Meet Kenneth D. Nichols, the Father of Oak Ridge - Production Facilities, Part 2 (1942-1945): K-25

(As published in The Oak Ridger's Historically Speaking column the week of April 7, 2025)

Barbara Scollin, grandniece of Major General Kenneth D. Nichols continues her series on his life.

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Ample reasons, most notably leadership skills, personality traits and qualifications, led to choosing General (then Colonel) Kenneth D. Nichols as Deputy District Engineer and subsequently as District Engineer of the Manhattan Engineer District (MED). In this capacity he had supervision of the research and development connected with, and the design, construction and operation of all plants required to produce plutonium-239 and uranium-235, including the construction of the towns of Oak Ridge, Tennessee, and Richland, Washington.

The responsibility of his position was massive as he oversaw a workforce of both military and civilian personnel of approximately 125,000; his Oak Ridge office became the center of the wartime atomic energy's activities. He also was responsible for internal security operations in the production facilities that helped keep the development of the atomic bomb secret.

In this thirteenth installment of several articles covering the life and accomplishments of Kenneth D. Nichols, we learn why the Manhattan Project's biggest secret was K-25.

Colonel Kenneth Nichols wanted to be an engineer in his teens. His passion drove him to graduate first in his Class of Engineering and fifth in his overall class of 1929 at West Point so he could choose the Corps of Engineering branch of service (see 1st article).

His Ph.D. in hydraulic engineering and years of teaching engineering at West Point further laid the foundation for his responsibility to design, construct and operate the Oak Ridge and Hanford production facilities (see 4th article). He was a doer. The next two years of his career would amply use his talents and energy to orchestrate the biggest construction project in the history of the world at the time.

Unlike the Y-12 Electromagnetic Separation Plant, the K-25 Gaseous Diffusion Plant for separating isotope U-235 from U-238 was "far more difficult to organize, coordinate, and expedite" remembered Nichols. Theoretically the gaseous diffusion principal worked but was untested outside the laboratory.

Nichols explains, "Uranium hexafluoride gas would be pumped through a bundle of porous tubes contained within a tank called a converter or filter. Passing along the length of the tubes, approximately half the gas would diffuse through the porous wall of tubes; the other half would flow out the end of the tubes. Due to the difference in molecular weight of U-235 and U-238, the part of the gas that diffused through the porous walls of the tubes would contain a slightly higher percentage of U-235 than the gas that flowed through the tubes. …The process would consist of thousands of stages. …

"A production plant would consist of miles of barrier tubes; miles of interconnecting pipes; thousands of large converters confining the tubes in each stage; thousands of motors, pumps, and pump seals; and instrumentation piping and instruments to control pressure and volume of flow throughout the plant. The entire system had to be leakproof to a degree never before achieved by such a large system involving flowing gas. The statement was frequently made that the leakage into the entire process could not exceed the equivalent of one pinhole. If air leaked into the system it would react with the uranium hexafluoride, and the barriers would become plugged and useless."

The almost insurmountable problem with the K-25 plant was the barrier. Nichols explains,
"The main problems to be solved involved expert metallurgical, chemical and mechanical engineering as well as scientific research. The hardest problem was developing and producing a suitable barrier material.

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Everything depended upon the separation and enrichment rate of the barrier. … To proceed with the plant without good prospects for a suitable barrier involved the biggest gamble in the whole Manhattan Project. [Brig General] Groves persistently stuck by the decision to proceed with the plant… that took guts."

Nichols first met Dr. Harold C. Urey, head of the gaseous diffusion as well as heavy water projects on the S-1 committee, at a S-1 meeting in June 1942. Nichols' first impression of Urey was that "he would be difficult" and that proved to be true. Confusion at subsequent S-1 meetings on who would be the scientific leader of the K-25 plant created delays.

Eventually, Nichols' discussions with Columbia University and Urey led to Urey designated as the Research Director and Dobie (Percival C.) Keith, vice president of Kellogg Co., responsible for R&D work to ensure success of the gaseous diffusion process. Groves and Conant approved.

Initially Urey was active in addressing the barrier problems but gradually lost confidence in the prospects of success. Nichols recalls this led to Urey, "[writing] a letter to Groves that in effect recommended abandoning the entire gaseous diffusion effort or basing the project on the British design and technology.

"Groves obviously was upset when he showed me the correspondence. …It was the type of letter that could be used to crucify Groves if he continued the project, disregarding the advice of his top scientists, and we failed. We had to do something. It would be a tough decision."

Meeting with the 'British team' did not resolve the barrier problem. Nichols recalls disappointment with the lack of British support and that Groves and Nichols' "necks were way out and we had to succeed". By January 1944 Groves and Nichols decided Urey had to go to be replaced with Lauchlin M. Currie from National Carbon to handle all research on the K-25 process except the barrier. Keith and Hugh Taylor, chairman of the department of chemistry at Princeton, would be responsible for the barrier. Keith organized a new company, Kellex as a subsidiary of Kellogg, to handle the barrier issues.

Pushing construction of the gaseous diffusion plant "on faith" was quite a risk. Nichols said, "It was obvious that if we failed, the whole U-235 project would have no chance of producing enough U-235 for a weapon until sometime late in 1946. If we succeeded, our date of August 1945 would be attainable."

By May 1944 no suitable barrier yet existed. Nevertheless, Nichols proceeded with what could be done at the Clinton Engineer Works (CEW). He recalls, "Construction of the entire K-25 project at CEW was 45% complete, the electric power plant 86% finished, the conditioning plant 87% complete and the main plant 37% finished, but no barrier material." Cost estimates for K-25 reached $281M (approximately $5B in 2025) before it was known whether or not it would succeed.

As production activities were mainly focused on Oak Ridge, Nichols' time was spent coordinating the work of many contractors. Nichols and Groves consulted from time to time with Lyman Bliss, a Union Carbide vice president, about the K-25 project. When Nichols shared with Bliss that he was devoting about 80% of his time with the K-25 contractors, Bliss said, "the only mistake you are making is that you are not spending 100% of your time on it. If the gaseous diffusion plant doesn't produce soon, the entire CEW project will be a failure."

New processes and procedures were developed. Nichols recalls, "A new level of quality control for cleanliness had to be maintained. Special welding classes had to be conducted to train welders to meet these new high standards. Leak detectors needed to be developed, and men trained to operate them. Kellex did an amazing job of setting the specifications and standards, and we had to take unusual measures to ensure compliance."

Finally, by year-end 1944, acceptable barrier tubes were manufactured and installed. Nichols recalls, "Dunning was good on solving his end of the problems. But on the barrier, it took Carbide getting into it

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and Bell Telephone Labs and finally a young fellow in [Dobie] Keith's Kellex Laboratory came up with the answer."

Gradually increments of K-25 went online upon completion and testing with almost full operation by April 1945.

The civilian and military persons involved in K-25 during the war peaked at 19,680. The amazing efforts of Kellex, J.A. Jones Construction and other critical companies are too numerous to mention here. General Nichols provides a detailed account of the problems and successes involved with K-25 in his book T*he Road to Trinity, A Personal Account of How America's Nuclear Policies Were Made* (New York: William Morrow and Company, Inc., 1987. ISBN 0-688-06910-X. OCLC 15223648) as did William J. Wilcox Jr. in his *book K-25, A Brief History of The Manhattan Project's "Biggest" Secret* (Oak Ridge TN, January 1, 2017 ISBN OCLC104123336). Please take the time to read these two must have books and others written on this amazing story.

One of the other critical companies was Chrysler who manufactured the converters used in the gaseous diffusion units. K.T. Keller, president of Chrysler, initially had problems agreeing to certain MED contract provisions but terms were resolved.

Nichols recalled, "It was about a $60M project. . . .We had no idea what it would cost. [Keller] said, 'I can estimate that it would cost the same per pound of material as an automobile does. That would be $60M. You can audit it, and we'll audit it, and we can agree on overhead figures, and I will give you any unused money back when we finish the project.'

He called me one day, he'd finished auditing first, because he had to bill us. He said, 'Nichols, I saved $20M. What should I do with the money?' I said, 'Send me the check.' And he always commented about that: That was the first time anybody had given him a direct answer so fast. . . .I figured if he had the $20M he wanted to get rid of, let's take it."

K-25 set records in every way – covering 44 acres (2 million square feet) with four floors it was the largest building in the world at that time. The "U" shaped plant was the most advanced, most fully instrumented of its time. The single most expensive gamble of the Manhattan Project, K-25 cost a total of $512M (approximately $9.2B in 2025). The barrier material was an enormous technical challenge and is still considered top secret. Without the determination of General Groves, Colonel Nichols, Dobie Keith, John Dunning and a host of others, it would not have succeeded.

Thank you to everyone involved with K-25 and their families for their critical work and sacrifices during the war.

Next up: Production Facilities, Part 3 (1942-1945): X-10 & HEW

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Thanks to Barbara Rogers Scollin, grandniece of General Kenneth D. Nichols, for writing this Historically Speaking column and series. She has captured the perception of then Colonel Nichols as he was in the thick of it and very much engaged in the success or potential failure of the Manhattan Project.

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Military review on Blankenship Field, Capt. Salvatore Latona receives a metal. Lt. Francis Kratch and Capt. Taylor Womack, left, also received metals from Col. Kenneth D. Nichols, Oak Ridge TN, June 17, 1944. Photo by Ed Westcott. (Courtesy Emily [Westcott] and Don Hunnicutt)

K-25 Gaseous Diffusion Plant, Clinton Engineer Works, Oak Ridge TN. Covering 44 acres, K-25 was the largest building in the world in 1945. (Public domain courtesy of Barbara Scollin)

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K-25 Gaseous Diffusion Plant, Clinton Engineer Works, Oak Ridge TN. An operator on bicycle tours the K-25 Operating Level, a mile in length around its "U". (Public domain Courtesy of Barbara Scollin)

K-25 Gaseous Diffusion Plant, Clinton Engineer Works, Oak Ridge TN The Control Room was the most advanced, most fully instrumented plant of its time. (Public domain Courtesy of Barbara Scollin)