Y-12's SECOND MANHATTAN PROJECT

THE LITHIUM 6 Super Bomb Story.

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[During the Manhattan Project (from May 25, 1943) a Jr. Chemist, Tennessee Eastman Corp., Y-12 Plant]

A Brown-Bag Talk in the Y-12 Cafeteria Conference Room

June 22, 2004

Thank you for inviting me to come back again to this plant that has so many fond memories for me of people and tough problems we solved working together. I'm always pleased to have a chance to tell people stories of Y-12's proud history, and it's a special privilege to talk to you who are today carrying forward its long traditions of service to our nation.

I'd like today to tell you how Y-12 rose to and met its second great challenge! The first, of course, was the WWII challenge of separating the isotopes of one of the heaviest elements, uranium, something never before done anywhere, thought by some reputable physicists not possible in the quantities of hundreds of pounds of U-235 needed. This Bear Creek Valley was transformed and Y-12 did the near impossible in 2.5 years, providing the fuel for the first atomic bomb that helped bring an end to that terrible war. A year later, the huge U-235 calutron plant shut down, the staff went from 22,500 to 2,500, and those of us who were left were wondering what next?

Our second great challenge came in the early 1950s when we were called on by Washington to take on another isotope separation task – this time of one of the lightest elements, lithium. Y-12 rose to the challenge again, and opened the door for the brand new era of thermonuclear weapons. These weapons were to become a key to our nation's nuclear defense, without which we could not have won the Cold War that dominated the last half of the 20th century! Another major contribution in this plant's proud past. Well, how did it happen?

Way back in 1941, when physicists were still debating whether or not the fantastic power of any atom's nucleus could be released, Enrico Fermi astounded his colleagues by suggesting that if one could get enough U-235 and cause it to fission, that bomb might reach temperatures high enough to ignite a thermonuclear fusion reaction, producing far greater energies!

When the Manhattan Project started the next year, the whole notion of even a fission bomb was far from a certainty, though President Roosevelt decided that if there was any chance that one could be built, we had to get one first. He knew the Germans and Japanese were already working on development of the technology, so he gave our Manhattan Project top priority. Y-12's U-235 separation was the most costly and first order of business.

Throughout WWII the idea of concept of a much more powerful bomb made when atoms of hydrogen, deuterium, or tritium fused remained on the back burner at LASL, though Oppenheimer tried to keep his team focused on the fusion approach. A major, three-day conference on what had come to be known the "Super" was held there in April 1946, unfortunately attended by Klaus Fuchs of Britain who passed along to the Soviets the conclusions that the Super can be built, it will work, and that the D fuel will be a more effective explosive than U-235 or Pu-239! The argument raged as to whether and when such a program should be undertaken, with Edward Teller the most outspoken for a crash effort and Oppenheimer counseling against it.

The arguing stopped after the Soviets fired their first bomb, a carbon copy of our Trinity test shot, in the fall of 1949. It had taken them 4 years to build what we did in 2.5, even though Fuchs had given them a drawing of our Trinity implosion device! In January of 1950 President Truman settled the matter once and for all with a public announcement that the US was going ahead with the development of the Super Bomb. The Cold War was now public.

Simultaneously, the AEC tasked Y-12 researcher (soon to be transferred to ORNL but still working in their old labs in 9733-1, 2, and 3) with the challenge of separating large quantities of Li-6 from Li-7. Again the lighter isotope, Li 6, is the desired one and the less abundant in naturally occurring ores, 7.5% Li6 and 92.5% Li7.

The first process developed was called ELEX (for ELectrical Exchange), based on chemical exchange of the two isotopes as they passed to and from solutions of aqueous lithium hydroxide and lithium in mercury, or lithium amalgam. An electric field is needed to make the lithium dissolve in the mercury, and only a small enrichment is effected in a given pass or stage, thus a cascade of many stages is needed, similar to the process developed in the gaseous diffusion plant. K-25 engineers were called on to help design the Y-12 plants. An ELEX pilot plant was successfully operated in Alpha 2 in 1951 and then the process was turned over to Y-12 to build and operate a production plant in Beta 4. It began operations in 1952. The sight and sound of the 50,000 agitators to create mixing I'm told was awesome, and separate the light lithium isotope it did, but not in the rates needed. Our country was scooped in the fall of 1953 when the Soviets tested the first TN device, with a rudimentary, low yield - but impressively more than fission weapons. The impact here was that a frantic effort was called for to greatly expand production capacity and to do it ASAP. Two days after the Russian test, the AEC General Manager came to OR and told ORO Manager. Sam Sapirie they wanted a MP form of operation to produce Li-6.

And as it did before, Y-12 again proved it had a "Can-Do" organization. Almost incredibly, in view of the problems that had to be overcome, two huge new plants of a brand new design were ready for start up in 15 months. Providentially, one of Y-12's own scientists, Forrest Waldrop in 9202, had brilliantly conceived of a much better idea than ELEX in back in 1951, and we had worked out first in 2" columns, then 8" inch in the Alpha 2 building in 1952 and 1953, so that when the urgent directive came, COLEX was hands-down the better way to respond to the call for the huge expansion than to continue to use ELEX. The Y-12 process utilized the same basic chemical exchange principle, but was radically different in using tall columns with the amalgam flowing down through a stream of lithium hydroxide flowing up. Hence the name COLEX, or column exchange.

It now sounds straightforward, but it was anything but! Major problems had to be solved, for example, in developing pumps for circulating the tremendous quantities of the very heavy lithium amalgam. Production data and design details are still classified, but you can get some appreciation for the size of this awesome Y-12 operation from the fact that the columns and amalgam making facilities filled two of our largest buildings, Alpha 4 and Alpha 5, the former having four cascades of many 30 inch diameter columns, and the latter with six cascades of 20 inch diameter columns, 50 feet tall! The amount of mercury required in COLEX was so large that President Eisenhower was called upon to make it available from the national strategic stockpile rather than cornering the world market! The quantity involved was kept secret for 40 years until Secretary of Energy Hazel O'Leary in 1995 told the public it was 24 million pounds! That is 316,000 standard flasks of 76 pounds!

The COLEX plants had a very rough start in 1955 with major problems in this entirely new, complicated, and potentially hazardous technology. The leakages of amalgam from pumps and seals caused air concentrations of mercury to rise unacceptably, and the health programs started in 1953 programs of air sampling, urinalysis, and worker health checkups were greatly intensified. In 1956, for example, 280,000 workplace air samples were taken! The huge exhaust fans that were installed in Alpha 5 to bring in fresh air could be heard in Oak Ridge!

But the production and health problems were soon worked out and the two COLEX plants in Alpha 4 and 5 fulfilled the nation's current and future needs for Li-6. Alpha 5 was shut down in 1959, Alpha 4 closed in 1962. The lithium project cost was $233 million (1955-1962), COLEX project cost was about half the cost (48.7%) of the Manhattan Project, and stretched over eight years compared to four years.

Hey, one thing I should mention. Someone who worked in Alpha 4 or 5 when this was going on would think I was talking Greek or lying through my teeth! Like the uranium work during WWII, the lithium project was super secret, and code words were used for everything – "Need to Know" was the guiding principle, so very, very few people at Y-12 knew the whole picture of what we were doing and why. The word mercury wasn't mentioned, the code word was "Solvent", though this wasn't too much of a secret to anyone who saw that shiny metal leaking out or pooling on the floor. The Li-Hg solution = Li amalgam was referred to as "Solvex". Our product - highly enriched Li 6 was known as "Alloy", hence the name of the Production Division that ran the two COLEX plants was the Alloy Division, headed by Bill Whitson reporting to George Strasser, the Asst. Plant Superintendent. The name for the highly enriched Li 7 was "Marble," useful in shielding and certain nuclear operations.

Though process losses were small percentage-wise, the huge quantities of mercury involved meant the total pounds lost was considerable. For example, during the eight years of production 1955-1963, losses to the EFPC creek that rises in the plant were about 200,000 lbs., 85% of the losses to the creek over the next twenty years. The average concentration in the creek water for the highest year, 1957, was only 2.16 parts per million. It's a tribute to the Y-12 operators that losses to the creek were measured and recorded right from the beginning in 1955, and after two years of operation, the process for cleaning the mercury was changed and greatly reduced the mercury losses. After shutdown, cleaning up the buildings together with losses from sumps and piping resulted in much smaller but some continued losses over the years. The Y-12 discharges to the creek in 1957, the worst year of the pollution event, averaged 198 pounds per day with creek water averaging two parts per million of mercury. By 1959 the loss was reduced to 51 lbs./day and by the time production stopped in 1963 the loss was down to 3 lbs/day.

During our COLEX operations there was no inkling that the release of Hg to the creek might represent any threat to public health. That did not come until 1970 when the whole country was awakened to the news that mercury in water or in sediments can be transformed to a poisonous (to humans, not to fish) methyl mercury form which if eaten (in fish) could be fatal. There was a serious event in Minimata, Japan where many people died. A few samplings of fish and sediments at Oak Ridge were taken right away by Y-12, ORNL, and by DOE and a wide spread sampling by TVA in all their reservoirs showed some fish higher than desired mercury levels especially in other TVA lakes (but not Watts Bar) where mercury was being discharged from Chlor-Alkali plants that used brine electrolysis sodium chloride and sodium amalgam to make chlorine and lye, a process that our ELEX process simulated.

There was suddenly lots of interest in who was discharging mercury into streams, rivers, and lakes. For most communities, this was a revelation. By 1970, Y-12 discharges had been reduced to 2 lbs./day. An ORNL survey report (Robin Wallace et al.) of other polluters in 1970 showed by comparison Diamond Shamrock discharging 13.2 lbs/day into the Houston Ship Channel in Texas, Diamond Shamrock, 8.6 lbs/day into the Tennessee River; Diamond Shamrock, 29.1 lbs./day into the Delaware River; Olin Matheson, 2.2 lbs./day into the Hiwasee River at Charleston, TN then into Chickamauga Lake; and many others – all into larger streams than EFPC!

In 1983, as the result of the hue and cry over the twenty-year old pollution event, major studies were sponsored by the DOE to study all the aspects of the contamination of water, fish and other biota, and the sediments of the Oak Ridge environs including the EFPC, Poplar Creek, the Clinch River, and Watts Bar Dam. By 1983 when the Pollution Event was made public here, Y-12 discharges had been reduced to 0.15 lbs/day, and as the result of intensive new efforts to prevent other losses, the losses were further reduced by the year 1993 to 0.04 lbs/day.

With regard to mercury, the findings as of 1997 are that there is no threat to the public health from this significant pollution event that occurred about forty years ago, or from the small discharges that occurred in the following years. With significant reductions in the very small amounts being added to the creek and with the conversion of mercury in the sediments to the inactive sulfide form by natural processes, and with the natural burying of the mercury contaminated sediment layers by other sediment layers; the fish, water, and sediments no longer pose significant health risks to the public.

DOE is still funding studies trying to determine if people were hurt by the original pollution event. Workers were exposed to mercury far more than anyone in the public and these risk were studied intensively then and since. There have been no deaths due to mercury poisoning in the more than 2400 workers. The rates of death of mercury workers were no different than workers with no mercury exposure. An independent study by University of Michigan medical experts of living mercury workers showed only one of 72 having symptoms that might be attributable to mercury exposure.

The uranium isotope separation task that Y-12 carried out with such notable success 60 years ago was turned over to K-25 after the war, never done here since. But we won a new mission for ourselves right after the war, making component parts for the national defense stockpile of weapons of the WWII designs. The story I have told you today, is how we rose to our next huge challenge, of separating the lithium isotopes in the 1950s, providing our nation with the material needed to fuel a whole new arsenal of nuclear weapons that, together with so many other capabilities that work led to, has ensured Y-12's role as a vital member of our nation's nuclear defense complex ever since.

I salute you who are carrying on, building Y-12 into a plant that can contribute more to our country in the years to come.

Thank you.

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