The long shadow of Admiral Hyman Rickover

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This is the sixth in a series of articles being published in Energize tracing the history of nuclear energy throughout the world.

"When the civiian Atomic Energy Commission (AEC) assumed its stewardship of the national atomic energy program in 1947 (in the USA), it was faced with the problem of deciding what avenues of power-reactor development to pursue". [Hogerton, 1968: 21]

Today, the pressurised water reactor (PWR) is practically the industry standard for nuclear power plants worldwide. All nuclear-powered submarines and surface ships use this type of reactor, and most 'new' (that is, installed since the early 1960s and still operating) large nuclear power stations are powered by nuclear reactors that are cooled and moderated by water (i.e. PWR reactors and boiling water reactors (BWRs)).

Why should this be so? The answer is largely through the vision, competence and enormous influence of one man, Admiral Hyman Rickover of the United States Navy. Rickover is no longer with us, having died in 1986 after 63 years of active duty (he was 82 when he retired with the rank of admiral).

The man who oversaw the construction of the world's first nuclear submarine (and the first nuclear power station in the USA), the expansion of the American nuclear navy and the rise of nuclear power stations in the USA, was not American, but an immigrant from what is now Poland, but was then part of Russia. Rickover emigrated with his family in 1905 and was brought up in Chicago.

Admiral Hyman G Rickover, architect of the US nuclear navy, in a hatch of the "Nautilus", the world's first nuclear-powered submarine. (Photo: US Navy Submarine Force Museum).

To understand how the PWR developed the way it has, one must first follow Rickover's remarkable career. Like the early developments of nuclear energy in the United Kingdom (see next article "From Montebello to Magnox Reactor and beyond"), it was military priorities that determined which type of nuclear reactor was to be developed, particularly the race to build the world's first nuclear- powered submarine.

A submarine perspective

"Submarine duty (then in the 1930s) was dirty and hazardous. The air was foul. A lurking danger was an explosion of hydrogen released by faulty batteries." [Wicks, 2004:3]

When Hyman Rickover graduated in 1922 after studying engineering at the US Naval Academy in Annapolis, the painful memories of the First World War were still raw. But the powerful role played by submarines in the conflict, where German U-boat submarines had nearly succeeded in cutting Allied supply lines across the Atlantic, were still fresh in many minds, including Rickover's.

Rickover soon became interested in submarines. In his postgraduate training at Cornell University, he studied electrical engineering, focusing on what was then the only type of submarine - those powered by diesel-electric engines.

He soon learned the limitations of this type of power generation at first hand. While serving on a submarine, a fire started in the battery room. Putting on a gas mask, he managed to smother the fire. Hydrogen released by faulty batteries could all too easily lead to explosions, something Rickover was constantly forced to be aware of during the three years he served on US Navy submarines. At this stage of his career, he must have wondered if there were not a better way to power submarines [Wicks, 2004:1-8].

The race to develop a nuclear submarine

"The AEC's strategy of reactor development (after 1948) was to launch an attack along

several main fronts. One front involved the pursuit of fundamental knowledge. A second front, and the one to which most money was allocated, was the development of nuclear reactors for propelling submarines and aircraft." (Hogerton, 1968:22).

After the end of the Second World War, Rickover had his chance. Until now his career had not been very exceptional. After serving on various submarines and on the battleship USS New Mexico, he was given a command in 1937. But he was given a minesweeper, the USS Finch, to command, and not a submarine.

In 1939 he had been assigned to Washington DC, to the electrical section of the Navy Department's Bureau of Ships; he later headed this section throughout the Second World War. In July 1945 he was transferred to Okinawa in preparation for the invasion of Japan.

In Okinawa, he was first made aware of the power of nuclear energy when two atom bombs brought an end to the war. The huge force that was preparing to invade Japan was stood down, and Rickover was transferred to San Francisco. His new job involved mothballing ships. But he had now personally experienced the limitations of diesel-electric submarines and the enormous power that nuclear energy held.

Then, in June 1946, came what was to be one of the most important stages of his career. He was assigned to Oak Ridge in Tennessee for further instruction in nuclear physics and engineering. It was here that his interest in submarines merged with his new knowledge of nuclear energy. By the time his training was over, Rickover had the idea that was to revolutionise the development of nuclear energy - that developing a submarine powered by nuclear energy was now a real and feasible option.

The actual idea of using a nuclear reactor to propel a submarine had come much earlier, even before the Second World War. On 17 March 1939, Enrico Fermi (who had emigrated to the USA just after receiving the 1938 Nobel Prize in physics), gave a confidential briefing to some specialists at the American Naval Research Laboratory on the enormous energy nuclear fission could release. Three days later, Dr. Ross Gunn, a physicist working at the Naval Research Laboratory, and Captain Hollis Cooley outlined a plan to build a nuclear reactor for powering a submarine to one Admiral Harold Bowen. Gunn, Cooley and Bowen had all attended Fermi's confidential presentation. While these men and others pioneered the idea, it was Rickover who actually transformed the idea into the world's first nuclear submarine. Today, Rickover alone is remembered as the father of the nuclear navy, while the contributions made by Gunn, Cooley and others are largely forgotten [Ref. 9;6 - 8].

The first large water-cooled graphite-moderated reactors that had been developed and built at Hanford, Washington, in 1943 and 1944 to supply plutonium for the wartime atom bomb programme (the Manhattan Project), were still operating successfully. During the Manhattan project, some experience had been gained in recirculating coolant for small experimental reactors, but, as with the Hanford reactors, the temperatures had been low. The priority had been plutonium production, and not higher temperatures to generate steam, drive turbines and generate electrical power.

Rickover felt that producing a small, compact reactor to power a submarine with a recirculating coolant would mainly involve engineering problems, and no radical new physics. Returning to the Bureau of Ships in September 1947, he began to manage the navy's nuclear-propulsion program [Wicks, 2004:1-8], [Hogerton, 1968:21-31], [Ref. 9].

As things turned out, he was right. As the next sections show, the pressurised water reactor was successfully developed and made possible submarines that could cruise underwater for distances that only a few years earlier would have seemed like science fiction.

The other programme of the AEC, to produce nuclear powered-aircraft, literally never managed to get of the ground. Despite spending more than $7-billion between 1946 and 1961, no nuclear-powered aircraft were ever built, although huge experimental engines based on air-cooled and other reactors were successfully tested. Unlike the nuclear submarine programme, the problem of shielding was never really solved.

Another reason the programme to make nuclear aircraft stalled was major organizational problems. Unlike with the nuclear submarine programme, there was no one person with the necessary clout to ensure that the AEC (responsible for developing the reactors) and US Air Force (responsible for the aircraft and the rest of the hugely complex system) worked together properly. The results were some technical successes, no working prototype, and huge cost overruns [Ref.18;2]. The programme was cancelled by President Kennedy in 1961. Had nuclear-powered aircraft ever been built using the engines that were developed, they would have been huge, requiring runways 16 km long just to land and take-off! [Ref. 6] [Ref. 7]

Serving (and exploiting) two masters

"On organizational charts, Rickover now (on January 1949) headed a branch in two organizations, the AEC and the Navy. He had become effectively "two-hatted" and in a position to exploit the authorities, procedures and resources of both the AEC and the navy to accomplish his objective – the design, engineering, and construction of the Nautilus" [Ref. 9; 9]

In July 1948 Admiral Earle W Mills was ill at ease. For years he had been fighting for a nuclear submarine programme. To ensure that the United States build a nuclear-powered submarine, he was deciding whether to appoint the then Captain Hyman Rickover as liaison between the US Navy's Bureau of Ships and the AEC. This was mainly to ensure that, after years of bureaucratic delays, something finally happened and that a nuclear-powered submarine was actually built.

But Mills had no illusions. He knew that he was effectively placing Rickover in command of building the world's first nuclear submarine, but he also knew that Rickover was a difficult person to get on with. He guessed that, once Rickover was given authority, he would, *"outwork, outmaneuver and outfight the AEC, the civilian Atomic Energy Commission, its laboratories and the Navy"* and would *"threaten, cajole, and even insult those who stood in his way and would no doubt embarrass Mills and the Navy"* [Ref. 10; 76].

Fortunately for posterity, Mills decided to appoint Rickover in order to unleash his potential, and to support him, come what may. Admiral Mills guessed that Rickover would get the job done and build what became the Nautilus, but he could not have guessed the status and influence Rickover would eventually achieve for decades to follow.

A fanatic for personal intergrity, safety and quality, Rickover held his status for 31 years. Not only did he build the Nautilus, but, as we shall see, he also designed and supervised the construction of the first civilian nuclear power plant in the USA, at Shippingport.

Rickover insisted on personally interviewing every officer applying for a post on any of the nuclear-powered ships he built. Over the years this came to mean literally thousands of officers (including one president of the United States, Jimmy Carter), passed through his hands. This also meant he knew, personally, the captain of every nuclear-powered ship in the US Navy. That was more than 107 nuclear powered submarines and 6 surface warships. This proved to be an extremely useful power base, as many of these men later took up positions outside the navy, especially in the US nuclear power industry. It also meant that most key decision makers in the US nuclear power industry had had the importance of safety drilled into them in no uncertain terms, and also the importance of the PWR as a safe power plant.

Rickover made a point, an exceptionally powerful one, of being present on the sea trials of every nuclear submarine and surface ship in the navy. His message was loud and clear - he was prepared to put his life on the line to ensure safe submarines and reactors. It is largely thanks to him that there have been no known nuclear failures in US navy submarines [Ref. 12; 2].

Rickover was able to hold his unique position for 31 years largely because he quickly gained considerable political influence in the US Congress. This was mainly because of his repeated testimony in support of growing the nuclear navy and, less obviously, his activities in support of civilian nuclear power plants.

By 1955 Rickover's position had become virtually unassailable, as he wore two very powerful hats as it suited him. One "hat" was that of rear admiral in the US Navy (where he was Deputy Commander for Nuclear Propulsion, Naval Ship Systems Command), and the other that of a Washington official in charge of the Nuclear Reactors Branch in the AEC. His position in the AEC was that of Director, Division of Naval Reactors [Ref. 9;16], [Ref. 3; 9].

This dual appointment gave him the power to "cite Navy rules that were not being followed when he ran into trouble with the AEC and to cite AEC rules when he ran into trouble with the Navy" [Ref. 11; 660]. Rickover became virtually untouchable by his nominal superiors in the navy and Department of Defense. But his abrasive, domineering personality made him enemies, especially when his goals clashed with those of his superiors! Repeated efforts to remove him or curtail his influence came to naught, with Rickover eventually only being forced into retirement when 82.

To be continued..

References

See end of the third article on Rickover (Part 8 of this series) for references on the three Rickover articles . ❖