

Births of nuclear navy & commercial nuclear power: ORNL's influence

(As published in The Oak Ridger's Historically Speaking column on September 26, 2016)

Carolyn Krause brings us a review of one of the more significant scientific advances to come from Oak Ridge. The U.S. Navy has a lasting connection with Oak Ridge because of this Hyman Rickover historical interface with the Oak Ridge National Laboratory about which Carolyn is reporting here, but also because the nuclear fuel for their reactors has always originated from Oak Ridge. First, the enriched uranium came from the K-25 Gaseous Diffusion Plant and now continues to be provided by the Y-12 National Security Complex since 2002. And of course there is the Sea Wolf propulsor that was manufactured at Y-12.

Here is Carolyn's reflection on how it all began:

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Hundreds of American nuclear reactors have operated in the world's oceans and never had a nuclear accident, according to "Rickover: The Birth of Nuclear Power," a PBS video aired in December 2014. The video claims this success "is the greatest contribution that Admiral (Hyman) Rickover has made to his country."

Rickover was a Polish Jew who came to the U.S. and trained to be an electrical engineer for the U.S. Navy's Bureau of Ships. Several people who knew Rickover describe him in the film as a "flamboyant maverick," "a genius and SOB" and "the greatest engineer who ever lived on Earth." In an interview, "the father of the nuclear navy" said, "My job was not to work within the system. My job was to get things done and make this country strong."

According to Wikipedia, by 2003 the U.S. Navy had accumulated more than 5,400 reactor years of accident-free experience and operated more than 80 nuclear-powered ships," which included aircraft carriers and submarines. The Russians lack this excellent safety record. A number of their nuclear submarines have had loss-of-coolant accidents, and four Soviet nuclear submarines accidentally sank with nuclear weapons on board and remain on the seafloor to this day.

American submarines used to surface often to run their diesel engines and charge their batteries. Powered by small nuclear reactors, they became true submersibles and could stay underwater indefinitely until the crew's endurance and supplies ran out.

Rickover's success was not achieved in a vacuum. Just as it takes a village to raise a child, it took Oak Ridge's influence to give Rickover and a few naval officers the information they needed. Once Rickover figured out how to hurdle bureaucratic roadblocks, he and his colleagues were able to chart a path to today's all-nuclear submarine force (with nuclear missiles aboard) and commercial nuclear power plants.

In his 1994 book "The First Nuclear Era: The Life and Times of a Technological Fixer," the late Alvin M. Weinberg, former director of Oak Ridge National Laboratory, wrote about his indirect influence on Rickover. He noted that when Rickover and his naval officers had come to Oak Ridge in 1946 to learn about nuclear reactor technology and try "to launch a project to build a nuclear-powered submarine," a coolant had not yet been selected. A reactor coolant is a liquid or gas that removes heat from the nuclear core to prevent dangerous overheating and to produce steam for generating electricity.

According to Weinberg, Rickover favored high-temperature sodium as a coolant, possibly because he knew that General Electric was experimenting with it.

"Though I was not part of Rickover's team," Weinberg wrote, "I was in fairly close touch with his people, and I naturally called to their attention the ideas we had developed on the use of pressurized water as a coolant. For a submarine reactor, pressurized water had two main advantages: first, a reactor based on it would be small enough to fit comfortably in a submarine, and second, water, unlike sodium, was something the Navy ought to know about; it was less exotic than sodium."

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Rickover's initial objection to water was that its use limited the steam temperature, lowering the reactor's thermal efficiency. But Weinberg's arguments impressed Rickover's assistants, especially Lieutenant Commander Eli Roth. They saw that the simplicity of a pressurized-water power plant outweighed its lower thermal efficiency. Roth convinced Rickover of the merits of pressurized water for powering a submarine.

"Thus was born the pressurized-water reactor – not as a commercial power plant, and not because it was cheap or inherently safer than other reactors, but rather because it was compact and simple and lent itself to naval propulsion," Weinberg wrote. "But once pressurized water was developed by the Navy, this system achieved dominance for central station power."

According to his 2002 book "The Rickover Effect: How One Man Made a Difference," former ORNL nuclear engineer Ted Rockwell stated that Rickover's shift to favoring pressurized water as a coolant occurred about the same time that ORNL's work on the Daniels pile (gas-cooled power reactor prototype) was foundering.

Rickover met with Weinberg and Harold Etherington, who worked on the Daniels Pile, and asked if they would be interested in dropping this project and spending the remaining funds on developing a submarine reactor plant. "Surprisingly, the ORNL folks were willing to shift their focus," Rockwell wrote, noting that the Atomic Energy Commission did not find out about this diversion of funding until later and then agreed with the money transfer.

Weinberg wrote that it was "natural for Harold Etherington's Daniels Pile team to be redirected to Rickover's reactor. And, before the entire team left for Argonne, where the reactor was actually developed, Etherington had sketched out the general layout of the power plant."

Weinberg continued, "I have always believed that Harold Etherington and Sam Untermyer have never been adequately recognized for their contributions to the Nautilus power plant. Could it be that Rickover disliked sharing credit with those who did the technical work and who had a much more sophisticated grasp of the technology than he himself possessed?"

The Nautilus was the world's first nuclear submarine. It astonished the world on Aug. 12, 1958, by surfacing off Portland, England, after sailing submerged from Pearl Harbor via the North Pole.

Weinberg considered Rickover "as nifty as anyone I have ever met," as demonstrated "a few years later, when he decided to build the Nautilus prototype in Idaho Falls without first building a much cheaper pilot model of a pressurized-water reactor."

Weinberg also wrote, "Rick would have none of my conservatism. To interpose a small experiment to test the nuclear behavior of the Nautilus would add at least a year to his schedule: for him it was full speed ahead, first with the Nautilus prototype and then with the Nautilus itself. In retrospect I have always admired Rick's courage as illustrated by this decision, though I did not like his autocratic methods."

For his 1953 "Atoms for Peace" initiative, President Dwight D. Eisenhower gave a speech that called for global powers to stockpile uranium for use in generating power rather than making nuclear weapons. Responding to Ike's speech, the AEC turned to Admiral Rickover, head of the AEC's Naval Reactors Branch, and asked him to apply the successful experimental reactor design from naval research to the atomic power plant that Duquesne Light Company had won the bid to build in Shippingport, Pa.

In 1959 Rockwell (who appears in the 2014 Rickover video) presented a Congressional Gold Medal to Vice Admiral Hyman G. Rickover, U.S. Navy, "in recognition of his achievements in successfully directing the development and construction of the world's first nuclear-powered ships and the first large-scale

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nuclear power reactor devoted exclusively to production of electricity." Wonder if Rickover remembered to thank Oak Ridge?

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Thanks Carolyn for another look into Oak Ridge history and pointing out the substantial use of nuclear power in U.S Navy ships and submarines which have had a huge impact on the nation's ability to maintain a strong naval presence in the world.



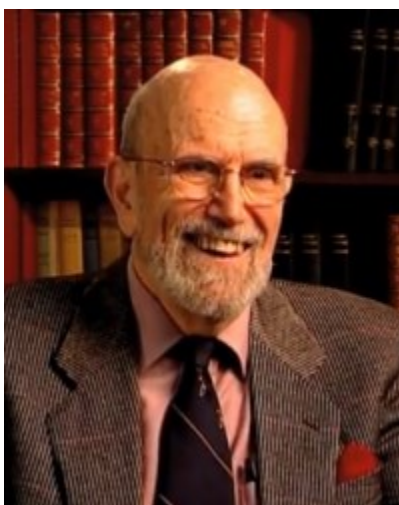
Alvin Weinberg

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Hyman Rickover inspecting the Nautilus submarine



Ted Rockwell (photo from Atomic Heritage Foundation's Voices of the Manhattan Project Oral History, used with permission)