "Pl" as a joke. The committee considering the name accepted the "Pu" without a word of discussion. Seaborg had facetiously selected the name as a play on the childlike “pee-yoo” often said when something smells bad.

Compton proposed the following time table for the plutonium bomb: By July 1942 – determine if a chain reaction was possible; by January 1943 – achieve first chain reaction; by January 1944 - extract first element 94 from uranium; and by January 1945 - to have a bomb. Of course this effort resulted in the Graphite Reactor being built at Oak Ridge as a pilot reactor to prove the practicality of a large scale reactor to produce appreciable quantities of plutonium.

So, the political scene was changing constantly, the scientific progress was frustratingly slow, the planning of the S-1 Executive Committee was having trouble making anything tangible happen as agreement among the scientists was difficult to reach. Each had his own favorite method and all were vying for the available research money. The only thing moving ahead rapidly was Lawrence and his converted cyclotron. As early as December 1941, he had produced a beam of uranium ions ten times as large as had been produced. This leap to a much larger output caused Lawrence to be even more optimistic regarding the practical potential of his machine. He began talking about his progress as a “short cut” method.

In January 1942, a nine-hour run of Lawrence’s converted cyclotron produced eighteen micrograms of uranium enriched to 25% uranium 235. By February 1942, he was up to 30% uranium 235 and had produced sufficient quantities for both the American and British research needs.

Lawrence was talking about his “Calutron,” as it was now called, in terms such as spectacular and tremendous. His promotion of the idea of electromagnetic separation grew even bolder as his optimism grew greater and greater with each successful modification to the 37-inch cyclotron that he was rapidly converting from improvement to improvement. He was beginning to think of the possibilities the 184 inch cyclotron held for even more and better calutrons.

Lawrence’s optimism caused him to send a report to Vannevar Bush that Bush then passed on to President Roosevelt which stated that if things kept going as they were at present then by the summer of 1943 practical quantities of uranium 235 could be available. He also stated that the United States was strong in research in the electromagnetic processes. See his daring and bravado? Lawrence must have been an exciting person to be around.

Some of the individuals we will discuss a bit later came from his Radiation Lab in Berkley to Y-12 to help work out the details and difficulties of the first calutrons installed there. They were most interesting individuals.

As an example of what I mean that we will see in upcoming stories, Robert S. Livingston is one such individual. He was interviewed in 1987 while still living in Oak Ridge and speaking of his work with Lawrence at the Radiation Lab at Berkley, said, “I didn’t start on the project the very first day that it started. But, I did start the day after Pearl Harbor, which was in December, 1941.

“Some work had already been done. The 37-inch cyclotron in the old wooden building at the Radiation Lab had been dismantled from the clyclotron and some new guts had been put in it to make a mass spectrograph. It was actually running as a mass spectrograph, and the electromagnetic processes were really based on scaling up the mass spectrograph - a scientific instrument which had been known for a long time. Ernest Lawrence, it was his laboratory and it was his initiative that started the project.”

Chauncey Starr was another of the individuals who worked with Ernest Lawrence and who came to Y-12 to help with the calutrons. He worked in the first building completed at Y-12, Building 9731 – one of the buildings at Y-12 that is being nominated for Historic Landmark Status on the National Register of Historic Places.

Next week, Bush makes changes to bring in the Army and Colonel Kenneth D. Nichols comes on board.

CAPTION: Ernest Lawrence is shown with the 37-inch cyclotron control panel doing research on the Calutrons for Y-12