Operating Oak Ridge's "Calutrons"

The following Oral History is taken from *The Manhattan Project - The Birth of the Atomic Bomb in the Words of Its Creators, Eyewitnesses, and Historians,* edited by Cynthia C. Kelly, President of the Atomic Heritage Foundation and published by Black Dog & Leventhal Publishers (2007). It is reprinted here with permission.

OPERATING OAK RIDGE'S CALUTRONS:

In this oral history, Theodore Rockwell talks about the Y-12 plant at Oak Ridge where the calutrons were operated by young women, many just out of high school. Rockwell, an engineer during the Manhattan Project, recounts the practical problems of working around the giant magnets inside the cyclotrons.

From Atomic Heritage Foundation's Oral Histories
Interview with Theodore Rockwell

"At its peak, the plants at Y-12 had 22,000 workers who ran the 'calutrons,' machines designed after the cyclotron or 'atom smasher' invented by Ernest O. Lawrence at the University of California. The Y-12 'calutrons' were used to separate the two nearly identical isotopes of uranium. The heavier isotope, U-238, is very stable and makes up most of the uranium found in nature. The other isotope, U-235, which can be used to fuel an atomic bomb is less than one percent of naturally occurring uranium.

"The process involved heating up uranium salts with electric heaters and vaporizing them. The vapor would rise, go through an ionizing path with electron-producing filament. And as each atom became ionized by giving it an electrical charge, it would take off, attracted to the opposite, negative or positive, charge.

"The atoms would be pulled by a strong magnetic force that caused them to accelerate around the D-shaped tank following a semicircular path. The heavier isotopes (U-238) would be flung a little further out because they were heavier and end up falling into one receiver while the lighter atoms (U-235) would fall just short, ending up in a different receiver, just a little closer. Of course in real life, the isotopes would get scattered and the separation into the two receivers was very incomplete. But in theory you could get 100 percent separation this way.

"Individually, the separation units look like a capital D. The units were lined up in big ellipses that were called 'racetracks,' which they resembled. Facing out were the faceplates or the straight part of the D. The curved part of the D formed the inner part of the racetrack. The material was fed into the bottom part of the D, accelerated up to the top and then collected in receivers.

"The control panels for the process were located on the floor above the racetracks [this is confusing as in all cases I am aware of, the control panels or cubicles were located on the same floor as the calutron racetracks but in separate rooms – Ray]. At each panel an operator controlled one of these Ds, adjusting various knobs to maximize the output. To do this well was quite a feat as it was a very complicated, tricky process. Only Ph.D.'s were allowed to run the cyclotrons at Berkeley. With the shortage of labor, however, the calutrons at oak Ridge had to rely on young women, many of which had just graduated from high school.

"To the surprise of the scientists, the women operators did extraordinarily well, especially considering they were not told that they were separating isotopes of uranium but merely that they were making some sort of catalyst that would be very important in the war. An analogy is the country kid who has an old model T who doesn't know anything about engineering but can really tune up the engine with his fingertips and make it run just right. And these women were really incredible. While they had no idea what they were doing, they understood how to optimize this mechanism and make it sing.

"And sometimes one of the Ph.D.'s would come along and say 'I think we could do this a little bit better.' And he would start trying to tune that thing but instead of improving the performance, he would cause it to deteriorate. Pretty soon the operator would have to take over and readjust the controls to get it back on track. The women just had a feel for it that the more highly trained men did not.

“The calutrons involved high-voltage electricity and the huge magnets. If you walked along the wooden catwalk over the magnet you could feel the tug of the magnetic field on the nails in your shoes. It was like walking through glue. People who worked on the cautrons would take their watch into the watch-maker and discover that it was all smashed inside. The magnetic field had grabbed the steel parts and yanked them out by the roots.

“You weren’t supposed to bring any magnetic material, any steel, anywhere near the magnet. If it got anywhere near the magnetic field then ‘Wham-o!’ it would slam up against the calutron. One time they were bringing a big steel plate in got too close to the magnetic field. The plate pinned some poor guy like a butterfly against the magnetic field. So the guys ran over to the boss and said, ‘Shut down the magnet! Shut down the magnet! We got to get that guy off.’ And the boss replied, ‘I’ve been told the war is killing 300 people an hour. If we shut down the magnet, it will take days to get re-stabilized and get production back up again, and that’s hundreds of lives. I’m not going to do that. You’re going to have to pry him off with two-by-fours.’ Which is what they did. Luckily he wasn’t badly hurt, but that showed what our priorities were.

The above excerpt is a good example of the information available in *The Manhattan Project*, an anthology of several acknowledged experts and experienced veterans of the Manhattan Project. It also serves to give a first-hand account of a person who lived the experience where the world’s first industrial scale separation of uranium occurred. Y-12 was then and is today a place where unique and extraordinary challenges are met routinely.

In this series on the history of Y-12, we will continue to identify individuals and groups who were involved in world-changing events. Among many other things in Y-12’s history we will see Y-12 begin the medical isotope program through the efforts of Chris Keim and others.

An example relative to that history is Martin Skinner, who worked in Building 9731 and who, by walking the old building with me recently, helped me to understand just how the Beta calutron magnets, still in 9731, were used during those exciting times when isotopes other than uranium 235 were first being separated. His memory of the exact locations of the controls, offices and laboratories within 9731 was most helpful. It was also exciting to see him relive the times so long ago when he was doing such valuable research.

Martin and those like him contributed significantly to the introduction of the nuclear era through their jobs and commitment to precise and difficult accomplishments required to usher in the amazing and powerful new tools for research and industrial applications. Theirs is a great and far-reaching story. It is Oak Ridge’s heritage. It is yet to be fully explored and yet to be fully appreciated.

Heritage Tourism can be an effective vehicle through which the world comes to Oak Ridge to learn of the introduction of the Atomic Age. Here they can see the genesis of the wonders that have resulted from the atomic bomb to nuclear medicine and scientific research that even today continues to do amazing things. Ours is a story, a heritage, an achievement that is ongoing and intriguing. It just needs to be “well told” often and with creativity.