Electromagnetic separation of isotopes at Oak Ridge – L.O. Love (part 1)

Amid all the changes at Y-12 over the years, including much work being done by the Oak Ridge National Laboratory in several of the original Manhattan Project era buildings at Y-12, one program remained constant and consistently produced desired results. It was known as the Stable Isotope Program and was managed by the Electromagnetic Separation of Isotopes Department of the Isotopes Division of the Oak Ridge National Laboratory.

The primary location for the effort was Building 9731, the first building completed at Y-12 and where the Radiation Laboratory personnel from Berkley, California, had made initial improvements to the Calutron operations. Later, in 1959, Building 9204-3 (Beta 3) was added to the effort as the demand for isotopes grew.

While the beginning of the program was initiated by those individuals at the working level, it quickly gained favor with the newly formed Atomic Energy Commission in 1947. But as early as 1945, experiments were being conducted.

According to L.O. Love, the Superintendent of the operation, it all began when diagnosing a problem with the early application of calutrons. It seems the vapor of elements other than uranium was also ionized when it was inadvertently allowed to mix with the uranium. These additional vapors caused erosion of the interior of the calutron as their arc varied from the uranium arc path and thus struck the walls rather than the pocket designed to capture the uranium.

On page 12 of his book, Love said, “The intensity of these unwanted beams prompted remarks that the machine would be fine for separating elements other than uranium, and late in 1945 the two beta calutrons in the pilot plant were used to separate the isotopes (63 and 65) of copper – our first stable isotope collection.”

Love notes such individuals as W.A. Arnold, Roy N. Goslin, C.P. Keim, C.E. Larson and P.W. McDaniel as primary investigators who “should be remembered for their efforts to save a portion of the electromagnetic plant which enabled the nation to provide separated isotopes for programs extending into the fields of biological, medical and nuclear research.”

Citing the “recently developed medical scanning techniques in nuclear medicine,” Love notes the sales of only two stable isotopes alone exceeded $300,000 in each of fiscal years 1971 and 1972. These stable isotopes, when exposed to neutrons in nuclear reactors, produce radioactive isotopes that are used in early diagnosis of malignant tumors.

Several other uses of isotopes separated in the Building 9731 calutrons developed as their availability grew. One such unusual use was the isotope mercury-202 in milligram quantities for use by the National Bureau of Standards to create an optical wavelength standard.

In attempting to exceed 95% purity of the desired isotope, the liner walls of the calutron needed to be refrigerated to reduce the natural mercury vapor and concentrate the mercury-202 striking the silver pocket. Dry ice was chosen as the cooling material, but a suitable transfer medium was needed.

Love says, “A handbook search revealed that the compound ethanol met the specifications, and an order for 35 gallons was placed. We were operating on a continuous basis in those days, without regard to holidays or weekends, and the system was completed and ready for use on Christmas Eve.

“Shortly after the order was placed phone calls began to come in inquiring about the uniqueness of an experiment that required the properties of this particular substance. I was so involved in trying to lick the technical problem that the coincidence of the request for ethyl alcohol and the festive season did not occur to me, and I first failed to recognize the significance of requesting 35 gallons of grain alcohol on Christmas Eve.

“The stockroom attendant did see the significance and showed his acumen by billing the entire amount to me in pints. To top it off, the operators had been instructed to be extra safe in venting the system to avoid a pressure buildup. It has always been difficult to convince listeners that the alcohol ordered a week later on New Year’s Day was to resupply the cooling system because of excessive evaporation.

All four of the calutrons in Building 9731 were used to separate isotopes. By 1960, all elements with naturally occurring stable isotopes had been processed at least once.

By 1959 the quantities of isotopes being requested exceeded the capacity of the four calutrons in Building 9731 and the Atomic Energy Commission approved the conversion of the 72 calutrons in Buidling 9204-3 (Beta 3) for use in general isotope separation.

Desiring to separate several elements at one time, a decision was made to remove six of the 36 calutrons in the west racetrack and install three 80–100 ton iron cross yokes in their places. This formed four separate “racetracks” consisting of three groups of eight calutrons and one group of six leaving a total of 30 calutrons.

Generators were also needed to power the various racetracks. One was found in Los Angeles that had powered the city’s elevator system until they changed from direct current to alternating current. Another was still at Y-12 left over from the Manhattan Project with a date of 1904 and was rumored to have been used in a sugar refinery or cotton gin.

A third unit came from northern Michigan where Henry Ford had a woodworking factory to construct bodies for early model cars. After wood was no longer used in cars, Ford kept the factory for his own personal pleasure of watching the machines run. After his death, the Ford Motor Company scrapped the plant and the motor-generator was purchased and brought to Y-12.

The Ford Motor Company motor-generator worked well for years as did the other units needed to support the calutrons in Building 9731 and Building 9204-3 (Beta 3), which operated until 1974 and 1998, respectively. The calutrons in Beta 3 are still in standby today.