General Groves and Oak Ridge, by Robert S. Norris, Part 2

(As published in The Oak Ridger's Historically Speaking column the week of 10-5-2020)

Robert S. "Stan" Norris, author of *Racing for the Bomb*, has graciously agreed for us to publish his lecture created for the 2020 Secret City Festival. When he was unable work the event into his schedule or even to travel because of the COVID-19 crisis, he sent the content of his prepared lecture for us to use. What follows is part two of the content of his lecture.

***

K-25: The second enrichment process at Oak Ridge was the gaseous diffusion method based on research by the Nobel Prize winning scientist Harold Urey of Columbia University and his colleagues. As with his other atomic factories Groves recruited large industrial corporations to design, build, and operate what came to be known as K-25.

Designing K-25: To design K-25 Groves chose Percival C. (Dobie) Keith. Keith was a VP of the M.W. Kellogg Company and one of the top chemical engineers in the country. Keith, born in 1900, had grown up in Sharon, Texas and after college did three years of graduate work at MIT with a degree in chemical and electrical engineering.

As an executive with Kellogg he was already knowledgeable about the secret research on isotope separation and had been on the OSRD Planning Board, a forerunner of the S-1 Committee, for one year. He first met Groves in December 1942 and they got on well. Initially he refused the job but his former Professor W.K. Lewis of MIT told him to take it.

He demanded to be given complete responsibility and Groves gave it to him. A subsidiary of Kellogg, known as Kellex, was formed and eventually 3,000 personnel worked at headquarters, on three floors of the Woolworth Building in lower Manhattan, and elsewhere.

Building K-25: To build the plant Groves chose the J.A. Jones Company of Charlotte, NC. J.A. Jones had built more Army camps under Groves' supervision than any other contractor in America and Groves knew Edwin Lee Jones, the eldest son of James Addison Jones well.

The building was staggering in its scale, covering 43 acres. The main building resembled a squared-off letter U. Each side was 2,450 feet long and 400 feet wide, with the floor space approaching that of the Pentagon, another of Groves' construction projects that was completed in January 1943. The peak labor force to build it occurred in April 1944 at 19,680 with many of those housed in the temporary facilities at nearby Happy Valley.

Operating K-25: Groves recruited the Union Carbide & Carbon Corporation to operate K-25. Some of their affiliate companies were already involved in Manhattan Project activities. The company came highly recommended by Keith and DuPont. The key person was James A. Rafferty a chemical engineer by training and executive VP since 1939. He was a dynamo within the company, a leader in the new industry of deriving synthetics from petroleum.

Groves met Rafferty at the Union Carbide offices on the corner of 42 Street and Madison Avenue in New York City around Christmastime 1942. They liked each other immediately and Rafferty assembled a team that worked with Kellex and Jones as it was being designed and built so that it would be operating properly it when it was done. The total cost to build and operate K-25 was $512 million, which is approximately $10.7 billion in today's dollars.

Three Problems at K-25: Let us briefly look at three seemingly overwhelming problems that had to solved if the gaseous diffusion method was to work. These examples show the ingenuity that expressed itself over and over during the Manhattan Project.
The first was to find someone to design and manufacture large metal diffusers, containers in which the barrier material that would separate the isotopes would be placed. On March 20, 1943 K.T. Keller, the President of Chrysler was contacted and a meeting with Groves, Nichols, and Keith took place in Detroit on April 2nd.

General Groves and Oak Ridge, by Robert S. Norris, Part 2

(As published in The Oak Ridger's Historically Speaking column the week of 10-5-2020)

KT was quite a figure in his own right. Born dirt poor in 1885 he pulled himself up by his bootstraps and after working at General Motors for 14 years came to Chrysler. He was a tough character, knew everything about Chrysler and was made president in 1935. KT was briefed that several thousand of these diffusers would be needed and they had to be able to resist the highly corrosive uranium hexafluoride gas.

The only material that would resist the gas was nickel. Making them out of solid nickel was out of the question as it would have consumed the entire national supply. The logical solution was to plate steel with nickel. The attempts thus far had not worked as the gas ate through the plating. Chrysler was known for its plating innovations and KT accepted the challenge, and received a $75 million contract.

He gave the problem to Dr. Carl E. Heussner the Director of the plating laboratory and the problem was solved in less than two months by the end of May. Within Chrysler the secret project was known as X-100. To manufacture and plate the diffusers Chrysler converted a Dodge automobile plant (then making tank transmissions and truck parts) known as the Lynch Road factory in eastern Detroit. Absolute cleanliness standards were imposed. Chrysler would eventually deliver over 3,500 of diffusers to K-25.

The second problem had to do with designing and manufacturing compressor pumps to force the gas through the cascades at high velocity. The crucial problem was that the pumps needed to have seals that were leak proof. They had to be resistant to the corrosive gas and work without any lubricants which would contaminate the process. Groves went to Allis-Chalmers, of Milwaukee, WI which was already building the gigantic magnets for Y-12.

They were told to build a pump plant — and did so in 57 days beginning in April 1943 — but without the precise design for the pump, a typical Manhattan Project procedure. Dobie Keith recruited George Watts, the chief engineer of Standard Oil of Indiana, who was given primary responsibility and Groves called President Edward Seubert to have him released. The pump was actually invented by Judson Swearingen and Allis-Chalmers delivered 7,000 compressors to Oak Ridge on time.

The third problem was to design and produce a porous barrier or membrane that would allow the lighter U-235 atoms of the uranium hexafluoride gas to pass through but not the heavier U-238 ones and not be destroyed in the process. Much of the work was done at Columbia University.

The holes had to be tiny, one-ten thousandth of a millimeter, could not become clogged, and must be tough enough to withstand high pressures. The preliminary designs were thumb-sized while several million square feet of the material eventually would be needed. One promising candidate was the Norris-Adler barrier, but the design ran into problems at the Columbia pilot plant. The material was brittle and the holes got clogged.

A competing design was offered by Clarence Johnson, a Kellex engineer, with much help from others. Groves was faced with choosing which design would be used to produce on a mass scale. He initially chose the Norris-Adler design and hoped there would be improvements and a plant in Decatur, Illinois was being built to produce it.

But by January 1944 the design looked less promising. After an all night drive through Indiana and half of Illinois Groves arrived at the Decatur factory for a meeting. He announced his decision to the startled executives and ordered the almost finished plant stripped of the just-installed equipment and rebuilt to manufacture the Johnson-Kellex barrier material. By the summer of 1944 large quantities of the material were being shipped to the Lynch Road facility to be placed inside the diffusers and from there on to K-25.

General Groves and Oak Ridge, by Robert S. Norris, Part 2

(As published in The Oak Ridger's Historically Speaking column the week of 10-5-2020)

S-50: Groves later acknowledged that one of his mistakes was not to have explored the liquid thermal diffusion process earlier. This had to do in part with the fact that it was a Navy research program. Eventually in the spring of 1944 it was brought to his attention that, by enriching the uranium through thermal diffusion the resulting slightly enriched uranium could be used as feed for the other two processes.

Once convinced that linking the three enrichment processes together would speed things up Groves wasted no time in building S-50. He chose H.K. Ferguson, another company that he had had good experiences with and put one of his engineers, a Lt. Col. Mark Fox in charge. He told Fox that he wanted to begin operations in 120 days.

When Fox complained Groves said now he wanted the first product in 90 days. When Fox complained again Groves said that now he wanted it in 75 days. Fox shut up after that and got busy. On September 17, 1944, sixty-six days after ground had been broken, one-third of the plant was complete, enough to begin preliminary operations.

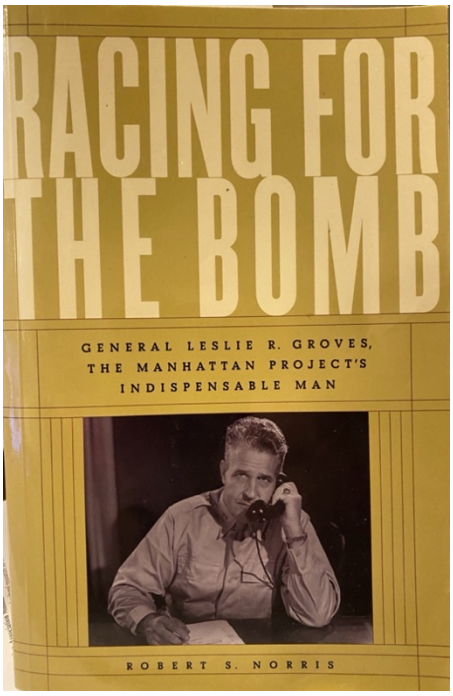
***

Thanks Stan, the insights into each of the facilities at the Clinton Engineer Works helps us appreciate General Groves' leadership and the importance of Oak Ridge to bringing that awful killing war to an end. Next Stan will tell us about General Groves as he visited Oak Ridge.

Robert S. "Stan" Norris, author of *Racing for the Bomb*

General Groves and Oak Ridge, by Robert S. Norris, Part 2

(As published in The Oak Ridger's Historically Speaking column the week of 10-5-2020)



Cover of the book: *Racing for the Bomb: General R. Groves, the Manhattan Project's indispensable man*

K-25 Gaseous Diffusion Building

General Groves and Oak Ridge, by Robert S. Norris, Part 2

(As published in The Oak Ridger's Historically Speaking column the week of 10-5-2020)

S-50 Thermal Diffusion Plant