



Mission: History

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1958: *Nautilus* Crosses North Pole On Voyage from Hawaii to England



THE TRACK OF USS *Nautilus* as she made her top secret voyage from Pearl Harbor to England to participate in NATO exercises. Elaborate dissimulation and misinformation had even her crew thinking the ship would transit the Panama Canal but instead she navigated under the Arctic ice cap, reaching the North Pole at 1115 Eastern Daylight Savings Time on 3 August 1958.

Nuclear Submarine Operates Flawlessly On Undersea Cruise

*U.S. Naval Reactor Group
Design Now Generates
17% of World's Electricity*

When headlines across the United States told on 4 August 1958 that an American submarine, USS *Nautilus* (SSN-571), had on the previous day reached the North Pole, submerged under the Arctic ice cap, everyone knew it was big news.

Almost no one knew just how big that big news was. The voyage of *Nautilus* under the ice cap begat an industry that now supplies 20 percent of the electricity consumed in the United States, about a third in Japan and the United Kingdom and 75 percent in France. Reliable figures are not available for former Iron Curtain countries because of the unreliability of their Soviet-era reactors, but they too are heavily dependent on nuclear generation.

Worldwide, about 17 percent of the electricity consumed is generated in nuclear power plants. All of these power plants, and all of the industries that serve them, grew out of the U.S. Navy's development of the nuclear reactor that permitted *Nautilus* to navigate under the Arctic ice to the North Pole.

We are interested here in events in

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USS *Nautilus* Highlights Navy's Submarine Force Museum

The Submarine Force Museum in Groton, Conn., home of Historic Ship *Nautilus* (SSN-571), is the Navy's official submarine museum. The mission of the museum is to collect, preserve, interpret and present the history of the submarine force.

The museum, located on the Thames River, maintains the world's finest col-

lection of submarine memorabilia. It is the only submarine museum operated by the Navy, and is the primary repository for artifacts, documents and photographs relating to U.S. Submarine Force history. The museum traces that history from David Bushnell's Revolutionary War Turtle, to the modern Los Angeles, Ohio and Seawolf class submarines.

Far from the Sea, in Idaho, a Reactor is Built in a Submerged Submarine Hull

An Obscure Engineering Officer Takes Command

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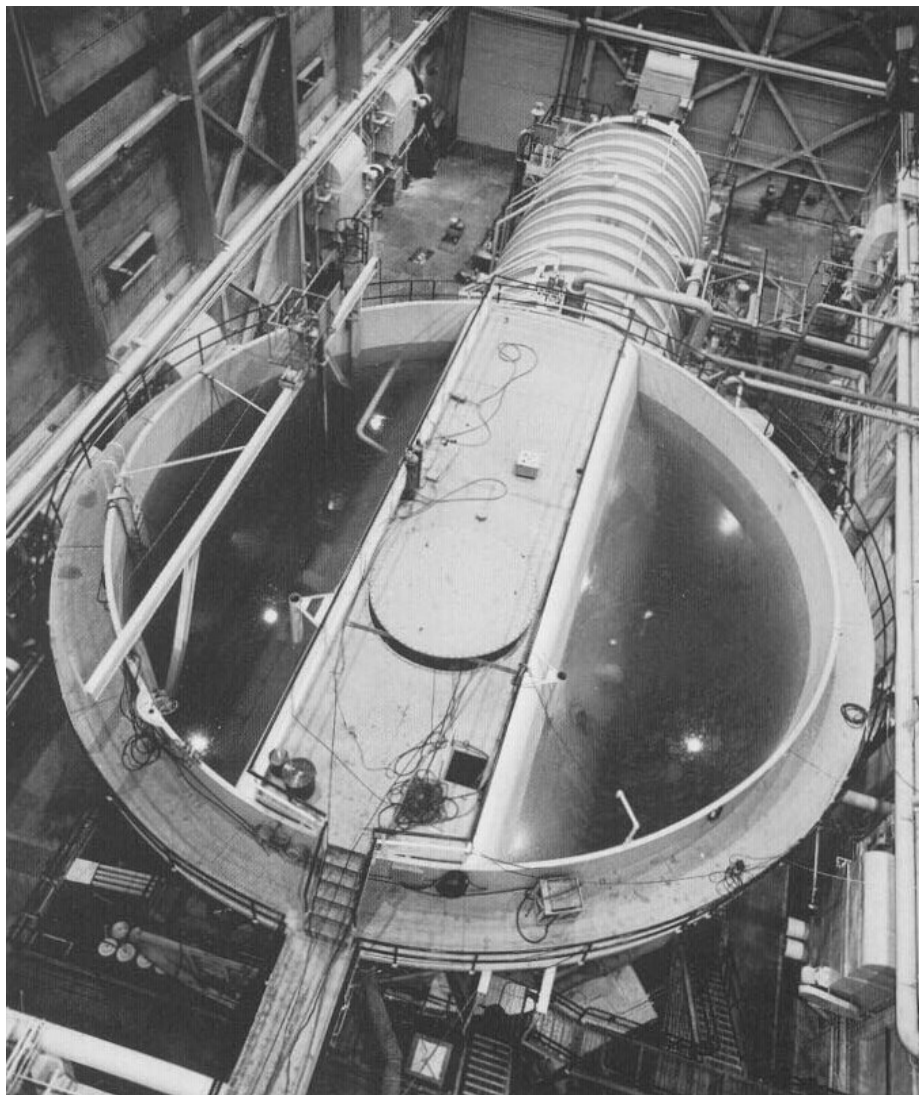
maritime history, so we'll first address the cruise of *Nautilus*. We will return to the nuclear power industry later, for the U.S. Navy has its hand on the helm, as we shall see.

The Birth of the *Nautilus*

In September 1947, at the request of then-Capt. Hyman G. Rickover, a study was begun at Oak Ridge, Tenn., to explore the use of a pressurized, water-cooled nuclear reactor to create steam that would drive the propulsion machinery of a submarine. The following January, the Department of Defense asked the Atomic Energy Commission, now the Nuclear Regulatory Commission, to develop and build such a reactor.

In August 1949, the Chief of Naval Operations, Adm. Forrest P. Sherman, established a January 1955 "ready for sea" date for a nuclear powered submarine. In August 1950, President Harry S. Truman signed Public Law 674, authorizing construction of *Nautilus*.

Construction began immediately on a prototype reactor at the National Reactor Testing Station in Idaho, now the Idaho National Engineering and Environmental Laboratory. Not only was this reactor built from scratch, it was



RICKOVER STUNNED ENGINEERS from Westinghouse and the Argonne National Laboratory who had planned to build a prototype reactor in a large building so things could be spread out. "The plant will be built into a simulated life-size submarine hull," he said, "And the hull will be under water." Here it is, at the Arco prototype plant in Idaho.

built inside a mock-up submarine hull which was itself in a tank of water. The development was 100 percent new engineering, with cut-and-paste shortcuts not allowed. And Rickover was everywhere.

At 2317 Idaho time on 30 March 1953, the reactor "went critical" — that is, a nuclear reaction took place. That moment marked the beginning of production of useful power from a nuclear reaction. In late June, the reactor began a 96-hour full-power test.

In August 1951, the U.S. Navy had awarded a contract to the Electric Boat Company of Groton, Conn., for construction of the first nuclear powered submarine, and the keel of *Nautilus* was laid on 14 June 1952. On 21 January

1954, Mamie Eisenhower broke a bottle of champagne across the ship's bow, and *Nautilus* slid down the ways and into the Thames River. She bore the most famous name in submarine history. And she lived up to it.

Nautilus was commissioned on 30 September 1954, her propulsion plant was first operated at partial power on 20 December and at full power two weeks later, tied alongside the dock. On 17 January 1955, she put to sea for the first time, and her commanding officer, Cdr. Eugene P. Wilkinson, sent the message:

'Underway on Nuclear Power'

On her sea trials, *Nautilus* made high speed runs, surfaced and submerged, at speeds never before seen in a submarine

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RICKOVER, IN MUFTI, takes a look at *Nautilus* in 1957. The relatively benign expression means he's pleased with what he saw.

Nautilus Breaks Records As Soon as She's Launched

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and made more than 50 dives. Her propulsion machinery operated without incident. She was accepted by the Navy on 22 April 1955.

On her shakedown cruise, *Nautilus* began breaking records right and left. She sailed 1300 miles in 84 hours from New London, Conn., to San Juan, Puerto Rico, submerged the entire distance. She then steamed from Key West, Fla., to New London, a distance of 1,400 miles, in about 70 hours.

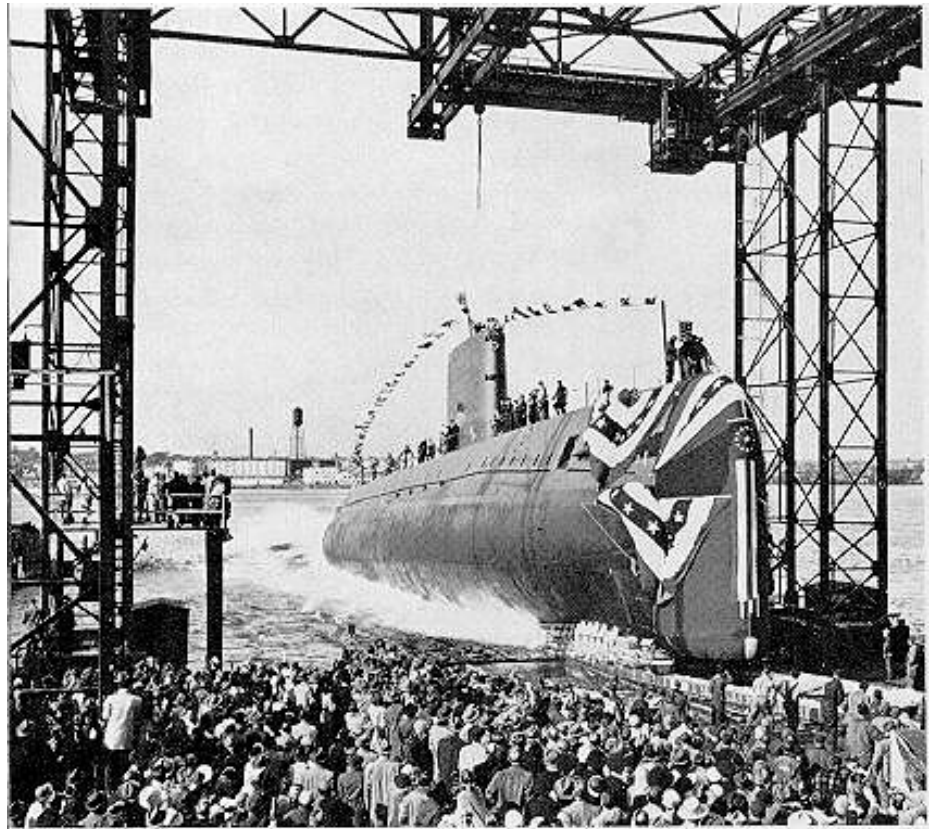
After two years in service, during which she steamed more than 62,500 miles (more than half of it submerged), *Nautilus* returned in April 1957 to New London to be refueled. Refueling a nuclear power plant consists of removing bundles of fuel rods — metal tubes containing pellets of enriched uranium oxide fuel — and replacing them with bundles of rods containing fresh fuel. The spent fuel can be reprocessed to provide more fresh fuel or, as in the United States for political and ideological reasons, stored at great expense.

Once refueled, *Nautilus* deployed to the Pacific via the Panama Canal, returning to the Atlantic for NATO exercises. During that year, she made several voyages that took her under the Arctic ice cap, presaging what was to come.

90° North Latitude

Nautilus, now commanded by Cdr. William R. Anderson, departed Pearl Harbor on 23 July 1958 under highly classified orders. The name given her task was "Operation Sunshine," perhaps because where she was headed was the Land of the Midnight Sun, perhaps in dissimulation. The submarine's crew thought she was bound for Panama and had outfitted themselves accordingly. A good deal of planning had gone into the voyage, and it was done with almost no knowledge of the Arctic and its ice.

How thick was the ice? How much did that thickness change? How deep was the sea under the ice? Those questions came immediately to mind. Then, one wondered, what of navigational instruments? A magnetic compass would be useless, it was agreed, but what of a gyro? Navigation by dead reckoning would be impossible for *Nautilus* — and



FIRST LADY MAMIE EISENHOWER cracked a bottle of champagne on her bow and *Nautilus* slid down the ways and into the Thames River at the Electric Boat Co. in Connecticut, where so many GATO class fleet subs had been built during World War II. Though nearly as large as a FLETCHER class destroyer, she was still a "boat" to the submariners who manned her



NAUTILUS WAS A FAST SHIP, faster than any submarine before her. On her sea trials, she covered the 1,400 miles from Key West to New London at an average speed of 20 knots.

there would be no "star to steer her by."

A tentative probe of the ice pack had been made a year earlier, in August 1957, and *Nautilus* had reached 87 degrees north latitude, about 180 miles from the North Pole. It was a learning experience, and among the things learned was that neither compass would function that far north. *Nautilus* was sub-

sequently fitted with an inertial guidance system developed by North American Aviation for the intercontinental missile program.

In the spring and summer of 1958, *Nautilus* was working with the Pacific Fleet. Later that year, she was scheduled to participate in NATO exercises in Europe. The need to get from the Pacific

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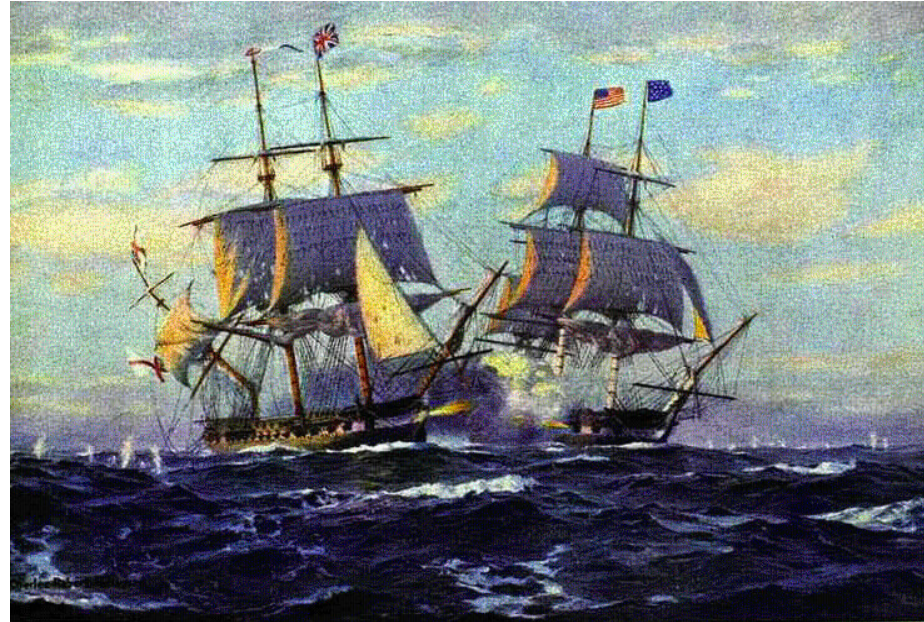
1812: *Constitution* Earns the Name 'Old Ironsides'

With Providential Victory over British *Guerrière*

The war between the United States and Britain — the conflict we now call the War of 1812 — was only ten weeks old when early risers in Boston saw on 30 August 1812 a frigate glide into Nantasket Roads. She was flying the British ensign beneath the Stars and

Stripes of the new country. A battle had been won and a British ship vanquished, her ensign taken as a symbol of victory. But who had fought it, and where?

In the early days of the war, the portly Capt. Isaac Hull in the American frigate *Constitution* had sailed



HULL HAD NEVER FOUGHT AN ENGAGEMENT and held his fire until he knew it would be effective. When he did open fire at less than a pistol-shot distance, *Constitution*'s double-shotted guns were devastating. Here, an early broadside topples *Guerrière*'s mizzen.



THE TWO SHIPS COLLIDED SEVERAL TIMES, and each time *Guerrière* suffered for it. When Hull sought to cross the British frigate's bow in order to rake her decks with deadly fire, stern to stern, he fouled *Guerrière*'s bowsprit. The tugging on the forestays pulled down her foremast, which took the already weakened mainmast with it. In his action report, Hull failed to mention the collisions which were of such benefit to him.

from Annapolis under orders to join Commodore John Rogers at New York, but seeing a British blockading squadron guarding The Narrows, continued on to Boston. Word came that Rogers had sailed from New York and that there were no orders left for Hull, so on 2 August Hull left Boston, bound for the Gulf of St. Lawrence to prey on British shipping.

Hull had already captured and burned an English merchantman when, on 15 August, he came upon a British sloop of war fighting four American ships, three of which had been captured. *Constitution* made short work of the enemy sloop, taking on board prisoners from whom it was learned that six English frigates were patrolling the approaches to the St. Lawrence. Hull went looking for trouble but finding none after three days turned south. In the early afternoon of 19 August, about 500 miles south of Cape Sable, Nova Scotia, he sighted, and was seen by, a sail.

Each captain soon realized the other ship was an enemy, and Capt. James R. Dacres of the British *Guerrière* slowed to allow the American to close. Hull approached cautiously, shortening sail and sending down his royal yards. At about 1610, the British opened fire at long range without effect. Hull continued to close slowly, yawing side to side to spoil the enemy's aim. When he had closed to within pistol-shot range, Hull opened fire with double-shotted guns, aiming for *Guerrière*'s rigging.

After 20 minutes, *Guerrière*'s mizzenmast fell, causing the ship to veer into *Constitution*, fouling her port mizzen shrouds and wrecking a ship's boat. As she banged aft against *Constitution*, the British ship smashed Hull's gig where it hung in its davits, before finally breaking away. The ships weren't through hitting each other.

Hull wanted to cross *Guerrière*'s bow to deliver a rake of gunfire down her

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Constitution Once More Collides With *Guerrière*, Brings Down Two Masts

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length and, as he passed her starboard bow, he fired a pair of broadsides which combined the English ship's two forward gun ports into a single, gaping hole. He then cut *Guerrière*'s bow too close and *Constitution*'s shrouds fouled on *Guerrière*'s bowsprit. The tugging on forestays was too much for *Guerrière*'s damaged foremast, and it fell to starboard, taking the mainmast with it.

While the ships were entangled, each side made preparations to board the other, but heavy musketry suppressed the attempts. American Marine Lt. William Sharp Bush paused at *Constitution*'s rail to ask permission to board *Guerrière* and was shot dead. His replacement, Lt. Charles Morris, was seriously wounded. American Marines, firing down on *Guerrière*'s deck from the rigging of their ship, killed a British lieutenant and wounded the captain and another lieutenant.

After the ships broke free of each other *Guerrière* was little more than a hulk, so Hull drew off to mend rigging and tend to wounded. When he returned at about 1900 to continue the battle, Dacres fired a single gun to leeward, away from *Constitution*, to signal his surrender. *Guerrière* had no mast from which to strike the British colors.

A wounded Capt. Dacres came on-board *Constitution* at about 2000. He had commanded *Guerrière*, which had been captured from the French in 1806, for about a year. When he encountered *Constitution*, he had been bound for Halifax to replace his rotten masts, repair rigging and have his hull scraped.

Hull, who had never before fought an engagement with an equal ship, had been luckier than he knew. *Constitution*'s gunfire had weakened already weak masts, but it was the series of collisions which dismasted *Guerrière*. Dacres told Hull that when British shot had rebounded from *Constitution*'s hull, his sailors had exclaimed "Her sides are made of iron!"

On the morning of 20 August, *Guerrière* was scuttled and *Constitution*

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How Poetry Saved Old Ironsides from the Wreckers

The *Boston Daily Advertiser* reprinted on 14 September 1830 an item from the *New York Journal of Commerce*:

"Old Ironsides. -- It has been affirmed upon good authority that the Secretary of the Navy has recommended to the Board of Navy Commissioners to dispose of the frigate *Constitution*.

Since it has been understood that such a step was in contemplation we have heard but one opinion expressed, and that in decided disapprobation of the measure. Such a national object of interest, so endeared to our national pride as Old Ironsides is, should never by any act of our government cease to belong to the Navy, so long as our country is to be found upon the map of nations.

In England it was lately determined by the Admiralty to cut the *Victory*, a one-hundred gun ship (which it will be recollected bore the flag of Lord Nelson at the battle of Trafalgar), down to a seventy-four, but so loud were the lamentations of the people upon the proposed measure that the intention was abandoned.

We confidently anticipate that the Secretary of the Navy will in like manner consult the general wish in regard to the *Constitution*, and either let her remain in ordinary or rebuild her whenever the public service may require."

Upon reading that item in the *Advertiser*, a very young Oliver Wendell Holmes became so incensed he dashed off a bit of poetry. Holmes would be-

come a widely known man of letters and a professor at Harvard of anatomy and physiology, but in 1830 he was a 21-year-old patriot.

The *Advertiser* printed Holmes' poem on 16 September. It was effective poetry and is widely credited with saving the ship, which is today a national treasure.

Old Ironsides

*Ay, tear her tattered ensign down!
Long has it waved on high,
And many an eye has danced to see
That banner in the sky;
Beneath it rung the battle shout,
And burst the cannon's roar;
The meteor of the ocean air
Shall sweep the clouds no more.*

*Her deck, once red with heroes' blood,
Where knelt the vanquished foe,
When winds were hurrying o'er the flood,
And waves were white below,
No more shall feel the victor's tread,
Or know the conquered knee;
The harpies of the shore shall pluck
The eagle of the sea!*

*Oh, better that her shattered bulk
Should sink beneath the wave;
Her thunders shook the mighty deep,
And there should be her grave;
Nail to the mast her holy flag,
Set every threadbare sail,
And give her to the god of storms,
The lightning and the gale!*



MARINE LIEUTENANT WILLIAM BUSH stands on *Constitution*'s rail, aft of her mizzen. Sword drawn, he asks for permission to board. Before the portly Capt. Hull, standing on a ventilator in front of the ship's wheel, could answer, Bush was shot dead. Each ship wanted to board the other, but withering musketry on both sides prevented the attempts.

On a Trip to Europe for NATO Exercises: *Nautilus* Crosses the Top of the World

Planning Was Top Secret, Crew Thought Submarine Would Transit Panama

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to European waters coincided nicely with a decision, supported by President Eisenhower, to try for the North Pole.

Planning for the voyage was done in the utmost secrecy, for it would do great damage to the Navy's nuclear program if the ship failed in a publicized attempt. Information — or misinformation — was let out that *Nautilus* would transit the Panama Canal. Work orders were written for a stop at New London. The crew, as noted, went shopping for clothes appropriate for summer liberty in the Canal Zone. Anderson, in order to get a first-hand look at the Arctic ice fields, made several trips to Alaska, clad in mufti and using an assumed name.

The voyage under the ice contained few dramatic moments, even from a submariner's view. In the forty-two years since, writers have provided their own drama, some contrived, some perhaps true. One story has a member of the crew sneak himself into a forward torpedo tube so he could be the first to reach the North Pole. Another has Anderson counting off the seconds, as is done in a space launch, as *Nautilus* crept toward the North Pole. The real drama lay in the achievement — at 1115, Eastern Daylight Time, 3 August 1958 *Nautilus* crossed under the North Pole and continued on her underwater journey to England, arriving nine days later.

Atoms for Peace

Even though the feat had been accomplished by a warship, the world could immediately see that it was a peaceful application of atomic power, and rejoiced. It was only a matter of time before this awesome power was put to use lightening mankind's load.

That, in fact, had already happened, on dry land in Pennsylvania, and the U.S. Navy had done it.

In 1953, Rickover's Naval Reactor Group was working on a prototype for an aircraft carrier. It would be a reactor twice as large as those used in submarines. There were other large reactors in the U.S., England and Russia, but they



JUST SHOWIN' OFF. *Nautilus* was maneuverable as well as fast. In fleet exercises, anti-sub surface ships had a hard time keeping up with her on the surface and couldn't find her when she was submerged. She introduced a new dimension to sea warfare.

were used for making weapons grade plutonium. Some of those reactors produced insignificant quantities of by-product electricity. By July of that year, the aircraft carrier had been shelved, but Rickover's cadre of nuclear professionals was about to be asked to build the world's first nuclear power plant.

A ground-breaking ceremony for the commercial nuclear power plant was presided over by President Eisenhower at Shippingport, Pa., on 6 September 1954. As was the case with the *Nautilus* prototype, much of the design took place during the plant's construction. On 26 April 1955, for example, Rickover decided that the tubing that contains pellets of uranium oxide to form a fuel rod should be made of a zirconium alloy, a departure from naval reactor practice. The tubes were successful and the fuel rod design became standard for most of the world's nuclear power plants. The pellets of fuel, incidentally, are about the size of the eraser on the end of a wooden pencil — and each of them contains the amount of energy you would get from a ton of coal.

Perhaps it is time to briefly describe the operation of a nuclear power plant. The reactor, where the nuclear reaction takes place, can be thought of as a different kind of boiler. Heat from nuclear fission creates steam which spins turbines and they in turn drive generators to produce electricity.

The nucleus of an atom contains small particles called protons and neutrons, and uranium as a very heavy element

contains many of these in its nuclei. Fission begins when a neutron strikes a nucleus. The nucleus breaks apart into two smaller nuclei, releasing more neutrons which strike more nuclei and so on. This is called a chain reaction. The chain reaction is controlled by using an element



RICKOVER REACTS in his customary manner to perceived stupidity. Ignorance was okay — it could be corrected.

that readily absorbs neutrons. Cadmium was used in the first reactor built by Enrico Fermi in the basement of the squash courts at University of Chicago.

Clusters of fuel rods are interspersed with control rods made of hafnium, the selection of which was made on the recommendation of Dr. Alvin Radkowsky, Rickover's chief physicist. The entire assembly is placed in the reactor core, which is itself contained in a pressure vessel. When the control rods are fully

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A Reactor is Just a Boiler; The Power is in the Steam

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inserted into the bundles of fuel rods, no reaction takes place. As they are gradually removed, a reaction begins and gains strength as the control rods are further removed. As the reaction grows, intense heat is generated. Powerful pumps circulate water through the pressure vessel as a coolant. The superheated, pressurized water is pumped through thousands of small tubes in steam generators where water from another source is turned to steam that powers the plant's — or ship's — turbines.

At Shippingport, the first reactor core was installed on 6 October 1957. On 2 December, engineers inched up the control rods and the plant "went critical," meaning a nuclear reaction had begun. Ramping a nuclear power plant up to full power is a complex and meticulous process even today, with numerous "hold points" for testing and verification of data. It was *very* meticulous at the world's first commercial power plant. On 18 December, the plant was synchronized with the regional transmission grid and went on line. On 23 December, Shippingport's naval operators ramped the plant up to design capacity of 60 megawatts, puny by today's standards, but big then.

When President Eisenhower formally "switched on" Shippingport on 23 May 1958, he said the plant "represents the hope of our people that the power of the atom will ease mankind's burdens and provide additional comforts for human living." The impact of that event was worldwide, and the Navy had done it. Commercial nuclear power had become a reality just four and one-half years after the job was turned over to Rickover and his Naval Reactors bunch.

Today, with 104 reactors churning out about 85,000 megawatts of power in the U.S., the presence of the Navy is still strongly felt. Hundreds, and perhaps thousands, of engineers were trained for industry by Rickover's group, and many more chose the electric power industry after serving in the Nuclear Navy. Possibly the two most prominent executives in the commercial nuclear power business today are Corbin A. McNeill Jr., chairman, president and chief executive of



EVERY SHIP HAS A SAILMAKER and it appears that *Nautilus* was no exception. The marlin-spike seamanship of someone was put to good use fashioning the commemorative flag held here by two of the submarine's crew.



FOLLOWING NATO EXERCISES in European waters, *Nautilus* returned to the United States and a rousing welcome by a fireboat. In Washington, President Eisenhower hosted a reception for the sub's commander, Cdr. William R. Anderson. Incredibly, Rickover was not on the guest list. Anderson halted the entourage so he could pay his respects to the man who made it possible.

Peco Energy Co., the old Philadelphia Electric Co., and Oliver D. Kingsley Jr., president of the Nuclear Generation Group of Unicom Corp., the parent holding company for Commonwealth Edison Co. of Chicago. They are both former submarine commanders, and both worked miracles at their companies by

applying Navy standards to moribund corporate nuclear programs.

The American nuclear power industry, born with USS *Nautilus* 42 years ago, has never been in better shape. As this is being written, the country's nuclear power plants are operating at a power factor of more than 95 percent,

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Hull's Action Report Turns Battle into a Half-hour Thriller

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headed for Boston where she could be repaired, arriving in the pale morning light of 30 August. The American public, beset with bad news from other fronts, went wild with the good news of a victory over a ship of the vaunted British Navy, which had been winning sea battles for more than 200 years.

Hull helped out. His report of the battle was not only short itself, it shortened the battle from three hours to 35 minutes and omitted any mention of collisions. Congress promptly awarded the American commander a gold medal and his ship was known thereafter as "Old Ironsides," a name bestowed by her foe.

Newspaper Editorial

On 2 September 1812, the New York *Evening Post* carried the following related editorial:

After the gloomy accounts which have crowded upon us for some days past, we are happy to be able this day to give our readers something in favor of the courage and activity of our countrymen. We have always contended that our people would fight whenever they should have a chance, and that on an equal footing they would be beaten by no men on earth; the naval action, the particulars of which we publish this day, proves our assertion. Captain Hull, who has immortalized himself in the capture of The *Guerrière*, is a relation of General Hull, who has been sacrificed by an imbecile Administration on the borders of Canada. We have no doubt that General Hull would have fought as manfully as his kinsman, and that the result would have been as favorable, had he been placed in a situation where there had been the least chance of success; but without provisions or munitions of war, what could be done against a veteran and well-appointed army?

Though very little present benefit is to be expected from the war, commenced as it has been and carried on as it will be, under the present Administration, yet it may have one good effect: it will prove that in a contest where the freedom of the seas is the object, a naval force is much superior to an army on the land ... And will settle the question: Whether a nation can exist as a powerful maritime nation without a well-appointed navy?



WITH HIS PRIZE DISMASTED, Hull took off *Guerrière's* officers and crew — and one battle ensign. When *Constitution* returned to Boston, she flew the British ensign below the Stars and Stripes, to show the world she had fought and won an engagement.

Rickover and Nuclear Navy Provided Clean Power

and they are producing competitively-priced electricity without polluting the environment. With recent concern over "global warming," it would appear to the



RICKOVER STRIKES RARE POSE, seemingly at peace with the world.

rational observer that nuclear generation offers the best opportunity to reduce the amount of greenhouse gases emitted into the atmosphere.

Admiral Hyman G. Rickover and his Naval Reactors Group developed the first practical nuclear reactor for *Nautilus* and developed the first commercial nuclear reactor for Duquesne Light Co.

Almost all of the nuclear power plants in the world today are built on principles established by Rickover and his team. The renaissance in nuclear generation of electricity in the U.S. today can be traced in large part to the efforts of progeny of the Navy nuclear program, to the development of *Nautilus*, and to her dramatic voyage under the Arctic ice cap.

Members of the United States Navy community can take pride in this record, which in President Eisenhower's words "represents the hope of our people that the power of the atom will ease mankind's burdens and provide additional comforts for human living."

How to Get in Touch

Mission: History has been asked to provide an address for reader communications. E-mail may be sent to this address:

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Submissions are not encouraged because of constraints on the time available for editing. If such are sent, they should be sent as e-mail attachments in Microsoft Word 6.0 or as type-written copy, double-spaced, accompanied by a 3½-inch diskette containing the submission in Microsoft Word 6.0 for Windows.

Quite welcome are suggestions of events for coverage. Please offer suggestions two months ahead of the anniversary of an event.