HOW OAK RIDGE HELPED IN WORLD WAR II[1]

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A Paper Prepared for Knoxville Audiences

Journalists at the turn of the century ranked the role of the Manhattan Project in the ending of WWII as the leading story of the 20th Century. Regrettably, that story is fast disappearing from the American history taught in schools. Few East Tennesseans today are even aware that the largest part of the Manhattan Project was carried on there and that the nationwide $2.2 billion project ($26B in 2008) was administered from the "Secret City" that sprang up un-announced and un-welcomed in Knoxville's backyard. Nor do many realize that the infusion of scientists, engineers and other professionals from university towns and big cities from the Atlantic to the Pacific who came in answer to their country's call, many of whom afterward settled here, has been a major factor in changing the face of the region into the Knoxville-Oak Ridge science corridor it is today.

This history began back in the midst of WWII, in the fall of 1942. Back then, Allied soldiers were fighting for their lives and ours in North Africa, Italy, and across the Pacific. Like us, Knoxvillians were totally involved in supporting the war effort. TVA was hard at work building a dozen hydroelectric dams to supply power for nearby Alcoa plants whose aluminum production was crucially needed for bombers and fighter planes. The Rohm and Haas Company was supplying the vital plastic nose cones and gun turret "bubbles" for big bombers. The Coster Shops were providing vital services to keep the nation's essential railroads running. Knoxville knitting mills were turning out thousands of uniforms and other gear for the armed forces. Everyone worked overtime on Saturdays for the war effort, so the big stores and the S&W Cafeteria and other places we loved to eat on Gay Street (to get away from our Army Cafeterias), stayed open till 9 PM Monday nights for all of us to go shopping. All of us read the war news every morning in the Knoxville Journal, every night in the Knoxville News-Sentinel.[i]

I. Mission

Well, why did Oak Ridge spring up in Roane and Anderson Counties of East Tennessee? It came about because shortly after the beginning of WWII, President Roosevelt became convinced it was crucial for this country to be the first to make an atomic bomb if one could be made at all. Albert Einstein told him

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the Germans were trying to do it, we had great respect for their scientists, and Roosevelt knew Hitler would not hesitate to use such a weapon against Britain, so he authorized research programs in a half dozen universities to look at the possibility. Then six months after Pearl Harbor, Roosevelt was told by the National Academy of Science that it might be done with a huge effort, so he ordered all the research efforts to be combined and the Army Engineers to lead the effort but keep it all very secret. The Army District engineer's office put in charge happened to be in downtown New York City, hence the code name the "Manhattan Project."

After looking all over the country for a site of about 60,000 acres, in September 1942 they settled on this particular East Tennessee area, which all through the war was known by the simple code name "Clinton Engineer Works" (CEW) after the closest town. The site met all their criteria: it was sparsely settled (fewer than 1,000 families had to be moved out), it had TVA power from Norris Dam, good cooling water from the Clinch river, it was close to a good labor supply in Knoxville, it had two good railroads (the Southern and the Louisville & Nashville); and East Tennessee's unique parallel ridge and valley geology meant they could put the three plants and the town each in their own valley so if anything untoward happened to any one of them it wouldn't demolish the others. The risks were unknown, but real.

So six months later, in the summer of 1943, the Army engineers and their construction contractors were swarming over this CEW area, turning farmland into a new city, which in two years grew to 75,000 people, the 5th largest in the State, with the 9th largest bus system in the U.S., bringing in at the peak some 20,000 commuters every day from as far away as Chattanooga. But their purpose and what they were making or doing was a deep dark secret. Even Knoxville's major domo Cas Walker couldn't fathom it, and the town of Oak Ridge did not appear on any maps.

Because in most of the popular documentaries about the Manhattan Project, the exciting focus is on the bombs made at Los Alamos, it is not often appreciated that Oak Ridge represented the largest investment of the Manhattan Project. Sixty cents out of every Manhattan Project dollar were spent in Oak Ridge. Twenty-one cents were spent on the huge plutonium production plants out in Washington state at Hanford, and four cents on the vital programs at Los Alamos, NM where they discovered how to theoretically and then actually make the atomic bombs. That 60% was $1.1 billion dollars, in today's dollars it would be over $14 billion! And the entire project was administered from Oak Ridge; the top Army official here reporting directly to Brigadier General Leslie R. Groves in Washington was Colonel

Kenneth D. Nichols who served as the Chief Operating Officer of the Manhattan Project's 125,000 people. In 1943 he was 35 years old.

Just what *was* Oak Ridge's role? Our very secret mission was uranium enrichment – separating the two forms of uranium with slightly different weights that occur in nature. Back in 1939, the same year Hitler started WWII by invading Poland, physicists began looking into the possibility that an atomic bomb of awesome power might be built if someone could just figure out a way to produce a hundred or so pounds of nearly pure U-235, the slightly lighter of the two forms of uranium that exists in nature. The heavier form is U-238. There is very little difference in weight. If the uranium atoms were two identical basketballs, one might illustrate the difference by taping a five-cent piece on one ball to make it the heavier form. The two forms are called isotopes. They can't be separated using chemical processes such as are used to separate iron from iron ore; isotopes behave identically in all chemical reactions. You have to take advantage of that trivial 1.3% difference in weight, and if that isn't hard enough, the desired U-235 is quite rare. In every 1000 pounds of uranium mined from the ground, there are only seven pounds of U-235 intimately mixed with 993 pounds of U-238. You can't make a bomb from it directly.

II. Approach to Mission

Breaking ground for Oak Ridge's first U-235 separation plant code named Y-12, took place in February 1943, and its first unit successfully ran January 27, 1944. That $500 million hi- tech plant in today' dollars would cost about $5 billion – built in what today would be an impossible 11 months to first successful equipment startup. In that war things moved fast. This first-of-its-kind gamble employed 1,152 just invented, big physics machines called Calutrons that produced separation when the uranium isotope mixture was driven through a very strong electro-magnetic field. Most of those electromagnets were huge, eight feet tall. Copper for their windings was in very short supply, so Y-12 borrowed silver from the U.S.Treasury to use instead of copper. They borrowed 13,500 tons of silver then worth more than $300 million to make the magnets, and after the war stripped it carefully out and sent it back to the Treasury. The magnetic field was so strong it would jerk an ordinary crescent wrench right out of your hand if you walked within a few feet of the machines, and it would wreck the mainspring in your watch. It took an enormous staff to run this amazing plant, 22,400 at its peak.

But because Y-12, barely out of the laboratory, was far from being a sure-fire process, the Army decided they better have a backup for that big gamble. They chose to build another huge plant they called K-25 which employed a very different technology called gaseous diffusion. The gigantic K-25 Plant required

a “U” shaped building, 400 feet wide, a mile long, and 44 acres under roof. It was the largest and most costly of the entire nation-wide Manhattan Project, jammed full of pipes, pumps, and separation tanks. The contractor couldn’t believe the Army’s specifications - miles of steel piping all nickel plated and clean inside (even no fingerprints), all as vacuum-tight as a thermos bottle. Like all the other wartime facilities, it was built in a hurry. The first uranium gas was put in the plant in January 1945, eighteen months from ground breaking, less than seven months before war’s end. So close to the end of the war, K-25 with its peak of 11,000 workers contributed only in a small though significant way to helping Y-12 with the U-235 needed for the first atomic bomb. But the K-25 process was so much less expensive that the WWII Y-12 plant was completely shut down a year after the war ended (end of 1946). Y-12’s workforce dropped in one year from a peak of 22,400 to 2,200 at the end of 1946, and this caused the decline of Oak Ridge’s population of 75,000 to 30,000 in 1950; a little below which it has remained for the 50 years since. In the summer of 1947, Y-12 was given a new mission to be a key part of the nation’s nuclear defense system, which it has superbly discharged for the past half century.

Though almost all of Oak Ridge’s effort was spent on producing the U-235 for the first atomic bomb, we do have a tie with the second plutonium bomb. That tie is through Oak Ridge’s Graphite Reactor, the world’s first nuclear reactor designed to produce plutonium that was started up in November 1943. Its purpose was to make small amounts of the element plutonium so that chemists could find ways to process it when they got the production reactors running at Hanford. Plutonium does not occur in nature any longer, and must be made in a nuclear reactor. In contrast to Oak Ridge’s uranium enriching (isotope separation) efforts that involved a peak of 36,000 workers, the Graphite Reactor efforts only involved 1,500, but out of its small roots evolved Oak Ridge’s world-renowned research institution of today, the pre-eminent Oak Ridge National Laboratory.

III. Life After Mission

What was life like after work? Back in WWII Oak Ridge looked entirely different than it does now. Today the very green tree and grass filled city of 27,000 is a sleepy little town compared to the bustling city of 75,000 that it was during the war when it was filled with construction almost 24 hours a day. The city looked then just like what it was – a big, brand new army installation, built on rural cornfields and pastures to do a particular job, never intended to last much past the war. The army engineers built fences, 300 miles of roads, nearly 10,000 various kinds of homes for families; 90 two story dormitories for 13,000 singles, 16,000 hutments and barracks spaces for construction workers, 9 neighborhood schools, a full service hospital, a dozen neighborhood shopping centers, and almost everything the eclectic population might want except for liquor stores. Knox, Anderson, and Roane Counties then had

"bone-dry" liquor laws, and that naturally tested the ingenuity of us residents on finding it and getting it past the well-aware guards posted at the entrance gates. To make up for this "loss," residents were treated to something they never had back in the universities and big cities they had left, namely seas of sticky, slippery mud on the streets whenever it rained.

Knoxvillians looked askance at their new wartime neighbors in 1943, who by their weird accents, and refusal to stop and chat about their town, did nothing to endear themselves to sociable southerners. Quite the contrary. Though we came from all over the U. S., to our neighboring long-time Knoxvillians we were all just "damn Yankees" who every Monday night came to town with their muddy shoes, dirtied up their fine Gay Street stores, and bought up everything that was in short supply anyway. And they kept what they were doing out there behind the gates a deep dark secret. If a sociable Knoxvillian asked one of those foreigners politely what they were doing, they got some crazy answer, like, "Oh, we're just building a bunch of homes for all the Army and Navy officers to come retire in after the war." Or, "We're just making luggage for that globe trotting Eleanor and fourth term campaign buttons for FDR." One worker said, "Shoot, I don't mind telling you what I'm making out there– it's 78¢/hour." A native maintenance man at Y-12 said, "Well, I'll jes be honest with you; I don't know what they'se makin' out there, but I'll tell you this much – the govmint could sure as hell go buy it somm'ers else a whole lot cheaper!"

And even though the Army engineers had experience in buying properties in other states for many TNT plants and Army bases, they managed to make a lot of folks in East Tennessee mad. First were the 1,000 families evicted from their homes and farms. Some of these same people had been evicted by TVA a decade before. They complained about getting far less that their land was worth (the average paid was $44/acre), and given too little time to get out (sometimes as little as two weeks), and their complaints finally resulted in a Congressional Committee hearing held in Clinton.

Top-level politics were no better. The Army made a real faux pas in the way they notified Governor Prentiss Cooper that his state had been "selected" for the honor of turning 59,000 acres of land over to the Federal government for the war effort. General Groves had a formal Proclamation signed by President Roosevelt, and sent copies down here for delivery to the Governor. But somehow, in all the haste, a young, inexperienced Captain was given the job of taking it to Nashville. He finally got in to see Governor Cooper, who because of tight security had never heard a peep about the matter. He hit the ceiling, protesting that it was a serious breach of protocol that this large installation was being placed in this sovereign state without his being consulted; and furthermore Washington had sent a junior rank

officer, not the Commander, to inform him. He tore the Proclamation in two, threw it in the waste basket and threw the Captain out of his office.[ii] Colonel Nichols dropped everything and went to Nashville to patch matters up by inviting the Governor to come for a visit of the Site and a personal reception. The tour, though not inside any plant area, the party with local dignitaries, and the assurances of its wartime importance (no hint as to the mission) all restored the peace. But General Groves in his account says, "We got off to a most inauspicious start with our new neighbors, and the ensuing resentment plagued us for several years."

V. Mission Success. Yes, but Why Was It So Successful?

In the early spring of 1945, Y-12 was finally operating smoothly as everyone had hoped, and by late June or early July, had finally sent enough pure U-235 to Los Alamos where the bombs were made to fuel the first bomb, code named "Little Boy." The last U-235 parts were finished in July and shipped out to Tinian Island in the Pacific, where the waiting Los Alamos team (Project Alberta) assembled the first atomic bomb by August 1st, and turned it over to Colonel Paul Tibbets and his 509th Composite Group waiting there with their special Silverplate Editions of B-29 bombers. The August 1 readiness date met General Groves' almost impossible target – 2.5 years from ground breaking to production using new technologies and, brand new science feats never before attempted. Oak Ridge's role was the furnishing of the rare U-235 fuel for that first atomic weapon.

I've often been asked why the Manhattan project was so successful. I can offer a half dozen reasons, but the most important reason so much got done so fast was that everyone from General Groves on down to the operators had one common purpose – to do whatever they could seven days a week to help end that terrible war. Nobody ordered us to work extra long and extra hard; we instilled that in ourselves by reading the papers each day and hearing on the radio every night of the atrocities and the killing of our boys and our allies in North Africa, on the beaches in Normandy, on the infamous Bataan Death march in the Philippines, and on islands in the Pacific whose names we had never heard before, and now can never forget. This is what is so hard to get across to the next generations. I've had a hard time describing it to my own children – that patriotism that made you work so hard, keep secrets, put up with the shortages, and live with rules you often did not understand. Everyone did it "to help win the war."

Our country glimpsed a kindred spirit in a few weeks following the horrific attacks of September 11, 2001 – an outpouring of that patriotic feeling: "What can I do to help?" But during WWII we read about awful horrors somewhere week after week for six long years (1939 to 1945). A million American

boys were killed or wounded in the three years and nine months this Nation was at war. I lost my best boyhood friend piloting a bomber over Germany; almost everyone you worked with knew someone who had lost family members.

So then, how did we here in Oak Ridge react to those two atomic bombings that marked the success of the Manhattan Project? Well, with the same incredible surprise and relief of the rest of the country. Nobody I knew felt any glory in the deaths of the 100,000 Japanese at Hiroshima any more than we gloried in the deaths of about that same number in the fire-bombing of Tokyo a few months before on the night of March 9/10th—a bombing that burned out 16 square miles of Tokyo, 4 times the area burned out at Hiroshima. [iii] Incendiary bombings had already burned out 60 other Japanese cities, and these two were slated for a similar fate. People looking for answers of Hiroshima and Nagasaki should look not into the ashes of those cities but into the all the graves from Dresden, Germany and Normandy in Europe to Bataan and Iwo Jima in the Pacific. No, what Oak Ridgers did take pride in was that the shock of the Manhattan Project's success finally caused their reluctant Emperor to stand up to his die-hard militarists and insist on ending the war they started. And that pride in the success of our efforts turned to exuberant joy a week later when we awoke the morning of August 14th to see the morning paper. That Knoxville Journal's front page was printed on red paper and carried an 8-inch tall banner headline: P E A C E. The blessed peace all of us had worked and prayed so long for was at last a reality. Even Knoxville was finally proud of their strange new neighbor.

The end of the war was the end of an era for both cities. Both began to change. For Oak Ridge, the first very public step toward normalcy was the opening of the gates to the city in 1949 so Knoxvillians and everyone else could finally come see what it was like. The gates opened despite the vote in a Town Meeting called to discuss the matter where 200 townspeople voted 4 to 1 against opening the gates. [iv] Another big step came 8 years later in 1957 when Congress passed legislation allowing the sale of the homes to the residents. In 1959, the town voted 14:1 to incorporate and we received all the deeds on July 1, 1960.

In one aspect we did not change from the wartime mold. The thousands of young professionals from all over the U.S. had brought with them a pot-pourri of cultural and educational interests. And before Oak Ridge was a year old, citizens had started up a volunteer Symphony Orchestra, a volunteer theater (The Playhouse), and dozens of social and civic clubs reflecting hobbies and interests from their homes far away. These interests of course survived the war and have proved to be the basis for many bonds between the two communities through the years; Ridgers became enthusiastic supporters and

participants in all of Knoxville's musical and cultural activities. Many took advanced degrees at UTK, and many have served on its faculty.

Shortly after the war, Oak Ridge led the way in making peaceful applications of atomic science; using Y-12 Calutrons and X-10's Graphite Reactor to produce radioactive and stable isotopes that have brought great benefits in medicine, agriculture, and industry to people all over the world. And ORINS, the forerunner of the present day ORAU, was founded in 1946 by a consortium of southern universities to enable students and faculty to participate in nuclear research here. Then in the 1950s and 1960s Oak Ridge again led the way in giving to the world nuclear research reactors and nuclear power plants whose clean electric power - though not yet widely accepted by the public in this country - has been welcomed and so beneficial to many countries of the world including Japan, our wartime enemy, but now good friend. The many peaceful benefits of nuclear energy, together with the blessed freedom of the world from WWIII for well over half a century, – these are rich legacies of the Manhattan Project in which Oak Ridge played such a vital and successful role.

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[i] The author especially treasures one edition of the News-Sentinel kept through the years that has its cover page printed on the red paper reserved for momentous news. This edition announced the long awaited D-Day invasion of France, June 6, 1944 and carried the banner headline "FRANCE INVADED". In the excitement of that day and rush to get out the paper, no one caught its garbled masthead that reads, "The Knoxs-Sentinelville New."

[ii] City Behind a Fence, page 49.

[iii] 140,000 were killed or seriously wounded by the firestorm caused by 334 B-29s from Tinian each carrying six tons of incendiaries. 1,000,000 were wounded. 16 sq. miles of the city were burned out on the night of March 9/10, 1945. In February the British and Americans fire-bombed Dresden, Germany with as many casualties. *Tibbets, Return of the Enola Gay, page 195. Rhodes, The Making of the Atomic Bomb, page 593 and 597-600.*

[iv] City Behind a Fence, page 204.