Dedication, Innovation, and Courage: A Short History of Y-12

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Introduction

The Y-12 National Security Complex has made it its mission to serve the United States during both wartime and peacetime. The Complex originated as a vital component in World War II's Manhattan Project. Y-12 has continued serving through the Cold War's arms and space races, and still works to protect and innovate. Y-12's contributions to the United States Navy have been numerous and our mission with nuclear materials has always been for the benefit of mankind.

The Manhattan Project plays an important role in Y-12's history, and it has shaped how the Complex serves today. Y-12 was one of several Manhattan Project sites all collaborating to build an atomic bomb. Our mission during the Second World War was to obtain and enrich enough uranium to send to the Los Alamos site where the bombs were all assembled and tested. Y-12 was the first site to begin construction, and it was one of three Manhattan Project sites to work with the enrichment of uranium. Many important military officials visited and worked at the Oak Ridge sites, but also many notable engineers and scientists were recruited for Y-12 jobs and others got their start working at the site.

The Y-12 site was constructed at the expense of many small communities in Roane and Anderson counties. Many families were evicted from their property so that this new war effort could be built, and Y-12 still works to honor that tremendous sacrifice through the exhibits at the New Hope History Center.

When World War II ended, Y-12 was immediately downsized, as the enriched uranium began to be provided by the K-25 Gaseous Diffusion Plant. However, Y-12's next mission became clear as the Cold War Era began. The Y-12 Plant became an integral part of the United States v. Union of Soviet Socialist Republics (U.S.S.R.) Nuclear Weapons race, building nuclear weapon secondaries for all of the nation's nuclear weapons and contributed significantly to the U.S.'s victory over the Soviet Union in the Space Race. Y-12's contributions during the Cold War also included advances in precision machining, and assistance to the U.S. Navy through providing fuel for nuclear reactors.

The Post-Cold War Era brought about new challenges, but nothing to which Y-12 could not adapt quickly and overcome. Y-12's mission grew to encompass the dismantling of nuclear weapons and the non-proliferation of weapon's grade nuclear material, as well as the protection of U.S. stockpiles of enriched uranium.

Our current mission is to continue serving the United States with the production of weapons parts; nonproliferation of nuclear materials; protection of special nuclear materials; and the preservation of an important piece of American history.

A Time of Sacrifice

Before Y-12, the region known as Bear Creek Valley and several other valleys in East Tennessee housed approximately 1,000 family farms. These farms were scattered throughout communities such as Wheat, Scarboro, Robertsville and New Hope. The Valley lies between Chestnut and Pine Ridges. It is approximately half a mile wide, and runs southwest from Scarboro Road across Highway 95 ending on the Clinch River next to Highway 58. The Manhattan Project's Oak Ridge site consisted of 59,000 acres in Roane and Anderson counties, and displaced some 3,000 people living in small communities throughout the region.

New Hope Cemetery

Bear Creek Valley has many legends tied to it, and the origins of its name are no less legendary. The name comes from a local folktale about a man named Henry Holloway who moved into the Scarboro community around 1830. The tale goes that Holloway had been drinking some of his homemade liquor one day, and got the idea to head into the woods and kill a bear. After loudly declaring his intention, Holloway went and grabbed his double-bladed axe, and drunkenly stumbled into the woods near his home. Apparently, he met his bear down near a creek in the valley, killed it, and Holloway's family soon saw him "come back with a big ole black bear."[1]

Settlement of East Tennessee's narrow valleys by European settlers began in the late 1700s, even before all treaties were signed with the Native Americans. Its inhabitants being mostly subsistence farmers, their lifestyle had not changed much by the Depression of the 1930s.

The Y-12 Story is not complete without speaking of the thousands of people that gave up their land, homes, farms, and stores to allow space for the war project. Their quiet farmland was set to be turned into a literal Allied war-machine designed to end the war in Europe.

Although there was some resistance, through the 1941 War Powers Act military officials were able to relieve residents of their land and evict them from their farms. All were notified to leave their property, and many were given as little as two weeks to leave.

A payment was promised to them in the coming months, based on an average amount per acre. Most people left without complaint believing that their sacrifice could help end World War II which would bring their sons, brothers, and husbands home safely. Many of them even went to work for the plant that was erected on their former property.

The New Hope community was located near the east end of the current Y-12 site. It was the home of many East Tennessee families, but all that remains of their community are the New Hope and Jackson Cemeteries.

New Hope Cemetery is located on the Y-12 site where families are still allowed special entrance to visit. Y-12's History Center houses the piano from the New Hope Baptist Church, an artifact on loan from Faye Martin. The New Hope Baptist Church burned down before the massive war project that transformed Bear Creek Valley forever.

The first mention of that massive transformation was, surprisingly, not made by any agency of the United States, but by a man named John Hendrix around 1900 more than 40 years before the start of World War II! Hendrix is considered a local prophet in Oak Ridge, and is famous for his prediction of the Manhattan Project. Born in Bear Creek Valley in 1865, John Hendrix remained in the valley with his first wife Julia. One day, Hendrix's youngest daughter died of diphtheria, but Julia accused Hendrix of her death because of how he had punished the girl the day before. Hendrix's wife took the other children and left for Arkansas, and John never saw them again. Hendrix became terribly depressed and begged God for a reason why his life has taken such a terrible turn. The legend continues that God eventually spoke to John, telling him that if he went into the woods and kept his head to the ground for 40 nights he would know the future of Bear Creek Valley. John did just that, and returned with wild stories that he would tell anyone who would listen. He predicted that there would be a railroad spur running along his property; a city on the area of Black Oak Ridge; a seat of power between Tadlock's and Pyatt's farms; and a great factory in Bear Creek Valley that would help win the greatest war there would ever be.

John Hendrix's Cabin

Original marker of John Hendrix's grave

People thought Hendrix was crazy, and he was eventually committed to a hospital for the insane from which he escaped. Not too long after that, he correctly predicted the lightning strike that would destroy the same hospital. Despite public opinion of his insanity, John Hendrix's Bear Creek Valley predictions rang true. 40 years later a railroad was built running along his old property line; a city called Oak Ridge was built on Black Oak Ridge; the Manhattan Project Oak Ridge headquarters was located between Tadlock and Pyatt's farms; and Y-12 was built in Bear Creek Valley. This site obtained the material for the world's first atomic bomb that led to the end of World War II.

John Hendrix made many other prophecies. Before there were airplanes, he told people of how cargo would be transported through the sky. He also elaborated on his prediction of the railroad stating that a tree would be split in half where they cut the railroad spur down by his property line. After the rail was laid, it is said that half a stump was painted white for many years to try to preserve the fulfillment of another Hendrix prophecy.[2]

John Hendrix died on June 2, 1915. Hendrix is buried in, what is now, Hendrix Creek subdivision. His original head marker was lost, but a new one stands tucked under a boxwood shrub in the same location.

A Prophecy Come True

The Y-12 site history begins with the Japanese bombing of Pearl Harbor on December 7, 1941, even though the actual construction would not begin until February 1943. The United States confirmed the state of war existing with Japan, and Germany soon declared war on the United States. Our official entrance into the Second World War intensified the military's interest in atomic weaponry, and led to the formation of the Manhattan Project. This military sect was mostly made of scientists and military engineers their goal being the research and production of uranium and plutonium isotope separation.

Scientist Ernest O. Lawrence from the University of California at Berkeley had been studying the theory of such separation, and in 1941 suggests that large scale separation of uranium isotopes could be accomplished through an electromagnetic process using specialized cyclotrons. Cyclotrons are particle accelerators that accelerate charged particles out from the center of a spiral path. The particles are held in this trajectory by a magnetic field and accelerated by an electric field. The idea of uranium separation was to separate uranium isotope- 235 (U-235) from uranium isotope-238 (U-238). The two isotopes had different masses, and, when accelerated, behaved much like a ping-pong ball and golf ball attached to rubber bands being spun quickly. Just as the ping-pong ball would travel in a smaller arc than the golf ball, because of centrifugal force, the U-235 accelerated in a smaller trajectory. Each isotope would be caught in a kind of "basket," and the U-235 could then be used.

Lawrence developed the specialized

Ernest O. Lawrence

cyclotrons called Calutrons that would perform the separation process. They were named **Cal**ifornia **U**niversity Cyclo**tron** for the University of California where Lawrence had researched and advanced the specialized process.

A group of top scientists, engineers and government officials coalesced into the S-1 Uranium Committee. It was their job to keep up with production progress, advise the military, and generally help in any way they were needed. Their first task was to produce possible methods of uranium enrichment and decide which could be done quickly and practically. Very quickly, three methods of uranium enrichment were decided on: electromagnetic separation, gaseous diffusion and liquid thermal diffusion.

A site was needed for the production of the materials, and the Army had specific guidelines for its location. The site had to be beyond the reach of enemy aircraft; it could not be within 200 miles of both the Canadian or Mexican borders; and it needed to be between the Rocky and Appalachian Mountains. In April 1942, Army representatives made their way to East Tennessee between the farming communities of Clinton and Kingston, which was decided to be the best site for such a large scale, top-secret project.

The area bordered the Clinch River, which would help with transportation and machine cooling. The location was ideal for transportation and energy sources as it also contained two railroads and was close to the newly constructed Tennessee Valley Authority (TVA). The site could be contained by the two ridges bordering its south and north, it was sparsely populated, and it was very close to Knoxville and could use their large labor force.

Senator Kenneth McKellar

Another interesting reason for the Army's choice has nothing to do with the perfect geography or the population size. The Senator from Tennessee Kenneth McKeller chaired the Budget Committee, which controls the federal purse strings. When President Roosevelt approached McKeller for funding he cautioned the senator that no one could know anything about the huge amount of money being spent on a secret war project. McKeller is said to have paused for a moment before replying, "Yes, Mr. President. I can do that for you. Just where in Tennessee are you going to build that thang?" Oak Ridge may have fit the necessary qualifications, but the real thanks go to Senator Kenneth McKeller.

The Oak Ridge site would be devoted to uranium excepting the X-10 site, which worked with plutonium production. Y-12 worked to enrich uranium through electromagnetic separation, while the other Oak Ridge sites S-50 and K-25 worked with liquid thermal diffusion and gaseous diffusion respectively. Plutonium enrichment was also done in Hanford, WA, and the manufacture and final assemblies of the Atomic Bombs was done in Los Alamos, NM.

After the Army bought the necessary acreage and began construction they circulated the name Kingston Demolition Range, named after the nearby town of Kingston. However, the implications of a demolition range caused concern that the surrounding communities would be come to fear the place, and the name was soon changed to Clinton Engineer Works (CEW) after another nearby town. The entire site was estimated to cost the exorbitant amount of $30 million, but ended up costing the United States around $1.2 billion in 1945 dollars.

Several private companies were contracted to help design, construct and run the Oak Ridge sites. Upon winning the government contract, the companies would have to isolate the portion of their plant that was committed to production for the Manhattan Project. The Boston based company of Stone and Webster, was hired to design, construct and manage the site. They managed the sites' central facilities which included facilities for the town, production plants and utility systems. The project needed specially skilled craftsmen, which were hard to come by, so Stone and Webster began recruiting employees from their Boston home site; opened an employment office in Knoxville; and informed several state and federal employment offices and national craft unions of their need.

While Stone and Webster could boast a fine job on general construction, another company called Tennessee Eastman was permitted to work on more detailed parts of the plant. The Kingston, TN based company was consulted on various construction projects; they pursued special research needs; provided training; and oversaw plant operations.[3]

The Y-12 site was the first of the Manhattan Project sites to break ground. On February 1st, 1943 ground was broken to begin construction. Building 9731 – also known as the "Pilot Plant," was the first processing facility, and housed the first Alpha Calutrons. Building 9731 still exists on the Y-12 site, but no longer processes uranium isotopes. The rest of the site was completed in only 18 months with construction continuing 24 hours a day, and processing operations in full throttle. The construction of the town began with the arrivals of 1,585 train cars filled with lumber, 63 cars of concrete block, five million bricks and 13,000 windows. All of this and more was intended for the construction of 175 plant facilities and a town that would, at its peak, house nearly 75,000 people.

The town was designed by another Boston company called Skidmore, Owings, and Merrill. Thousands of vendors and manufacturers provided materials and equipment for construction and operation of the town and plant including DuPont, General Electric, Allis-Chalmers and Westinghouse.

Just from the 19th century up to the Second World War, Bear Creek Valley underwent an incredible transformation. Families that had lived in the Valley for decades were evicted from their homes, and displaced all around East Tennessee in as little time as a few weeks. Huge processing buildings were constructed to produce a weapon to end World War II.

A town called Oak Ridge was built to accommodate the thousands of workers at the sites, and the Y-12 site became the headquarters and great hope of the federally funded Manhattan Project. It seems that the only familiar things that remained the Bear Creek Valley were the true words of John Hendrix, the Prophet of Oak Ridge.

Early planning for construction of Y-12

By: D. Ray Smith

Last week we examined the interactions and influences leading to a full scale electromagnetic separation production plant in East Tennessee. We noted that James B. Conant, President of Harvard University and a strong member of the S1 Committee, was a key factor in getting the electromagnetic separation technology selected as one of the three main approaches to getting enough uranium 235 or plutonium 239 for atomic weapons.

One story I heard just this last week from a local Oak Ridger, Harold McCurty, who shared some historical documents with me and who is a member of the ’43 Club, fit right in line with the research I have been doing on how the decision to construct Y-12 was made. He said he recalled hearing the story that Ernest O. Lawrence had become discouraged because he could not seem to get the right people to understand the electromagnetic separation process well enough to support it over the other methods to separate uranium.

McCurty’s recollection of the story has Conant taking Lawrence for a walk where they agreed to try one more time to convince the decision makers that Lawrence’s calutrons would do the job. Both of them were convinced that Lawrence’s calutrons likely could separate enough uranium 235 for a bomb well ahead of gaseous diffusion or any other separation method.

When he returned to the meeting, Conant made a strong defense of Lawrence’s research and first agreed to a smaller facility than Lawrence wanted built. However, this got their foot in the door with the calutrons and later the Y-12 construction effort was expanded several times, finally installing 1152 calutrons in nine major buildings!

Earlier in 1942, the experimentation at Berkeley by Lawrence and his staff had been expanded to include the giant 184-inch magnet - the largest magnet in existence at the time. Although they had had success with the 37-inch cyclotron magnet, the amount of separation was far too small to be of military significance. The information provided by the experiments on the 37-inch magnet, while extremely valuable to the researchers, was not convincing to others. So a method was sought to increase the visible output.

At the same time Lawrence was attempting to convince those making the decisions about which process would be most productive to separate the needed quantities of uranium 235, he also had his staff working feverishly trying to reach consensus on the exact designs of sources and collectors as well as other modifications to their experimental “calutron.” All this effort was an attempt to finalize the design in time for the construction to begin on what they hoped would be a full scale electromagnetic separation plant.

Lawrence and his staff attempted to calculate the optimum magnet size and placement. The beam resolution was examined closely. The configuration of magnets and vacuum tanks led them to think in terms of a “racetrack” configuration whereby the individual calutrons could share slots in a huge single magnet. The individual coils to create the huge magnet would be set up such that the vacuum chambers could be inserted between the coils. Some of these "coils" eventually became known as "D-Coils" because of their distinctive "D" shape in the Beta calutrons.

Decisions by the S-1 Executive Committee, based on as much scientific and engineering information as could be provided – though very incomplete - were made on three issues: 1. to build an electromagnetic separation plant; 2. if yes, then how large should it be built; and 3. at what point in the development should the design be frozen. These were vital decision points for Lawrence's calutron based approach.

On September 13-14, 1942, the S-1 Executive Committee recommended that the Army Corps of Engineers enter into contract commitments for an electromagnetic separation plant to be constructed at the Tennessee Valley site known as the Clinton Engineer Works. A part of that recommendation also included the fact that the plant might be cancelled on the basis of later information.

As early as November, 1942, General Groves alerted Stone and Webster that construction of an electromagnetic separation production plant was likely to be coming their way. This move by Groves, as was many of his actions, was well ahead of the full agreement of all decision-makers. He was making things happen where others before him had been stalled by waiting for full approval before taking steps that to Groves were obviously necessary. One of his traits that made him so valuable as the leader of the Manhattan Project was this ability to know which decisions he should make and when to make them.

On December 9, 1942, a report General Groves had prepared to be submitted to President Roosevelt was reviewed by the S-1 Committee. During this review James B. Conant objected strongly to the small size of the electromagnetic separation plant. Groves had included the Warren K. Lewis Committee's recommendation that an electromagnetic separation plant capable of producing 100 grams of uranium 235 be built.

The Lewis Committee had been charted by General Groves on November 18, 1942, to evaluate the various approaches being researched and to report back to him on the feasibility of each approach. They had traveled to each site and held reviews. The stop in Berkeley where Ernest O. Lawrence tried his best to convince them of the superiority of the electromagnetic separation approach had resulted in that approach losing favor with Lewis and the three DuPont members of the committee. They were convinced that Lawrence's calutrons could only produce small quantities of uranium 235 for research purposes and would not be capable of producing enough material for military purpose.

Conant had learned that the amount of uranium 235 needed for military purposes could not be produced using the gaseous diffusion process until an entire plant was constructed. He also thought the plutonium path was going to take longer than he felt was available to beat Germany to what he considered to be their goal, exploding a huge atomic bomb. He knew the United States had to get enough uranium 235 or plutonium for a bomb before Germany. He felt the first country to get that capability would win the war, period.

So, Conant objected to the order of the priorities as well as the small size of the electromagnetic separation plant in the Lewis report being repeated in Groves' draft report for the president. His objection was so harsh as to require him to meet with the members of the Lewis Committee on December 10, 1942, to smooth over the situation.

Nevertheless, Conant was partially successful. When he met with the Military Policy Committee the next day, he was able to change Groves' draft report to include a 100 gram per day electromagnetic separation plant. This was a compromise, but was far more acceptable to Conant than the merely 100 grams total capacity plant the Lewis Committee had recommended.

Vannevar Bush sent this final version of the report Groves had drafted to President Roosevelt on December 16, 1942. It not only contained Conant's larger electromagnetic separation plant, it also included a full scale gaseous diffusion plant and a plutonium plant. The total estimated cost at this point was $400 million. Interestingly enough, the cost of constructing Y-12 eventually exceed that first estimate for the entire Manhattan Project!

On December 28, 1942, President Roosevelt approved the recommendations and the Manhattan Project took an enormously important giant leap from being a research effort to becoming a full-fledged construction effort by private industry under Army supervision.

As would be expected, even before President Roosevelt's approval was executed much less communicated, General Groves was already heavily into contract negotiations with at least a half-dozen of the nation's largest and most capable corporations. He was moving ahead with the necessary arrangements for designing, constructing and operating the giant industrial complex that was to soon become a reality.

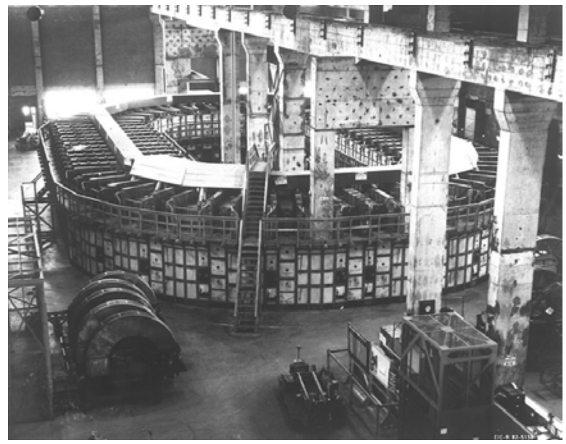
From his experience building the Pentagon, he knew the best companies that he thought would be able to do the job. For some of them, such as Stone and Webster and DuPont, this was a follow up to earlier conversations in November, 1942.

Harnessing the Power of the Universe

In 1939, two scientists from Berlin's Kaiser Wilhelm Institute discovered that the nucleus of a uranium atom can be split if it is bombarded with waves of neutrons. This fission of atoms would create a gargantuan amount of energy, and might be used for military purposes.[4] When hearing of this discovery, scientists Leo Szilard and Eugene Wigner urged the United States government to pursue this research as Germany was. Though the idea of atomic fission was exciting to several officials, the research received no government funding until late in the year when a letter signed by famed physicist Albert Einstein was delivered to President Franklin Roosevelt. The letter was the combined effort of Einstein, Szilard and Wigner explaining the German acquisition of large amounts of uranium ore and the possibility that Adolf Hitler might be constructing a bomb that would guarantee his victory over Europe. Roosevelt began funding small theoretical research teams, but would not begin aggressive research funding until Japan's attack on Pearl Harbor in 1941.

General Leslie R. Groves, fresh from his stint building the Pentagon in D.C., was assigned to the Manhattan Project replacing Colonel James C. Marshall. Marshall was taken off the Project because of the lack of production under his command, but Groves was known for his ability to get things done well and done quickly. Groves' first great milestone was the completion and use of the first Calutron by July 1943.

There were two types of Calutron: alpha and beta. Alpha Calutrons were 15 feet high, and arranged in two groups of 96 each in an oval formation. This formation gave the groups of alphas the nickname "racetracks."



Alpha Calutrons in "racetrack" formation

The beta Calutrons also took on the nickname, though their formation was rectangular. Betas were half the size of alphas.

Beta Calutrons

They totaled 144 in four groups of 36, and both alphas and betas combined totaled 1,152.

After the Calutrons began operations at the plant, the processes were constantly interrupted with problems unforeseen in their development. The machines required enormous amounts of electricity and there were all too frequent electrical failures, as well as cracked insulators and corroded chemical tanks. While these mishaps frustrated the scientists, nothing could compare to the discovery that, when the Calutrons did work, they only captured ten percent of the U-235. The other 90 percent was being embedded into the Calutron walls and had to be manually scraped out.

While all this was going wrong, the assembly site at Los Alamos reported their need for 300 percent more enriched uranium than had been anticipated. Desperate to achieve an effective bomb before Germany, General Groves expanded the electromagnetic plant to twice its previous size, and the Calutrons were designed to run independently of one another in case of problems.

Calutrons required large amounts of conductive metal for their operation. Normally, copper would be installed, but it was currently being used in weapons and machinery on the battlefield and there was none to spare. The next best thing was silver, and because of this Y-12 turned to the only entity with the massive amount silver it needed: the United States Treasury. 14,700 tons of silver was loaned to Y-12 by the US Treasury, most of which was returned after the war.

However, 67 tons of silver was retained for use in the few remaining Calutrons being used for post-war stable isotope separation. In May 1970, the 67 tons was replaced with copper and returned with only 1/3,600,000ths missing from the entire 14,700 tons.

The construction of Y-12 and its processing operations would have never been possible without the hard work of extraordinary people who took on everyday tasks. It was recorded that 242 people were hired as inspector-expediters, schedulers, field stenographers and "priority men" just for the inspection and movement of materials. The most familiar set of workers, however, were the Calutron operators. Sworn to absolute secrecy these workers were trained over a period of several months in order to operate the complex spectrometers.

What makes these workers so fascinating is the fact that nearly all of them were young women straight out of high school. The project's top brass was nervous about the young girls Tennessee Eastman had hired, and argued that the machines needed to be operated by scientists and engineers who had extensive knowledge of the Calutrons.

To find the best possible solution to this disagreement, they devised an experiment to see who could better operate the machines. One side of the racetrack would be operated by engineers and the other side by Eastman's girls for one week. By the week's end the result was clear: the girls, by merely doing exactly as they were trained, had separated much more U-235 than the engineers. The engineers had been experimenting with the Calutron knobs and dials to try and produce better results, but this experiment backfired and they lost production. Upon hearing this result, the

Army Corps of Engineers allowed Eastman to hire the girls.

Being sworn to secrecy was a common occurrence inside the Oak Ridge Reservation. Due to General Groves' compartmentalization security technique, no one was allowed to tell anyone what they did inside the plants, and asking too many questions could get you fired or even arrested. Only a very few scientists and Army officials knew the whole truth of what Y-12 was helping to build, and only one person was allowed on site with a camera. Ed Westcott was the official photographer for the Oak Ridge site, and one of the first few people hired. His photographs are available for viewing on the Y-12 website and can be found hung throughout the Y-12 site.

Oak Ridge residents could not speak freely of the work they did within the Y-12 plant and the inhabitants were required to report anyone who was trying to gain information about someone's job. Everyone, including children over the age of 12, was required to wear a security badge at all times within the plant.

The Oak Ridge Reservation, consisting of 92 square miles, was entirely fenced and guarded with all entrances and exits closely monitored by security authorities. While many civil rights were stripped from the workers, they knew their sacrifice was to help end the war and bring their soldiers home safely.

Winning the War

Harry S. Truman was inaugurated into the Presidency upon the death of Franklin Roosevelt on April 12, 1945. Truman had only met with Roosevelt privately twice during the 11 weeks into the new term, and the President had never mentioned the Manhattan Project with its enormous site in Oak Ridge. This ignorance of the Project ended 12 days into his administration when Roosevelt's Secretary of War Henry Stimson wrote Truman a memo stating:

> *Within four months we shall in all probability have completed the most terrible weapon ever known in human history, one bomb of which could destroy a whole city.*[5]

The Manhattan Project had no official policy statement other than a memo President Roosevelt signed at Hyde Park in New York which vaguely stated that the weapon might "after mature consideration" be used on Japan.[6]

In order to understand the possibilities of how the bomb could and should be used, Truman called together a meeting of the S-1 Uranium Committee. They met on May 9th to discuss the deployment of the atomic bomb on Japan, and in a meeting that spanned two days the committee came to three conclusions: first, the bomb should be used on Japan as soon as it was ready; second, it should be used on war plants which are surrounded by workers' homes and buildings likely to be damaged; and third, it should be used without warning.

The decision was somberly given to President Truman with a reminder and emphasis that the committee's role was entirely advisory. After intense and sober consideration, Truman ordered that the S-1 Committee's recommendation be carried out, and befitting the situation's gravity he explained that their conclusions were similar to those he had reached on his own. They all understood that the only way to obtain a genuine surrender from the Japanese Emperor and generals was to demonstrate an ability to destroy the entire Japanese Empire.[7]

The Enola Gay

Japan's refusal to surrender prompted the departure of the *Enola Gay* from the Marianas Islands on August 6, 1945. Y-12's uranium gun weapon *Little Boy* was on board and dropped on Hiroshima immediately killing more than 50,000 people and fatally wounding nearly 60,000. After a warning of continual bombardment and the dropping of the Handford site's plutonium implosion bomb *Fat Man*, Japan surrendered on August 14, 1945. Almost a day after *Little Boy* was dropped; President

Truman addressed the nation and announced the use of the devastating weapon.

> *Sixteen hours ago an American airplane dropped one bomb on Hiroshima…It is an atomic bomb. It is a harnessing of the basic power of the universe… We are now prepared to obliterate more rapidly and completely every productive enterprise the Japanese have above ground in any city. We shall destroy their docks, their factories, and their communication. Let there be no mistake…If they do not accept our terms they may expect a rain from the air, the like of which has never been seen on this earth…*[8]

Within three months of the Hiroshima bombing, the Oak Ridge population dwindled from 75,000 to 51,000. It fell again by 17,000 a year later, totaling a mere 34,000. Y-12's workforce has continued to decrease throughout the years from its peak of 22,482 on August 21, 1945 to its lowest ebb at less than 1,700 in 1949 except in the 1980s when 8,000 workers worked around the clock producing as many nuclear weapon secondaries as possible to help win the Cold War. The Y-12 site's employment totals approximately 5,000 primary contract employees as of 2014.

"The Miraculous Inventiveness of Man"

After the war, Y-12's future was uncertain. Scientists found the K-25 site's gaseous diffusion method of uranium enrichment more efficient than Y-12's Calutrons, and many of the site's buildings were being shut down and workers laid off. Fortunately, the Graphite Reactor site X-10 had begun experimenting with isotopes of elements other than uranium, leading to the birth of nuclear medicine and also the first nuclear reactors used to produce electricity.

The site, at this time called the Clinton National Laboratory, had no space for their research equipment, and turned to the many empty buildings at Y-12. The Clinton National Laboratory is now called the Oak Ridge National Laboratory, and continues to look into the effects of nuclear materials and their uses, as well as many other basic science and materials research projects.

The experiments were huge leaps for the cause of Nuclear Medicine, and Y-12 was happy to lend their space to such important research. While the Clinton Lab scientists were separating other elements on the periodic table, they also researched the effects of radiation on living organisms.

Such experiments were performed in Building 9207 and 9210 at Y-12. Because radiation exposure was studied with thousands of mice as test subjects, building 9210 is now referred to almost exclusively as the "Mouse House," nearly foregoing its original numerical name. This experimentation done at Y-12 gave scientists enormous insight into the negative effects of radiation on pregnancy, and other reactions, negative and positive, radiation can have on living organisms.

When theY-12 war-mission was over in 1945, Tennessee Eastman and the Manhattan Engineer District (MED) began discussing the possibility of using the Calutrons for basic and applied research. This would involve using Building 9731 to produce stable isotope separation, which would give insight into the physical characteristics of an isotope. Surprisingly, knowledge had been sorely lacking before this. With the understanding of different isotopes' mass, physical property or occurrence, scientists would lay the foundation of nuclear research.

Oak Ridge remained a closed city until March 19, 1949, when the city was opened to the public, and area security was decreased to exclusive monitoring of plant traffic. When Tennessee Eastman Company no longer felt the need to serve the war after its end, the Y-12 Plant was next contracted to a private chemical productions company called Carbide Carbon and Chemical Company later to evolve into Union Carbide Nuclear Division. Also succeeding the end of World War II was the formation of the 1946 United States Atomic Energy Commission (AEC). The United States created the AEC to control the production of atomic science and technology.

Despite the desperate conditions in which the bombs were used, many people were still greatly disturbed by the amount of destruction they caused. The Cold War had already begun and and one nation no longer could hold that much power alone, and so President Eisenhower decided it was time to announce the research scientists had begun.

In1953, Eisenhower made his famous "Atoms for Peace" speech to the United Nations. In a government funded program called by the same name, he assured the world that "…the United States pledges before you…to devote its entire heart and mind to find the way by which the miraculous inventiveness of man shall not be dedicated to his death, but consecrated to his life."

This new program required the United States' nuclear research be shared with schools, research institutes and hospitals around the globe. Medical researchers had been looking into the possibilities of nuclear isotopes for years prior to this program and jumped at this opportunity.

It is because of the research done at Oak Ridge and other Manhattan Project sites that doctors have the ability to diagnose and treat countless diseases.

Until the Second World War, the United States did not pursue science as a national interest. However, beginning with the Manhattan Project and its scientific advances, federal funding for scientific research continues. The United States government funded research on spy planes, atomic weapons, advanced computers and more done at the Y-12 site as well as many other research efforts across the nation.

Electromagnetic Separation of Isotopes at Oak Ridge – L. O. Love

By: D. Ray Smith

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, CA, 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 from 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.

Y-12 Helps Lift the "Iron Curtain"

At the end of World War II, the Allied Forces still had many issues to solve. The extreme difference in economic and political policy between the Soviet Union and the United States and Great Britain caused difficulties during the war, and they were reemerging as the Soviets began establishing occupational forces in Eastern Europe. Allied Tehran and Yalta conferences held pre-victory showed a splintering of all the "Big Three," Franklin D. Roosevelt, Winston Churchill, and Joseph Stalin.

Roosevelt's attempts to befriend Stalin were extreme and consisted mostly of excluding Churchill from conversations. Roosevelt and Churchill had different impressions of Stalin from the start of Russia's switch to the Allies. Roosevelt felt that

> *"… Stalin is not that kind of a man. ... and I think that if I give him everything I possibly can and ask for nothing from him in return, noblesse oblige, he won't try to annex anything and will work with me for a world of democracy and peace."*[9]

Churchill had refused appeasement policies with Adolf Hitler, and was not about to bend to the will of another megalomaniac leader. This experience gave the British Prime Minister a much more realistic view of the Soviet leader. Because the two Western leaders had such different opinions of Stalin, each was working with the Soviet Union on different deals requiring various levels of closeness.

Very soon after the war, Europe was partitioned into what was called the Free West, where democracy was being reintroduced, and the Eastern Bloc, which was dominated by the communist Soviet Union. The Bloc included both Soviet satellite countries, such as Latvia, Estonia, Lithuania, and eastern Finland, and nations absorbed by the Soviet Union including East Germany, Poland, Hungary, and Bulgaria. It was not long after this absorption that Winston Churchill visited Westminster College in Fulton, Missouri and made his famous "Sinews of Peace" address. Churchill assured the students that what he was about to say was not for any gain or ambition, and that, already having achieved his life goals, "there is nothing here but what you see." This declaration that would later be known as his "Iron Curtain" speech articulated the horrors that would spread across Eastern Europe, and reported that "an iron curtain has descended across the Continent."[10]

Winston Churchill speaks at Westminster College in Missouri

Once Stalin's intentions became evident, the United States declared its anti-communist policy through the practice of "containment" and the implementation of the Truman Doctrine. Under this policy, the United States allocated $400 million to the defense of countries against communist totalitarianism.[11] The idea was that free societies could contain the influence and spread of communist dictatorships through defense of countries within that sphere of influence.

After the Soviet Union successfully tested their first atomic bomb in 1949, the United States government turned to the Manhattan Project sites for the production of more atomic weapons for what was becoming an arms race. Los Alamos disliked the idea of becoming a production facility again, but Y-12 was more than ready for the job. Many of the buildings from the Manhattan Project were empty, and the site was waiting for its new mission. This new mission would contribute to the largest peace-time weapons build-up in American history, and would further cement Y-12's place in the new atomic age.

Once the success of the United States' efforts was known internationally, scientists' imaginations ran wild. Even as early as 1928, General Electric scientists had been convinced that "if science ever achieved atomic fission, the world's whole economic system and daily life might be revolutionized."[12] Scientists' fantastical ideas for atomic energy included everything from cars powered by nuclear reactors to underground communities using metal uranium as climate control and only surfacing to swim in their outdoor pools! Such fantasies were quickly deemed as impractical by publications such as *Astounding Science Fiction*. The editor is quoted saying that "if an atomic-powered taxi hit an atomic-powered streetcar at Forty Second and Lex, it would completely destroy the whole Grand Central area."[13] Though some scientists continued to pursue this advance, many returned to isotopic fission's pragmatic weapons uses.

Drawing of an atomic car

With this return Y-12 would eventually return to the forefront of nuclear weapons production. Immediately after the atomic victory, however, Y-12's future looked uncertain. The end of the war meant a decrease in weapons production as Los Alamos, which made Y-12's uranium enrichment nearly obsolete. This peacetime attitude was very quickly replaced by production frenzy when Soviet Russia tested their first atomic bomb called Joe-1 by Americans. President Truman had made implications of America's large supply of atomic bombs, and Joe-1 called his bluff. This situation had been predicted by scientists at Los Alamos who were advocating the free sharing of nuclear weapons information internationally. Scientists now knew Russia had been aware of their efforts since before the Manhattan

Project's inception, and they were concerned suspicion between the countries would lead to an arms race. It was now vital for national security that the old Manhattan Production sites continue their mission.

Most of Y-12's buildings were emptied after the war, and the X-10 site, now called the Clinton Laboratory, was using several remaining Y-12 facilities for their Stable Isotope research. The only work being done with the Calutrons was the production of radioisotopes for Clinton Lab's research and Calutron maintenance. When X-10 became the Clinton Laboratory it bequeathed its job of plutonium enrichment to the plutonium site in Hanford, and devoted its efforts to studying the effects of radiation on micro-organisms, plants, and – most famously – mice.

Los Alamos also wanted to dedicate their abilities to nuclear research, and was struggling with their role as a production site. Many of the site's scientists and researchers had been pressed into service for the war effort, and felt their commitment had been honored. Most had gone back to their pre-war professions or to finish their educations. The still military environment discouraged many from staying, and those that remained pushed for a civilian atmosphere. Los Alamos was the only site where nuclear weapons could be produced, and this push to become a research facility with an academic milieu could jeopardize the safety of the United States.

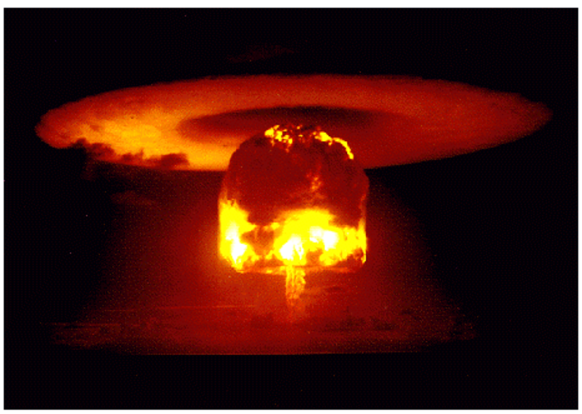
Fortunately, the electromagnetic separation site of Y-12 was prepared for a change of mission, and eager for the work. During Los Alamos' continuing production immediately after World War II Y-12 had also continued in its mission to enrichment uranium for nuclear weapons tests. The United States had begun testing with two nuclear bombs in 1946. When the federal government established the Atomic Energy Commission (AEC) in 1947, their first goal was to move weapons productions from Los Alamos to Oak Ridge, and get productions started. After a year of transferring equipment and knowledge from New Mexico to Tennessee, Y-12 finished its first weapons manufacturing in 1948. Los Alamos can finally dedicate itself to research and weapons design, and Y-12 goes from an enrichment site to a production facility.

It would be Y-12's later work with zirconium that gave the site its reputation as a "can-do" plant. Y-12 partnered with the Clinton Lab to create the first nuclear submarine. Captain Hyman G. Rickover, a scientist at the Lab, believed storing a small nuclear reactor in Navy submarines would allow for longer naval missions – much like earlier scientists had wanted atomic-cars to work. This could be achieved with the separation of zirconium from hafnium, which would be done in Y-12's Calutrons. This was a huge success, and Y-12 continues to supply the United States Navy

Captain Hyman G. Rickover emerging through a submarine hatch

with fuel for their reactors – though not from their Calutrons.

This successful undertaking is also the birth of Y-12's safety mission. The separation of zirconium and hafnium produces unstable, disposable waste. Improper storage and worker safety precautions caused the accidental death of two workers during the mid-1950s. This tragedy proved that safety needed to be paramount within Y-12's new mission. Fatalities had occurred during the Manhattan Project and very early Cold War projects, but the transfer to civilian management opened the eyes of managers and workers alike. Y-12's safety goal is still in effect today, and has culminated into one of the best safety records for a production site.



Hydrogen Bomb explosion

With the fission bombs development was nearing perfection, Los Alamos turned its eye toward the long-awaited hydrogen bomb. The H-bomb utilized two types of explosion: fission – like that of Little Boy and Fat Man, and fusion. The hydrogen fusion detonation could only be achieved using the intense heat of the first fission explosion. For this first explosion the bomb needed uranium or plutonium. This required Y-12 and Hanford to continue their enrichment work. The first Hydrogen bomb test was on an island in the Pacific near Bikini. The incredible force of the two explosions completely destroyed an island.

Y-12 played a huge role in the Cold War Arms Race, but their contributions to the Space Race are not as well known. Not long after Soviet Union successfully launched the first human into outer space in early 1961, President Kennedy announced the United States would put a man on the moon before the end of the decade. The National Aeronautics and Space Administration (NASA) worked toward the moon during three programs called Mercury, Gemini, and Apollo. Mercury and Gemini were experimental missions that tested equipment and trained astronauts, and only took astronauts into Earth's outer atmosphere. Apollo missions marked the halfway point as NASA began steadily sending astronauts closer and closer to the lunar surface. By the Apollo 10 mission, the only thing stopping astronauts from landing on the moon were orders to return to Earth.

Y-12 produced two essential devices for the Gemini and Apollo programs. The BIG-1 Device was designed to carry blood samples during the Gemini III mission. It exposed them to controlled amounts of radiation, and helped scientists understand the effects space travel can have on the human blood cell. The Apollo Lunar Sample Return Container, or "Moon Box," allowed Apollo 11 astronauts to safely bring samples of the lunar surface, such as rocks and soil, back to Earth for scientific study. It is a vacuum-sealed container that was designed to be extremely durable and to provide a safe environment for the sample materials. The Moon Box was constructed from a solid piece of aluminum alloy, and the only upset to its seamless design is the opening for the lid which was designed to help contain the vacuum of space.

More information on the NASA missions can be found in "A Rough Road Leads to the Stars."

While Y-12 was collaborating with NASA and producing secondaries for nuclear bombs at record speed, the plant also worked with schools across the United States to teach vocational trades to students. The school called Training and Technology (TAT) taught students invaluable skills such as metallurgy, carpentry, and even job-interviewing skills. This training saved many of these inner-city students from a bad path, and several of them went on to work at Y-12! Although the TAT program shut down in the 1990s, the 30 years of its existence changed many lives for the better.

After 40 years of passive-aggressive conflicts, the Cold War ended with the dissolution of the Union of Soviet Socialist Republics. The Berlin Wall fell in 1989, and the communist government fell two years later after a gradual return to capitalism consisting of a series of liberating economic and social policies. At the Soviet fall, the United States rushed with aid for the impoverished former satellites and border communities. Y-12 would go on to relieve former satellites of unwanted uranium materials, and return them to safe, secure locations within the Y-12 site.

The Cold War was not a war to be won through field battles – with tanks and bombs. It was a propaganda war - a series of battles fought with the words of the influential, and fought for the good opinion of nations. Y-12's ability to produce parts and material for weapons at such large numbers was the psychological push the Soviet Union needed to abandon communism, and overthrow the totalitarian regimes that had dominated much of Europe for four decades. Thanks to the Cold Warriors at Y-12 more countries have the international liberties of self-determination and a right to choose their governments.

These articles explain Y-12's contributions to the Arms Race in more detail.

Y-12's second era begins

As early as September 1941, Stalin knew of the likely pursuit of an atomic bomb project by the United States and Great Britain. This was a year before the Manhattan Project actually took shape. The intelligence came by obtaining a copy of the MAUD report. The final MAUD report consisted of two documents, one describing the use of uranium for a bomb and the other describing the use of uranium to produce electricity.

It was the one about the bomb that caught their attention and caused Stalin to assign Igor Kurchatov as the lead scientist to study to possibility of creating an atomic bomb. Another thing that alerted the Soviets that something was amiss was the total lack of publications regarding nuclear fission from the United States and Great Britain.

Even though Stalin agreed to start a uranium program, it was not a major effort during the war. Espionage fed the details of the United States and British efforts to the Soviet secret police. However, much of what was learned was not shared with the scientists; rather it was used as a check on the accuracy of their progress.

After the war ended, Lavrentii Beria, former chief of security for Stalin, was put in charge of the overall atomic bomb program with Kurchatov remaining as the scientific head. After the successful explosions at Hiroshima and Nagasaki, Stalin now wanted badly to create an atomic bomb.

Stalin declared that the design for Fat Man given to the Soviets by Klaus Fuchs in June 1945 would be the design of their first weapon test. And so it was, Beria insisted that the proven design be followed as closely as possible. The Soviets exploded their first atomic weapons test on August 29, 1949 in Kazakhstan.

During this same time from 1945 to 1949, Y-12 was busy transitioning from an electromagnetic separation plant to a nuclear weapons manufacturing plant. As early as 1947, when the Atomic Energy Commission took charge of the atomic energy program, Y-12 was selected to perform the manufacturing of atomic weapons.

Jack Case, for whom the largest office building at Y-12 is now named, was among the group of individuals sent to Los Alamos by the AEC to bring back the technology for machining uranium. After a bit of hesitation by the folks at Los Alamos, Jack and his group did just that. Almost immediately, Y-12 began to do the work needed to manufacture the special parts required to create additional atomic bombs.

The first weapons components manufactured at Y-12 were fabricated in Building 9212. This building first became operational on November 4, 1945. The original purpose for the facility was to recover uranium 235 and process the material into a usable form to recycle through the calutrons.

By December 1946 the K-25 uranium feed material (enriched beyond what the Alpha calutrons could do), was being processed in Building 9212. By May 1947, production of the K-25 and K-27 plants completely replaced the calutrons and was producing enriched uranium 235 product.

"It was during the second half of 1947 that the enhanced material reduction process for enhanced weapons production performed at Los Alamos was initiated at Y-12, in Building 9212." That is the exact language found in historical records at Y-12. What it meant was that Y-12 began producing uranium metal from K-25's product by the reduction method and also began to machine shapes needed for nuclear weapons from that special material highly enriched in uranium 235.

During 1947 nuclear weapons were still being manufactured at Los Alamos but the transition to bring Y-12's capabilities up was rapidly being put in place. The United States was moving ahead with nuclear weapons testing and beginning to create a stockpile of weapons.

In the spring of 1948, certain components of the normal uranium (not enriched) weapons assemblies were fabricated in 9212, thus initiating the first actual parts made from metal at Y-12 that were used in a nuclear weapon. This was the start of the first nuclear weapons program for manufacturing weapons at Y-12.

In May of 1948, the first enriched uranium weapon design earlier manufactured at Los Alamos was fabricated from basic product to metal and machined to a finished product at Y-12, in Building 9212. This was the first manufacturing of enriched uranium weapons at Y-12.

The second era of Y-12 had begun. It was now a nuclear weapons manufacturing plant and no longer a uranium separation plant.

Zirconium and hafnium separation at Y-12

By: D. Ray Smith

When then Captain Hyman G. Rickover completed his nuclear reactor training at the Clinton Laboratories in 1947, he quickly saw the advantage of using highly enriched uranium reactors in ships. That was when it was first realized that there was a need to separate hafnium from zirconium for pure zirconium. Zirconium does not absorb neutrons and thus was excellent for cladding reactor fuel for navy reactors.

While the actual separation did not occur until the early 1950's this work was done in Building 9211 at Y-12. When Rickover was assigned to the Division of Reactor Development, U.S. Atomic Energy Commission in 1949, his main efforts were directed toward the design of a specialized nuclear reactor for the Navy. As director of the Naval Reactors Branch, he implemented the design. A portion of that work was the separation of hafnium from zirconium at Y-12.

Like the separation of stable isotopes using the calutrons in Building 9731 that began immediately after the calutrons were no longer needed to separate uranium, this unusual and highly difficult separation of hafnium from zirconium was readily undertaken by Y-12. However, this was a chemical separation process rather than an electromagnetic separation.

Finis "Pat" Patton told me the details of this process. When he came to Y-12 recently for a knowledge capture interview, he wanted to see Building 9211. I wondered at the time why that building held special meaning for him, but as he asked, I drove close to it and showed the building to him. Then he said, "That is where we separated hafnium from zirconium for Rickover's nuclear reactors." Of course I made a mental note to follow up on that.

Several days later I called Pat and we talked about the process. It was a highly corrosive process, so much so that some of the building steel had to be replaced after the process had operated for several months there. Pat mentioned several aspects of the process that required careful handling and knowledgeable personnel. He led the effort and was instrumental in the design of the process.

The main equipment used consisted of 20' tall glass extraction pulse columns and measuring pumps. The seal for the glass columns was difficult to design and required springs on the outboard portion of the seal to hold it in place. Pat designed this seal personally and was proud of the manner in which it worked. The stainless steel plates inside the columns were porous and consisted of several stages.

The separation of hafnium from zirconium required several steps and during some of the transition steps a very unpleasant gas, phosgene, was present. This required gas masks to be worn. Not all the workers wore the masks and Pat said those who attempted to hold their breath and make the necessary adjustments when the gas was present as often as not could soon be seen on the grass outside the building throwing up. He described this situation as being somewhat "macho" image of the men who did not like to wear the gas masks. This is hard for us to understand in today's safety conscious climate, but evidently was not perceived as all that unusual then.

Other chemicals present in the process area included carbon tetrachloride, sulfuric acid, nitric acid and hydrochloric acid. All these chemicals were nasty characters requiring careful handling to avoid burns or inhalation.

Many of the process operations were vented to the atmosphere through the roof of the building. Pat said that he once went on the top of the roof and found it filled with dead birds. The phosgene gas had taken its toll on the birds.

The name of the first nuclear submarine was another interesting story. It seems that then Captain Rickover had finished the Reactor School at Clinton Laboratories in 1947 and then had set about creating the nuclear navy. One of his main goals was to build the first nuclear submarine.

Pat told me the source of the name for this first atomic submarine. He said that then Captain Rickover named the first atomic submarine for the Nautilus built by Captain Nemo in the 1870 classic adventure tale, 20,000 leagues under the sea by French author Jules Verne. Of course there was then a movie made by Walt Disney in 1954 named 20,000 leagues under the sea that used the same Nautilus sub-marine name.

Nautilus was authorized by congress in July, 1951. Construction took 18 months. The NAUTILUS web site notes the nuclear navy "was made possible by the successful development of a nuclear propulsion plant by a group of scientists and engineers at the Naval Reactors Branch of the Atomic Energy Commission, under the leadership of Captain Hyman G. Rickover, USN."

Nautilus was launched on January 21, 1954, and on September 30, 1954, Nautilus became the first commissioned nuclear powered ship in the United States Navy. The reactor used zirconium clad nuclear fuel using the pure zirconium from Y-12 and the enriched uranium from K-25. The film by Walt Disney was released December 23, 1954.

Y-12 and the Hydrogen Bomb

By: D. Ray Smith

A major increase in nuclear weapons work came to Y-12 directly after the first Soviet Union nuclear test on August 29, 1949. Y-12 was already the main source of machining and manufacture of the necessary nuclear parts for the weapons being stockpiled and for the tests being conducted. By the time the Soviet Union exploded its first test, the United States had already exploded six.

The soviet test, learned by US intelligence to have been a replica of Fat Man, hastened the investigation into espionage. The summer of 1950 saw Julius and Ethel Rosenberg, Harry Gold and David Greenglass arrested as spies. Klaus Fuchs, the person who gave the plans for Fat Man to the soviets, was also arrested early in 1950 in Great Britain and sentenced to 14 years in prison. He served nine years.

Discussion of the need for a thermonuclear weapon began anew in 1949 when Edward Teller returned to Los Alamos at about the same time as the Soviet Union's first test. Teller had earlier argued for the more potentially powerful weapon, but Robert Oppenheimer had refused to depart from the agreed upon atomic bomb designs using uranium for Little Boy and plutonium for Fat Man.

After the Soviet test, Teller immediately began to push for the greater yields of explosive energy possible with the fusion of hydrogen. Oppenheimer was among those who continued to oppose the development of the hydrogen bomb. An increase in the production of uranium and plutonium was approved leading to additional increased workload for Y-12. The stockpile of atomic weapons was growing and more testing was being planned, all based on the original atomic bomb designs.

The debate continued on whether to create an even more powerful nuclear weapon or to continue the path of producing more and more of the atomic bombs that relied on fission. Y-12 was becoming the primary manufacturing facility for the uranium portions of these weapons. When it became known that Klaus Fuchs had given nuclear secrets from the United States design to the Soviets, fear grew that he may have provided them the design work that had been done on the thermonuclear weapon.

Lewis Strauss, a member of the Atomic Energy Commission who would chair the commission from 1953 to 1958, recommended to President Truman that the hydrogen bomb be developed. Strauss was later to be a key figure in the hearings against Robert Oppenheimer. Strauss supported Edward Teller's position that the United States should have the hydrogen bomb because it was inevitable that the soviets and others would develop the more powerful nuclear weapons. Teller also testified against Oppenheimer later.

The sentiment that it was imperative that the United States have at least an equally powerful nuclear weapon as anyone else drove the inevitable consideration for building the hydrogen bomb. Although many scientists who had originally worked on the atomic bomb were now opposed to further creation of larger and more powerful nuclear weapons, the debate continued.

The decision for the United States to develop the hydrogen bomb was announced by President Truman on January 31, 1950. The workload associated with designing the thermonuclear weapon fell to Los Alamos. Many additional scientists were needed to work out the complicated interactions necessary to accomplish the detailed and exacting requirements of producing the conditions necessary for fusion of hydrogen and the resulting release of enormous amounts of energy.

It is important to note that during this time of expanded efforts to produce a hydrogen bomb, the Korean War broke out in June of 1950 when North Korea, after gaining the Soviet Union's implied support, crossed the 38th parallel and invaded South Korea. The Soviets were convinced that the United States would not intervene. However, the United States did act to bring the United Nations Security Council into the situation.

In August of 1950, the United States also acted by sending bombers to Guam loaded with atomic bombs. This deployment outside the United States was intended to be a show of strength through atomic weapons. President Truman indicated that the use of atomic weapons was a strategy that would be considered, if required.

Manufacturing the necessary parts for the hydrogen bomb designed by Los Alamos was the primary mission of Y-12. This collaborative arrangement developed during the first attempts to design a thermo-nuclear weapon established a working relationship that has continued through the years.

Not only with Los Alamos, but the intricate and highly precise machining required to manufacture nuclear weapons has created a similar collaborative relationship with all the other nuclear weapons design laboratories. Y-12 has historically been the primary manufacturing facility for the major items in the nuclear portions of the nation's nuclear weapons.

On November 1, 1952, just less than three years after the announced decision to build a hydrogen bomb, the first test was conducted on Enewatak, an island west of Bikini in the Pacific. One island was completely destroyed by the force of the blast.

The next major nuclear weapons work challenge given Y-12 resulted from the explosion of the Soviet Union's first thermonuclear test on August 12, 1953. It was a surprise to the United States.

Y-12 sets the pace in precision machining —Or: Establishing the pace for precision machining (title used by The Oak Ridger)

By: D. Ray Smith

Beginning in the very early years of Y-12's history, precision machining has played a strong and leader-ship role in the mission of machining uranium and other special materials for the most crucial elements in nuclear weapons. Every secondary stage for every nuclear weapon the nation has ever built and all nuclear tests the nation has executed were manufactured at Y-12.

As you will recall, Y-12 first separated the uranium 235 for Little Boy, then K-25 came online in March, 1945 and by the end of 1946 the gaseous diffusion process could produce the uranium 235 much more economically than could Y-12's electromagnetic separation calutrons. By December 1946, all the calu-trons at Y-12 except for those in Building 9204-3 and Building 9731 were shut down.

Thus the first mission for Y-12, producing the uranium 235 for Little Boy, ended and almost immediately the next mission of machining uranium began. The first two nuclear weapons, Little Boy and Fat Man, as well as the "Gadget" test exploded at Trinity were manufactured at Los Alamos. Only the uranium came from Y-12.

March, 1948 saw the first nuclear weapons parts manufactured at Y-12. Production of nuclear weapons "secondaries," that part of the nuclear weapon that contains the special nuclear materials, has been the primary mission of Y-12 ever since. Storage of reclaimed materials from dismantled weapons has grown into a major mission with the results of the Strategic Arms Reduction Treaties.

With the mission to fabricate nuclear weapons components that was moved from Los Alamos to Y-12 came the need to procure machine tools adequate to the task. From the beginning, the machining requirements called for close tolerances. Even those early weapons components, essentially duplicates of Fat Man, still required substantial machining capability be created in Y-12.

By 1950, machining of unique and new alloy materials that combined uranium with a number of other materials was commonplace. The advances in machining were fast being developed at Y-12. The demand for more unique materials in each new design of the nuclear weapons required Y-12 to continually experiment with new techniques and advanced machines.

In December, 1951, the Plant Laboratory moved from Building 9212 Headhouse to the location it still occupies today, Building 9995. The laboratory has been a mainstay for supporting Y-12 production efforts throughout its existence.

In January, 1952, a new Elza 1 electrical switchyard was completed. The electrical supply for Y-12 has been provided through multiple feeds since the earliest days when the calutrons required uninterrupted power.

In 1953, uranium casting facilities and another complete machine shop were added as well as a hydraulic press facility that was completed in October, 1953. All this was being done around Building 9212 as additional wings and even other buildings were being added to that complex. It was likely that this is the time frame for the identification of this area as "Area 5," but I am still unable to confirm that.

Building 9705 was located atop the hill north of the long-time administration building, 9704-2 and located where the courtyard of the Jack Case Center is today. This building was used as the Atomic

Energy Commission Patrol headquarters when it was first formed in 1947. It was sometime during 1953 that this building burned.

It was also in 1953 that the three white concrete "checking stations" or guard houses were taken out of service and the fences and gates relocated to the physical boundaries of the three main sites, K-25 (Gaseous Diffusion Plant,) Y-12 (Y-12 National Security Complex) and X-10 (Oak Ridge National Laboratory). These structures were built in late 1948 in preparation for the opening of the public road gates to Oak Ridge on March 19, 1949. So, they were only used from 1949 to 1953.

During 1953 at Y-12 a large variety of "spindle lathes" and various size milling machines were brought into these newly created machine shops. Furnaces were installed and the foundry operations expanded considerably. All of Y-12 was growing and expanding

Twenty six nuclear weapons tests were conducted in 1951 and 1952. The first thermonuclear weapon (Mike) was tested on October 31, 1952. King, the largest fission device ever exploded by the United States , at 500 Kilotons, was tested on November 15, 1952.

There were eleven nuclear tests in 1953, six in 1954 and eighteen in 1955. The expanding capacity needed to meet the nuclear testing schedule required new equipment and specialized machine tools be built and purchased expressly for Y-12's unique needs. This led to Y-12 being a strong leader in the machine tool evolution as many of the special requirements for nuclear weapons machining resulted in improvements in the machine tools available to private industry.

It was in this atmosphere that the request for Y-12 to separate Lithium 6 came and the challenge was readily accepted. As has been said, it was a "heady" time for Y-12. So many new and different things were being accomplished. While the COLEX (Column Exchange) process separated the nation's need for Lithium 6, from 1955 to 1963, so thermonuclear weapons with increasing yield could be built, other portions of Y-12 were working on the machining of uranium and other needed materials.

Y-12's Naval Mission

By: D. Ray Smith

Although the Department of Energy's Oak Ridge facilities have been working with the US Navy for over 50 years (reactor work in 1950's, sonar arrays in 1960's), this narrative will address activities that began in the 1980's. Most projects involved a collaborative effort between the Y12 National Security Complex (Y12), the Oak Ridge National Laboratory (ORNL), and occasionally the Oak Ridge Gaseous Diffusion Plant (now East Tennessee Technology Park). A summary of major (>$1M) projects is included at the end of the section.

In the early '80's ORNL was funded by the US Navy to provide prototype hardware and software associated with data acquisition for acoustics data. Previously ORNL had developed technologies for use in nuclear reactor systems that were applicable to Navy needs. During one visit, Navy personnel toured manufacturing facilities and became interested in the computer numerical control (CNC) machining and inspection capabilities available within the Oak Ridge complex.

At this time the US Navy's primary source for submarine propellers, the Philadelphia Naval Ship Yard (later Navy Foundry and Propeller Center – NFPC), was machining propellers with 4-axis mills and inspecting the finished product with templates and height stands. As of 4 October 2000 NFPC was still using 4-axis mills for propeller machining although improved inspection techniques have been introduced on a limited basis.

As a result of the Navy's interest, Y12 was asked to manufacture a test component to determine whether the facilities would be acceptable for manufacturing scale model hardware associated with a new type of submarine propulsion system. Y12 manufacturing facilities cast a ¼ scale surface ship propeller blade in H1 Foundry, machined the blade using CNC equipment, and inspected the blade using a coordinate measuring machine (CMM). Based on the successful completion of this test Oak Ridge became part of the US Navy's team to develop the USS Seawolf Class Submarine (SSN-21) propulsor.

From 1984 to 1994 Oak Ridge facilities completed design and manufacture for approximately ¼ scale model propeller assemblies for the Seawolf Program. Nine different design concepts were produced based on hydrodynamic and acoustic information provided by the Naval Surface Warfare Center – Carderock Division (NSWCCD).

In parallel with the scale model propulsor work the US Navy was attempting to procure, from private industry, the prototype full scale Seawolf propulsor. After several attempted procurements were unsuccessful, a request was made in 1989 for Oak Ridge to produce the prototype unit. This prototype unit was delivered to General Dynamics – Electric Boat Division's assembly facility in Groton, CT in December 1993. Oak Ridge continued to manufacture additional Seawolf class components through 2000 for SSN-22 and SSN-23.

In 1992, Oak Ridge began work on scale model hardware for the USS Virginia Class Submarine (SSN-774). Six sets of hardware were designed and manufactured between 1992 and 2000. Oak Ridge designed and manufactured the “duty prop” for the 1/3 scale model autonomous submarine to be used in SSN-774 scale model hardware testing at the Acoustic Research Detachment, with hardware shipment in 2000.

In addition to scale model hardware production, Oak Ridge has supported the SSN-774 full scale propulsor manufacturing program. Since 1992, Oak Ridge personnel have participated in the SSN-774 integrated product team for development of manufacturing processes and continues to participate in monthly SSN-774 manufacturing meetings.

The following paragraphs provide information on major Oak Ridge projects funded by the US Navy. Some of the tasks listed were completed primarily at one Oak Ridge facility (ORNL, Y12, ETTP) and some were collaborative efforts of multiple sites. This information is presented to provide information on the broad scope and magnitude of Oak Ridge support for Navy programs.

1. Large Scale Vehicle (LSV) Data Acquisition System (DAS) – The Instrumentation and Controls (I&C) Division at Oak Ridge National Laboratory (ORNL) developed the original data acquisition system for the US Navy’s Large Scale Vehicle, an autonomous ¼ scale submarine used for submarine R&D. This was a three year, $1.7M program that began in 1984.

2. Acoustic Measurement Facility Improvement Program (AMFIP) – This ORNL I&C task was associated with modernizing the US Navy’s Acoustic Measurement Facility in the Bahamas. This $32M program began in 1986 and was completed in 1999. Oak Ridge developed and implemented an acoustic beam measurement system. The system, when completed, had the ability to acquire 40 million acoustic samples per second and analyze the samples at utilizing a data analysis system with 40 Gflops of computational power.

3. Large Cavitation Channel (LCC) Data Analysis System – Oak Ridge developed a $5.5M DAS for the US Navy’s LCC located in Memphis during a period from 1989 to 1992. The LCC is used to provide hydrodynamic information on surface ship and submarine models. The Oak Ridge developed DAS acquires and analyzes the data utilized by the Navy to determine the performance characteristics of the models.

4. LSV Scale Prototype Propeller Models for Seawolf Class Submarine (SSN-21) – From 1984 to 1994 Oak Ridge completed design and manufacturing for a series of ~ ¼ scale model propeller assemblies for testing acoustic and hydrodynamic parameters. Approximately nine different design concepts were developed as part of the SSN-21 Program. Each design concept was manufactured by Oak Ridge during this $24M program.

5. Baseline Model Submarine Enhancement – Oak Ridge modified an existing ¼ scale submarine model to include characteristics that matched the SSN-21 hull. The cost of this one year program in 1985 was $5M. The task required development of new tooling and welding technologies to achieve the assembly accuracy required.

6. Steelhead Submarine Model Manufacture – The Steelhead Model was designed and manufactured in Oak Ridge using a US Navy concept. The ¼ scale submarine required development of specialized manufacturing techniques to achieve the required tolerances. The total cost of this program was $11M from 1985 to 1988.

7. Navy Gage and Standards Laboratory (NGSL) Support – Oak Ridge provided design, manufacturing, and certification services to NGSL from 1984 through 1994. During this period a large number of precision inspection gages were designed and/or manufactured. Tasks completed include: Trident Re-Entry Vehicle Contour Gage, Trident Re-Entry Vehicle Bus Gages, Trident Cold Gas Generator Energy Gage, Tomahawk Cruise Missile Wing Gage, and Tomahawk Cruise Missile Mid-Body Gage.

8. Seawolf (SSN-21) Propulsor – From 1989 through 1993 Oak Ridge completed design and manufacture of the prototype SSN-21 full scale propulsor. This ~ $65M task required development of new manufacturing processes that have resulted in basic changes in how the US Navy manufactures assemblies of this type.

9. LSV Scale Prototype Propeller Models for New Attack Submarine (Virginia, SSN-774) – Oak Ridge has participated in design and manufacture of hardware to test the acoustic and hydrodynamic properties of scale model hardware for the SSN-774 submarine that will eventually replace the SSN-688, Los Angeles Class. A total of six sets of trial hardware have been supported by Oak Ridge between 1992 and 2000 with design and fabrication services associated with this $12M program.

10. SSN-21/22/23 Risk Mitigation – As part of the Seawolf Program Oak Ridge provided transfer of manufacturing processes to private industry for manufacture of follow-on units. In addition, Oak Ridge manufactured one major assembly for the SSN-22. This $16M program began in 1992 and was concluded in 2001.

11. SSN-774 Integrated Product Team (IPT) Support – Oak Ridge has provided design and manufacturing support to the Virginia Class IPT since 1992. In this role Oak Ridge personnel provided design input into the SSN-774 propulsor for cost reduction and product improvement.

12. Surface Ship Torpedo Defense (SSTD) – Oak Ridge developed a manufacturing process and testing capability in support for this joint US/UK program that began in 1995. In addition, Oak Ridge personnel participated in a failure evaluation team for SSTD. During 2001 Oak Ridge was involved in manufacture of hardware and mechanical properties testing of the hardware.

13. Remote Sensing for Virtual Presence (RSVP) – ORNL Instrumentation & Controls personnel were involved in this $15M multi-organization ONR project. Oak Ridge technology in sensors and wireless communications was utilized to reduce shipboard manning requirements through replacement of watch standing personnel with wireless sensors in many shipboard locations. Oak Ridge teamed with the Naval Surface Warfare Center and commercial entities for this three

year Advanced Technology Demonstrator Program (FY99-FY01).

14. Large Scale Vehicle (LSV) II Duty Propeller – The US Navy procured a second LSV type autonomous model submarine for testing SSN-774 hardware. Oak Ridge was tasked to manufacture the main propeller assembly to be used with this platform. This two year task was completed in 2000.

BENEFITS

Benefits associated with US Navy work in Oak Ridge have been a two way street. Some technologies and methodologies developed by Oak Ridge have become the standard Navy procedures. The Oak Ridge developed process for welding thick (>6" sections) Nickel-Aluminum-Bronze is the basis for the NAVSEA procedure. Oak Ridge developed techniques for installing special materials have become the NAVSEA standard.

US Navy funded projects have also provided benefits to Oak Ridge. These benefits can be placed in four categories – hardware, modeling & simulation, CNC programming, and materials.

1. Hardware – One of the benefits to Y12 has been "free" access to additional manufacturing hardware. The US Navy provided funding for procurement of several major hardware items as part of the SSN-21 Program. Hardware included:

    - Giddings & Lewis 8-axis milling machine – This is a unique mill that provided capability and capacity that did not exist at Y12. The procurement cost of this machine in 1990 was $4.5M. The mill has been used for machining of DOE/NNSA Defense Programs related hardware in addition to WFO applications.
    - Dorries Vertical Boring Machine – The Dorries VBM also provides unique capability and capacity for Y12. The 26' diameter rotary table on this $1.2M machine provides a turning capacity unavailable at most DOE facilities.
    - Fanamation CMM – Procurement of this large capacity CMM provided Y12 with the ability to quickly inspect both DOE and WFO related hardware. Although the machine is presently out of service as a result of an obsolete probe head, it could be updated and would provide beneficial use for dimensional inspection of DOE/NNSA hardware.

    Each of these equipment items is still US Navy property. But the equipment is available for use on DOE/NNSA Defense Programs when not being used for Navy WFO.

1. Modeling & Simulation – The aggressive schedule for completion of the Seawolf Propulsor required Y12 design personnel to push the state-of-the-art with respect to modeling & simulation technologies.

    - Work was done with Navy funding to validate algorithms associated with a primary Y12 CAD software system. This work assisted the efforts to certify the package for weapons production use.
    - Oak Ridge personnel participated in Navy testing associated with CAD data transfer between different CAD software systems. This effort

provided experience and expertise in data transfer that was applicable to transfer of DOE/NNSA related CAD data.

- Utilizing Navy funds, Y12 developed methodologies for simulating machining and assembly of Seawolf components/assemblies. This work was a precursor to the Model Based Engineering efforts presently under way at Y12.

1. CNC Programming – The complex nature of Seawolf components required multi-axis milling to reduce part surface irregularities. In addition, the aggressive schedule required application of machining techniques not previously used at Y12.

- Work was done with Navy funding to certify the CNC programming package for a primary Y12 CAD software system. This work assisted the efforts to certify the package for weapons production use.
- Significant developmental work was done in the area of “lead angle” cutting and novel cutting tools. These developments can reduce cycle time and improve productivity in other manufacturing applications.

1. Materials – Developmental work was completed as part of the Seawolf Program that provided indirect benefit to Y12 materials technologies. Both metals and composite/polymeric technologies were addressed.

- Y12 Technology Development personnel developed, tested, and applied unique formulations of adhesives for Seawolf. The methodologies used in this development are applicable to Defense Programs activities.
- Machining and welding of a wide variety of metals provided experience and expertise in working with these materials. In some cases the properties of the materials are similar to metals used in Defense Programs activities.
- Y12 capabilities associated with non-destructive evaluation (NDE) of materials and welds were enhanced as a result of developmental work completed during the Seawolf Program.
- Machining and NDE of composite materials was required, enhancing these Y12 capabilities.

John Royster's TAT success story

By: D. Ray Smith

Our next story from Training and Technology history comes from John Royster, who writes:

"I really enjoyed your story on Mayme Crowell. It brought back a lot of memories for me. There were some truly remarkable people on staff at the TAT program.

"I was a 1973/74 TAT graduate. I feel, and I always have, that TAT guided me down a path that probably saved my life. I was 16 years old at the time. My father had passed away when I was 12. I was pretty wild.

"My mother had just about lost control of me. She did the best she could. She was a good role model, and still is. I just didn't notice it at the time. I was hanging out with the wrong crowd, skipping school, staying out all night partying…just asking for trouble. My grades were barely passing. No future plans whatsoever.

"Looking back now, the friends I had then, I can only think of a very few of them that didn't spend time in jail later in their lives. Some even spent time in the penitentiary. Most of them are now deceased. All died at a very early age. I was most likely headed that way myself. Who knows?

"One day at Oak Ridge High School (ORHS) the football coach stopped me in the hall. At first I thought I was in trouble—because I usually was. He asked me if I would like to join a group of students that were going to attend a six-month vocational school at the Y-12 Plant called "Training and Technology." At first I didn't think I would like it. He explained to me, I would spend eight hours a day at the facility, and I wouldn't have to come back to school. I was just months away from graduating and needed only a few more credits. I thought, "No more school? I'M IN."

"ORHS teachers came to the plant twice a week to help me finish my English and History classes. I would get to graduate and receive my diploma with my fellow high school students at the end of the school year, I was told.

"After an orientation exam, it was decided I would be in the Machining class. We were told if we missed three days or were late three times during the program, we were out. I tried to put my best foot forward.

"As it turned out, I liked it. I had different machining projects to work on. We operated milling machines, lathes, band saws, etc. We also had blueprint reading classes, and all different types of math we had to learn. One day it just clicked. I loved doing the math. I was pretty good at it. I thought: "this is all right."

"The instructors were great!! And they were all very patient. It was the first time I could remember doing something I thought was important. I started having more and more self-esteem.

"I used a lot of aluminum and steel on the machining projects. Holding some of the blueprint tolerances was tough. The instructors would inspect the machined parts. I mostly "killed" the parts in the earlier stages of the machining projects. The instructor would just go over to the scrap pile and throw in my assigned project and say, "start over." I finally completed, and passed all of the projects.

"I remember a few of the guys never did finish them. They were inner city teens from Chicago and Atlanta. The projects were pretty difficult. The instructor(s) were kind of strict. Looking back, that's probably what I needed at that time. It taught one that life will not be easy. One has to put forth an effort. Most of the kids in the program did.

"After graduation, and receiving my high school diploma and my Machining Apprenticeship in the same year, I went to work for a company in North Carolina as a Machinist…making a whopping $3.50 per hour. I thought I was rich. I earned some shop experience, and after a year, I decided to relocate back to Tennessee.

"I was lucky enough to get hired with a company in Clinton as a Precision Grinder. I started attending Knox Area Vocational School at night in the Machining program. Four years later, I was hired at Y-12 as a Machinist. I worked 23 years with the ATLC labor union. I then got the opportunity to be setup to a Machinist Supervisor in 2002. After 4 years of doing that, I have since moved into a production support position. Last week I celebrated my 31st year at Y-12.

"By no means have I been perfect through the years. I'm a long way from that. Life has had its struggles. But I can just only wonder how my life would have turned out without me having attended this great program.

"I have been blessed with two great kids (now young adults) that are both college graduates and have very successful careers of their own.

"Anyway, this is my small success story. And I feel I owe the TAT program for it. It was a great opportunity a long time ago for a troubled kid. It truly did turn my life around. I will be forever grateful."
—*John Royster*

I am sure you realize that John"s experience at TAT is typical of many others as well. The training program came along at a time in their lives when they were in need of structure, purpose and a resulting sense of accomplishment from achieving goals. Much the same could be said today…many young people benefit from training programs modeled after TAT and similar effective programs of the past.

Victory Means Growth for Y-12

The Cold War had solidified Y-12's role in America's defense, but the end of the war would mean a change of mission. Toward the end of the Cold War, the Soviet Union and United States signed a treaty to stop the production of long-range nuclear missiles, and to reduce their numbers of stockpiled nuclear weapons. President Reagan and Soviet General Secretary Mikhail Gorbachev signed *The Treaty Between the United States of America and the Union of Soviet Socialist Republics on the Elimination of Their Intermediate-Range and Shorter-Range Missiles* in 1987. This treaty meant growth in Y-12's defense mission. Many of the nuclear weapons parts made at Y-12 were returned for dismantlement, and the highly enriched uranium in those weapons was down-blended. This down-blended material was either sold as fuel for nuclear reactors in Navy submarines and nuclear power plants, or kept safely stored at the Y-12 site.

Soviet General Secretary Mikhail Gorbachev (left) and United States President Ronald Reagan (right)

The dissolution of the Union of Soviet Socialist Republics also meant a downsizing of the Russian nuclear program. The Russians had not contained the program within Russia's traditional borders, but allowed production in select satellite and absorbed states. The program downsizing was an abrupt transition and suddenly left newly independent nations with nuclear materials they could not protect. This left nuclear materials available for sale on the Russian black market, and terrorists were eager to buy. This threat of "loose nukes" would prompt missions around the world to collect unprotected nuclear materials, and store them safely at the Y-12 facility. This non-proliferation mission continues today.

In the fall of 1993, the U.S. ambassador to the newly independent state of Kazakhstan received intelligence that 600 kilograms (1,322 pounds) of highly enriched uranium was being stored in the previously "closed town" of Ust-Kamenogorsk. Closed towns were common in Russia as the Soviet government worked to build nuclear weapons. The ambassador was told the uranium had been enriched to 90% and U.S. experts would later confirm this. Such a huge amount of highly enriched uranium was enough for a skilled bomb-maker to produce 50 nuclear bombs!

When United States officials learned of the material the immediate fear was of the increasingly large post-Soviet black market. This would be a valuable commodity for terrorists or nuclear-hopeful nations, and the security for the material was thin. Kazakh security would not be able to withstand against an organized vie for the uranium.

Two extreme differences existed between Soviet and American nuclear material defense tactics: America invested money into technology-based security methods; and the Soviet Union relied on padlocks and manpower. The dissolve of the Union freed much of this manpower to abandon nuclear facilities, and as time passed the easily penetrable padlocks became weaker and more penetrable. Kazakh officials were very much aware of this, and dreaded the consequences of trying to hold on to the materials.

Before planning any kind of extraction mission, the U.S. government needed to verify the enrichment level of the uranium. It only made sense for them to turn to Oak Ridge. An expert from the Oak Ridge National Laboratory (ORNL), Elwood Gift, was sought out to go to Ust-Kamenogorsk and report back his findings. Gift was able to confirm the 90% enrichment level, and the mission immediately went into action. Originally code-named Project Phoenix by the Pentagon, the mission is much better known by its State Department name, Project Sapphire. A team including members from ORNL, Y-12, and various other government agencies flew out to Kazakhstan that fall, and began the packaging and removal of the uranium.

Project Sapphire did not go off without a hitch. President Clinton signed the Executive Order a month later than expected, and the mission was pushed into the dangerous Kazakh winter month of November. Harsh weather could mean dealing with icy runway conditions that would possibly delay or endanger the transfer of the materials. Another possible threat to this top-secret, covert operation would be the emergency use of unaffiliated nations' airspace. Rushed explanations to uninvolved surrounding nations would compromise the security of the mission. Russia was made aware of the operation only for use of their airspace, but the rampant corruption of the shaky Russian government instilled fears that the information would be leaked for the right price.

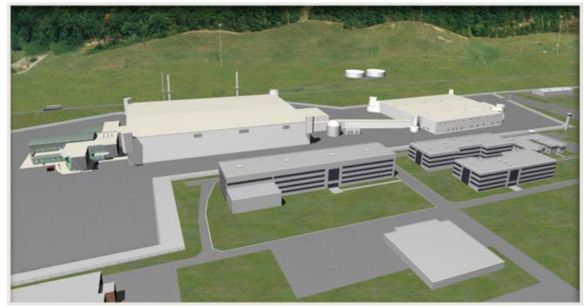
Despite significant delays and a snowy runway, the Project Sapphire team returned to the United States one week before Thanksgiving with all 600 kilograms of the highly enriched uranium, paid for by the United States federal government. Their plane landed in Delaware, and specially outfitted transport vehicles took the materials to Y-12. The materials would only add a fraction to the uranium already stored at the facility known as the "Fort Knox" of uranium storage. In a ceremony marking the event, President Clinton praised the Kazakh president for his show of "courage, vision and leadership."[14]

This project is just one of many domestic and global threat reduction operations Y-12 has undertaken. Two more include the much more recent Operation Golden Llama, where a team extracted highly enriched material from Chile in the midst of an earthquake, and in February of 2012 Y-12 joined the extraction team in Mexico package and deliver highly enriched materials back to Oak Ridge.

Chilean nuclear facility

Another project the Y-12 site has undertaken is the reduction of its infrastructure. Y-12 contained more than 300 Manhattan Project buildings on its site, and many of those buildings were not being used and had fallen into disrepair. It has become imperative toward our safety goals that these buildings be demolished and sparingly replaced with a few larger, more efficient facilities. This transformation has already occurred with the construction of three new buildings on the Y-12 site.

The New Hope Center was constructed in 2007 to help Y-12 become more accessible to the public. It contains the Zach Wamp auditorium which allows Y-12 to host large conferences and other events relative to its mission. The Jack Case Center, located within the protected area of Y-12, is a 40,000 square foot office building that houses 1,200 employees. Y-12's newly



Computer generation of the proposed UPF building (left) and existing HEUMF building (right)

finished Highly Enriched Uranium Materials Facility (HEUMF) is a store house for materials collected from around the world. All the highly enriched uranium left from the Cold War and bought from non-nuclear nations is stored at this facility until it is down-blended, and then sold as reactor fuel for power plants and nuclear submarines. In the next few years, the Uranium Processing Facility will replace Y-12's many Manhattan Project era processing buildings. This facility will be connected to HEUMF.

New Hope Center making history at Y-12

By: D. Ray Smith

Frequently I find it helpful to break away from documenting Y-12's past in these articles to remind us of something of historic significance that is happening right now. The recent visit by the alumni of the Nautilus nuclear submarine crew is an example.

Other examples are the Y-12 History Center and the Y-12 New Hope Center. The history center exhibits were placed there to highlight Y-12's history during the ribbon cutting ceremony to celebrate the opening of the Jack Case and New Hope centers in July, 2007. Since then the Y-12 History Center has become a mainstay of our community relations as well as an encouragement to Y-12 personnel and a point of interest for all our visitors. Our employees have contributed significantly to the quality and number of artifacts both on display and in storage for future display.

I believe it is an understatement to say that Y-12 has a renewed sense of our heritage and our history because of the Y-12 History Center and related videos, books, newspaper articles and etc. We have always known that our work is vital to the nation's security, but we have not heretofore had the venue to really show the public the details of much of that historic work over the years.

The Y-12 History Center is enabling us to do that now, for the first time. We have displays of early Manhattan Project era artifacts, equipment and stories. We have Cold War artifacts, equipment and stories. Some War on Terror details are there as well such as a display of the Highly Enriched Uranium Materials Facility, arguably THE most secure location in the world!

The New Hope Center, in a broader role, is also helping us to engage the community in new and refreshing ways. Receptions are regularly held there, conferences are held in the 420 seat auditorium, luncheon meetings are held there regularly and many people now find coming to New Hope Center as natural as visiting any other place in Oak Ridge.

But, this is Y-12! Yes, that's the point. We realize that vital and secret work is being done at Y-12 and that work is still protected and done in appropriate surroundings and with intended secrecy. However, much of our history is not secret and a lot of it never was intentionally protected, it was just included with other information or materials in sometime difficult places to reach. Much of what Y-12 has done in the past and even is doing today are things that can be readily talked about, fully understood and appreciated by the general public.

Take the Lunar Sample Return Container or more commonly known as the "Moon Box," something Y-12 is proud of having done and something that has no restrictions on it. We have added to the basic display to include a lunar globe, a carrying case for lunar material from between laboratories and even a partial space suit that was an early prototype for protecting the lunar materials from humans. The Lunar Materials Analytical Laboratory used glove box technology instead, so the spacesuit was never used. It sure does catch the children's eyes!

When foreign visitors come to Y-12 for training purposes, the first impression they get of our East Tennessee culture happens when they leave the hotel for events we plan to help them quickly acclimate to their surroundings. One of the very first things they receive is a package from the Y-12 History Center containing handout materials and history videos. It is much like a "welcome package" and it sets the tone for the rest of the visitor's stay with us.

Another thing that is done which helps people visiting Y-12 as they transition from the fully public arena to Y-12's necessarily restricted access environment is the manner in which visitor badges are provided. The Y-12 Visitor Center creates a "welcome and pleased you are visiting us" atmosphere by the smiling and friendly, yet strict and thorough approach taken to help the visitors meet requirements to visit Y-12.

On a recent visit, one person had left their driver's license in their truck at the American Museum of Science and Energy parking lot. While other visitors were processed, this person was transported to AMSE and their driver's license picked up. They were then able to continue on the tour.

At the recent Secret City Festival in June, we had 1,400 people tour Y-12. Unfortunately, many of them had to wait longer than we would have liked because of our limited capacity to handle that many tours. So the New Hope Center auditorium (420 seats) was placed into service and a Y-12 History question and answer session was created to help offset the impact of the delay forced upon our visitors. We will do better with tour scheduling next year, I promise!

The latest "happening" at Y-12's New Hope Center is a wonderful display of photographic art. The Camera Club of Oak Ridge is holding its 62nd annual salon in the main lobby. The giant curved wall that surrounds the south portion of the 420 seat auditorium and serves as the backdrop for the main lobby is being used to display the 220 printed images and 120 digital images are displayed on two huge flat screen monitors.

The salon starts Saturday, November 13. The show will continue until November 30, except for the Thanksgiving Holiday. The show will be available for viewing by the public. You may drop by and view the photographs anytime between 6 AM and 6 PM Monday through Friday. Bring your family and enjoy the show.

For more information, contact Ray Smith, phone 865.576.7781. Or if you have special needs and want to view the photographs at times other than when the New Hope Center is normally open to the public, I will be glad to help arrange a special showing for you or any out of town visitors or other unique situations you might have.

So, the New Hope Center is creating history for Y-12 as we reach out to the community and share this wonderful space. The Knoxville Christian Youth Bands now routinely hold all their concerts there. The Cold War Patriots have used it for two years for their events. We have a Science Fair scheduled for early next year. And there are others…

While this is a new way for Y-12 to be a good community citizen, we are proud of the opportunity the facility provides. It is truly historic for us.

Conclusion

As the world around us changes, one thing remains certain: the Y-12 National Security Complex will remain a site dedicated to the protection of America's liberty. Y-12's mission since its inception has been to defend America and republics around the world. The dangerous charge we were given at the start of World War II has become a vital calling. Y-12 has answered with enthusiasm and determination to protect America's freedom from those who desperately seek its destruction.

When the war was won, and the "iron curtain" drawn across Europe, it was Y-12 who took up the mantle of a Cold Warrior. Y-12 contributions during the 40 year Cold War would win the war on two fronts: an Arms Race and a Space Race. The record production of nuclear weapons' secondaries allowed the United States to retain its strong position in world events, and the creation of the Moon Box made America into a scientific and research leader. Y-12 made it possible for mankind to reach the moon, and return with the fruits of their labor. Because of the work done at Y-12, America achieved more than any other civilization in history.

Y-12 has done more than work for our defense. When the world cried out against the destruction caused by atomic energy Y-12 worked to prove that their purpose was not destructive, but for mankind's benefit. Atoms for Peace would allow research institutions, hospitals, and schools around the world access to radioisotopes that would advance medical research and treatment and save countless lives.

Today's mission has grown from previous priorities of nuclear weapon production. Y-12 specializes in the non-proliferation of nuclear materials. We understand that in order to protect republic ideals in America and abroad, international threats must be thwarted before a threat is made. Y-12 sends specially trained employees to countries around the world to collect "loose" materials and bring them to Y-12 to be safely stored. Y-12's history can be easily traced from the beginning.

Y-12's missions have grown since the Manhattan Project, but we continue to serve in the nation's defense. The Y-12 National Security Complex is the Nation's Uranium Center of Excellence, a National Prototype Center and has missions to support: nuclear non-proliferation, Defense Programs nuclear weapons efforts, and provides the United States' Navy feedstock for nuclear reactors.

In order to protect nations around the world from nuclear terrorism, Y-12 participates in global threat reduction teams to bring enriched uranium from unsecure areas to the Y-12 site for storage in the HEUMF building. Y-12 also provides Alarm Response and Global Threat Reduction Training to tens of sites across the country.

Y-12's history can be easily traced from the beginning. It was created to protect basic human freedoms, and remains a site that protects that right to liberty.

The Y-12 History Center exists to convey the heritage of Y-12's history to visitors and employees. The recently completed and award winning *Nuclear Family* documentary mini-series produced for East Tennessee Public Broadcasting System is the most complete version of Y-12's history to date. The concluding scene in the documentary film is a remake of the original Ed Westcott image known as "Y-12 Shift Change." The modern version shown below includes Ed in the image and allowed him to enjoy participating in the event nearly 70 years after his original photograph.

Without Ed's many black and white images taken during the Manhattan Project, we would not be nearly as able to tell the history of Y-12. This brief history of Y-12 is dedicated to my friend, Ed Westcott, to whom I was privileged in January, 2014, to present with East Tennessee Economic Council's Muddy Boot award.

Much appreciation is given to Eve Whittenburg who, while working at Y-12 as a summer intern, created this document.

Ray Smith, Y-12 Historian
March 28, 2014

Y-12's New Shift Change photograph featuring Manhattan Project official photographer Ed Westcott (middle right)

Endnotes:

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