# ADMIRAL RICKOVER

## A PERSONAL MEMOIR

## BY

## RICHARD CLAYTOR

# PREFACE

**Admiral Hyman George Rickover**, the "Father of the Nuclear Navy", was a career officer in the United States Navy, having graduated from the U.S. Naval Academy in Annapolis in 1922. In the early part of his career, he served in various surface ships and commanded a diesel-powered submarine. Later he became an engineering specialist and spent most of the Second World War as head of the electrical section in the Navy Department's Bureau of Ships.

Following the war, he was selected to explore the possibilities of nuclear energy for naval ship propulsion, and in 1948, over considerable opposition, he was assigned to head a joint Navy-Atomic Energy Commission naval nuclear ship propulsion program. This led to the development of the world's first two nuclear powered ships, the submarines *Nautilus* and *Seawolf.* Within a few years the nuclear Navy had grown to dozens of nuclear submarines and surface combatant ships, including the world's first nuclear powered aircraft carrier, *Enterprise*. All new submarines and aircraft carriers were to be propelled by nuclear power, with an unmatched record of performance and safety.

Because of his successful experience in developing the nuclear Navy, Rickover was assigned by the Atomic Energy Commission to develop the world's first commercial nuclear electric generating plant at Shippingport, Pennsylvania that began operation in 1957.

Rickover began his nuclear career as a captain and was successively promoted to ever-higher ranks, finally achieving the position of four-star Admiral. His Navy seniors often opposed his advancement, but he overcame this opposition due to his achievements and strong congressional support. He reached mandatory retirement age but was periodically kept on active duty through congressional legislation, finally being forcibly retired at the age of 82 by the Reagan administration in 1982.

Rickover became an international celebrity, befriended by presidents, honored in his lifetime with, among other things, a nuclear submarine named for him, the engineering building at Annapolis named Rickover Hall, and awards of the presidential Medal of Freedom and two congressional gold medals.

Rickover died in July 1986 at the age of 86.

**Richard A. Claytor**, the author, a 1949 graduate of Annapolis, joined Admiral Rickover's program in 1956 following designation as a Navy engineering duty officer and served for 17 years in the Naval Reactors program, first on Rickover's headquarters staff in Washington and later as his personal representative at the Atomic Energy Commission's Pittsburgh Naval Reactors Office. Claytor retired from the program in 1973 having advanced to the rank of captain.

# INTRODUCTION

This is a memoir. This is not an attempt at a biography. There already exist several excellent well-written biographies of Admiral Hyman G. Rickover, including especially Francis Duncan's *Rickover, The Struggle for Excellence.* There has been one notable "insider" book on the storied Admiral – that by Ted Rockwell, Rickover's technical director for several years, *The Rickover Effect, How One Man Made a Difference.* Rather, this memoir is a collection of experiences and anecdotes from the 17 years I served in the government's Naval Reactors (NR) Program under Admiral Rickover's direction.

Clearly most of the people who associated closely with the Admiral for any length of time in the NR program could no doubt compile interesting memorabilia of their association; and some indeed may have. In fact, at a 1992 NR reunion, Ted Rockwell did collect unedited comments, photos, and assorted material from dozens of active and retired NR personnel – it makes fascinating reading. Nonetheless, even though I was never a member of Rickover's "inner circle", and many served longer than I in the program, I did have substantial interaction with him and so decided some time ago that I should produce a record of the years that I served in NR. My memoir then is mostly about Rickover, but it is also about my personal relations with him and with others who were part of this important program.

There can be no denial that the "Father of the Nuclear Navy", an inscription engraved on the Admiral's tombstone, was a great man or that he was one of the finest engineers the U.S. Navy has ever produced. His accomplishments contributed mightily to the defense of this nation and to the strength of our armed forces that helped win the "Cold War". He was complex; he was driven; he was difficult and "controversial"; but above all he was one of the giants of American military history, and his legacy will endure.

I say all this in the context of this memoir that neither attempts to eulogize or denigrate Admiral Rickover but rather records experiences that might be of some use to future researchers probing into the depth that defines this great man, who had – more than anyone else – the most important influence on my life.

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Bethesda, Maryland
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# THE WASHINGTON YEARS

# INTRODUCTION TO ADMIRAL RICKOVER

It was 1955. Philip Sporn, President of American Electric Power Company, holder of at least ten honorary degrees and an internationally recognized engineer, had invited me to lunch with him. He had learned from my father, his friend and colleague in the executive ranks of American Electric Power, that I was soon to get my graduate degree in naval architecture and marine engineering and begin a career as an engineering specialist in the U. S. Navy

Sporn had become an expert in the nascent field of nuclear energy and believed the Navy would lead the way in the development of this new technology. In January 1955, the world's first nuclear powered ship, the submarine Nautilus, had successfully completed its sea trials and joined the fleet. Over lunch, Sporn, owlish and balding with a formidable intellect, wasted no time with small talk. He came to the point immediately: “You need to join the Navy's nuclear propulsion program as soon as you graduate. I know Admiral Rickover who runs the program. He's a brilliant innovator but very hard to deal with. He's getting along in years and will be retiring soon. (Rickover was 55 at the time, fairly old for a Rear Admiral.) You are young. You won't have to put up with him for very long. So go for it!"

Several months later, in January 1956, two of my fellow graduate students and I were on assignment to the Electric Boat Company in Groton, Connecticut. We were spending our winter work period from graduate school learning the rudiments of nuclear propulsion plant design for the *Skipjack*, the fifth of the submarine plant designs undertaken so far. One day appearing at Electric Boat was a tall, personable young naval officer in civilian clothes. His name was David T. Leighton. His boss, Rear Admiral Hyman G. Rickover, had sent him to Groton to have a look at these three graduate students to see if they might be worthy of consideration for Rickover's program.

Apparently, the three of us met some minimum standard and were all invited down to Washington for further observation by the Rickover staff and the great man himself.

"What books have you read recently? Who proposed - you or your wife? What does Episcopal mean? What is the highest mountain in Washington, D.C.? " A half-century later these seemingly unrelated questions remain fixed in my memory. These were the Admiral's questions at my first encounter with this small, frail, white-haired man. The interview took place in a decrepit World War II temporary relic on Constitution Avenue known as the T-3 Building. The Admiral's office was a mess: piles of papers and documents were everywhere in seeming confusion; secretaries went in and out during the interview; the phone rang frequently with the Admiral often interrupting the interview to take the calls. I did not sit in a chair with shortened front legs (nor do I recall that such a chair existed in the Admiral's office as has often been rumored) so I did not slide forward toward the floor. But I was not without fear, and the Admiral was far from polite.

I concluded that the answers to the Admiral's questions were not particularly important in

themselves. I had already been interviewed by five other Rickover subordinates earlier in the day and had apparently been pronounced acceptable by them. Rickover just wanted to watch my reactions to his questions and make sure I did not have some fatal flaw such as being too fat for his program (a condition requiring a weight-reduction regimen for some candidates prior to acceptance in the program). I weighed about 150 pounds at the time and was accepted. Incidentally, I could not identify " the highest mountain in Washington, D.C. "; according to the Admiral, it was Goat Hill in the Washington National Zoo.

## ARRIVING AT NAVAL REACTORS HEADQUARTERS

Having completed graduate school, I received Navy orders to report to the Bureau of Ships, Code 1500 (Rear Admiral Rickover's organization) in Washington, D.C. This group was also the Naval Reactors Branch of the U.S. Atomic Energy Commission. It was July 1956, the middle of a typical hot, humid, oppressive summer in Washington.

I was first assigned as an engineer in the section responsible for the piping systems for the nuclear propulsion plant of the submarine *Triton* and its prototype plant located at West Milton, N.Y., near the horse racing community of Saratoga Springs. My boss was Karl Swenson, a most reasonable, mild-mannered, and capable engineer, about ten years my senior. I often wondered later on as I became better acquainted with Naval Reactors personnel how someone of Karl's disposition and gentlemanly manner could hold a senior position reporting directly to Rickover. I soon realized that the Admiral routinely criticized him for his supposed "shortcomings", but Karl had the class not to berate his subordinates who no doubt got him in most of his trouble with Rickover. He, of course, was not alone in being berated by the Admiral. It soon became apparent to me that a key element of Rickover's leadership style was intimidating and aggressively criticizing those who reported to him. There were a few exceptions to this approach among the trusted, very senior people who had been with Rickover for many years.

The physical environment at Naval Reactors was most certainly like none other in the federal government. The group had transferred from the T-3 Building, where I had been interviewed, to the N Building, another World War II temporary structure located between the Washington Monument Reflecting Pool and the Main Navy Building on Constitution Avenue. Main Navy was itself a temporary building from World War I, still functioning now 40 years after the end of this first great war. The N Building was a classic example of a poor working environment. In true Rickover fashion, he insisted that the place be kept as austere and physically unprepossessing as possible. The sheetrock thin walls were never painted; the floors were covered with a brown linoleum which would often tear; no rugs were permitted anywhere including the Admiral's office; and window air conditioning units – a nod to Washington summers – protruded from office windows. For safety reasons it was necessary to repair the tears in the linoleum floor covering; the Admiral insisted that the original linoleum not be replaced but instead that the torn patches be cut out and replaced with linoleum pieces of very different color and design. The hallways soon came to resemble an ungainly mosaic of gray circles, squares and other shapes among the dirty, brown original covering. Also I recall one unique feature in the wall just outside the Admiral's office: this was a ragged hole in the sheetrock which was not covered over for a considerable period; it turned out that the hole was the result of a blow from the fist of a particularly infuriated Naval Reactors staffer who had just exited the Admiral's office.

It was apparent from the outset of my assignment to the Naval Reactors Branch that I had joined a group of extremely bright people. I soon realized that most of them were a good deal smarter than I, especially in their quick grasp of the complex engineering details of

nuclear propulsion. At age 56, Admiral Rickover was by far the oldest member of the staff, the average age, including that of the Admiral, being in the early thirties.

Rickover's approach to establishing and maintaining his headquarters staff was unique. In response to the question he was often asked: "Why don't you simply go out and hire good people since you are in charge of a highly interesting and challenging program that would naturally attract top talent?" his response invariably was: "The good people already have good jobs. What I do is I bring onboard the very brightest engineers right out of college and train them." And this he did, along with tapping the pool of more senior Navy Engineering Duty Officers who had received graduate degrees mostly from the Massachusetts Institute of Technology (I had come from this pool although from a different graduate school). The top staff reporting to him were a mix of these Navy officers and experienced civilian engineers, several of whom having worked for Rickover when he ran the Electrical Branch of the Bureau of Ships during World War II or when he teamed up with them at the outset of the Navy's nuclear propulsion program shortly after the war.

As time passed, he relied less on the Navy Engineering Duty Officers and much more on the young talent right out of college. In almost all instances, these young men (no women then!) were from the Navy's ROTC programs or, in lesser numbers, from the Naval Academy. Invariably they had astronomic grade point averages and were almost always in the top 5% of their class. He was able to maintain a significant degree of continuity by offering most of these young Naval officers mid-level civilian positions upon the completion of their 4 to 5 years of obligated naval service.

The bottom line was that this headquarters staff of exceptional talent resulted in a unique technical – as well as managerial – control of the design and development of nuclear propulsion for the Navy's ships. The result was unsurpassed technical excellence in his headquarters staff that helped produce one of the most outstanding technological achievements of all time: nuclear propulsion for the U.S. Navy's submarines and combat surface ships. It was clearly Admiral Rickover who recognized that this could not have been achieved without this central engineering control by people of extraordinary technical skills.

# THE BETTIS REACTOR ENGINEERING SCHOOL

Despite the need for strong technical and managerial leadership by the Naval Reactors staff in Washington, Rickover had recognized that the basic research, development and design of Naval nuclear propulsion plants would have to be undertaken by a laboratory/industrial complex in coordination with a shipyard experienced in Naval ship construction. Accordingly, early on he had contracted with Westinghouse and General Electric to establish and staff government laboratories for this purpose. These became, respectively, the Bettis Atomic Power Laboratory near Pittsburgh, Pennsylvania (Bettis) and the Knolls Atomic Power Laboratory near Schenectady, N.Y. (KAPL). Bettis became the designer of the nuclear reactor plant for the submarine *Nautilus*, the world's first nuclear powered ship, and KAPL designed the plant for the second such ship, the submarine *Seawolf*.

Rickover sent all of his newly hired engineers to a six-month school at Bettis, usually within six months to a year after they had been hired. I was in the seventh class of the Bettis Reactor Engineering School that began in April 1957. Typical of all of the Rickover sponsored activities, the school was incredibly demanding – not only in the extraordinary number of hours of outside study required but also in the need for extreme mental gymnastics in coping with the subject matter. A good example was a 3-week intense advanced mathematics course at the outset of the school that involved such esoteric subjects as partial differential equations and Laplace transforms; just to pass required staying up until 2 or 3 AM every night for three weeks. It seemed so irrelevant at the time to our work in Naval reactors, but later we recognized that this sort of high-powered mathematics was a sample of what engineers and scientists had to undertake to design nuclear reactors. Thus we acquired a better understanding of the work of the people we would oversee at Bettis and KAPL.

One particular classroom event deserves mention. Occasionally a visiting expert would deliver a lecture on some highly technical topic. In this instance, Dr. Alvin Radkowsky, the senior physicist on Rickover's staff in Washington, arrived to lecture us on the finer points of nuclear reactor physics. Dr. Radkowsky (known as "Rad" to his peers) had a well-deserved reputation as a brilliant scientist, which I later came to fully recognize. With his back to the students, Rad scribbled some barely legible formulae on the blackboard, mumbled inaudibly and seemingly incoherently, and then proceeded to erase what he had written before we could copy it down. I had not encountered Rad before in my early tenure at Naval Reactors and decided he could not possibly fit the mold of the extremely talented headquarters staff I had visioned. How wrong I was! Although he had no gift as an instructor, Rad was a genius, and his contributions to the physics of Naval nuclear reactors was enormous.

## USS *NAUTILUS* - WORLD'S FIRST NUCLEAR SHIP

Upon return from the Bettis Reactor Engineering School, I was reassigned to a position reporting directly to Admiral Rickover himself. I was relieving a very competent engineer and naval officer, CDR Frank J. Callahan, as Project Officer for commissioned nuclear powered submarines. Frank, well-regarded by the Admiral and having the extroverted and confident personality of his Irish heritage, had decided that working directly for Rickover had taken its toll on him and his family and that it was time to move on. He resigned from the Navy and went into business for himself, leaving me with the job of carrying out the Bureau of Ships (BuShips) responsibilities for the nuclear propulsion plants of the only two nuclear powered submarines then in commission - USS *Nautilus* and USS *Seawolf*. These responsibilities included tracking the performance of the ships' nuclear power plants and planning for any necessary alterations, overhauls and refuelings. In the Rickover program, my job went beyond the normal BuShips role since the Admiral chose to exercise an almost paternal role over the submarines, carefully monitoring almost every activity of these ships and keeping personally in touch with the ships' commanding officers nearly every day when they were in port.

Before I relieved Callahan, we became involved in my first major crisis at Naval Reactors. The crew of the *Nautilus*, in performing an evolution involving one of the salt-water cooling systems in the propulsion plant, had allowed salt water to leak into the upper level of the ship's reactor compartment; several hundred gallons of this salt water then leaked through openings in the deck separating the upper and lower levels of the reactor compartment. The ship was alongside the pier at the Electric Boat Division in Groton, Connecticut, with the reactor plant shutdown, when this event occurred so there was no danger to the overall safety of the ship or to the crew. However, the primary reactor cooling piping, valves, and pumps – made of stainless steel – were exposed to salt water, and there was great concern that the integrity of this cooling system might have been impaired by a metallurgical phenomenon known as chloride stress corrosion. I was then baptized into the crisis management approach always taken by Naval Reactors when there was evidence of a serious engineering problem. Callahan demonstrated why Rickover held him in such high regard. The Admiral put him in complete charge, receiving at least twice daily telephone reports from Callahan who had relocated to Electric Boat for a two-week period of 18 hour days (I was there with him observing, and wondering how well I could handle such a crisis if it occurred on my watch). Bettis Laboratory, designers of the *Nautilus* reactor plant, sent a contingent of metallurgists, mechanical and nuclear engineers, plant designers and other specialists to perform non-destructive examinations of the stainless steel systems. Meanwhile, a team of Bettis and Electric Boat electrical engineers undertook investigation of electrical systems that had been exposed to salt water and potentially damaged. Callahan directed all of the activities, staying in close touch with senior technical branch heads on Rickover's staff in Washington. There was frequent controversy among the technical people as to the proper steps to be taken, and some of the ship's officers interposed their objections to Callahan's plans. He ignored the distractions, gave full consideration to all of the technical issues raised (a hallmark of the Naval Reactors approach to solving technical problems), made

timely decisions, and proceeded to reach the ultimate objective of his task force – to assure the integrity of the reactor plant so that it and the ship could resume safe operation. It was an impressive performance. There was no permanent damage to the plant, and the *Nautilus* soon was back at sea, operating effectively.

On August 3, 1958, the *Nautilus* crossed the North Pole submerged under the polar ice traveling from west to east. This was a well-kept secret known within Naval Reactors to Rickover and only a few of his top people, not including me. I first learned of the *Nautilus*' polar trip when I encountered CDR William R. Anderson, the *Nautilus* Commanding Officer, in the men's room at Naval Reactors. I said, "Andy, what are you doing here? I thought you were with your ship headed back east through the Panama Canal from Pearl Harbor." Pearl Harbor had been their last port of call. Anderson replied, "Why, didn't you know? *Nautilus* crossed the North Pole and I've just come from a ceremony at the White House with President Eisenhower." Well, even though I was Rickover's Project Officer for *Nautilus*, I had not joined his inner circle and so was totally uninformed about this historic voyage. Incidentally, Rickover had not been invited to the White House ceremony, which promptly created a great uproar in Congress and caused Eisenhower to have Rickover represent him, in an ill-fitting white naval uniform, at the welcome-home ceremony for *Nautilus* when she arrived in New York City.

The polar voyage could well have been disrupted by a technical problem that developed a few weeks before the trip. Measurements routinely taken of the water chemistry in the so-called secondary system (the system which receives the heat from the reactor or primary system and provides the steam to drive the ship's turbines) revealed the presence of a small quantity of salt or chlorides. The source, presumably salt-water leakage into the system, could not be determined. The chief concern was that the presence of even this small amount of chlorides could lead to damage of the stainless steel heat transfer surfaces between the primary and secondary systems (the so called "chloride stress corrosion"). I was a visitor to the ship during its trip from San Francisco to Seattle and recall the alarm by CDR Anderson and his Executive Officer, Frank Adams, over the high chloride readings. Rickover was aware of the problem but seemed to take an uncharacteristically sanguine approach to resolving it, perhaps because he did not feel it was of sufficient technical concern to abort the planned polar trip. Later I learned that some enterprising member of the *Nautilus*' ship's force came up with the idea of using a commercial product, “Stop Leak”, to plug the supposed salt-water leak. A quantity of this substance was poured into the ship's main condenser, and it worked! The chloride levels returned to normal, and the ship proceeded on its traverse of the North Pole.

By 1959, *Nautilus* had been operating for four years. In 1957 its first reactor core had been replaced with a second one of comparable useful life. The first refueling had taken place at Electric Boat, *Nautilus*' builder and clearly the most experienced submarine shipyard in the country. The overhaul and second refueling was scheduled for late 1959 at the Portsmouth Naval Shipyard in Kittery, Maine. Portsmouth was in the process of building its first nuclear submarine and had considerable experience in the overhaul of conventionally powered submarines. The shipyard had no experience in overhauling and repairing a nuclear powered submarine with the concomitant presence of radioactivity.

Admiral Rickover decided that this first overhaul of a nuclear powered ship would be an excellent opportunity to examine in detail various components of the reactor plant to determine what effect, if any, the four years of operation had had on these components. He directed me to arrange to remove and examine several items from the reactor plant: a primary coolant pump, a primary coolant check valve, a large segment of primary coolant pipe, and several stainless tubes from a steam generator (the component which transferred heat from the primary to the secondary systems). This decision resulted in unprecedented work in a radioactive environment, which proved to be extremely complicated, and taxed the inexperienced Portsmouth work force beyond its limits. One of the Admiral's top assistants, and a superb engineer, Bob Panoff, strongly opposed Rickover's decision, which, in his view, would result in "carving up the *Nautilus*" with unforeseen consequences and the possibility that the operating capabilities of the propulsion plant would be detrimentally affected. He managed to convince Rickover not to cut out a section of the primary coolant pipe which was an eminently sensible reversal of the Admiral's plan since this, of all the planned component removals, was the one for which there was no provision in the original design of the plant.

Portsmouth proceeded with the planned *Nautilus* overhaul. The original schedule called for completion within six months, but it soon became apparent that the component removal work in the reactor plant would control the schedule and the six-month timetable could not possibly be met. As Project Officer in Washington, I was responsible for overseeing the overhaul work. I knew the schedule was in jeopardy but did not realize the extent of the difficulties we faced. Rickover, with his customary sixth sense that the *Nautilus* overhaul was getting out of hand, sent Bob Panoff, accompanied by me, to Portsmouth to investigate. Panoff quickly determined that the reactor plant work was controlling the overhaul schedule, that there was no realistic schedule for completing the reactor work, that the overhaul was likely to take an additional several months, and that the Portsmouth manager in charge of the reactor plant work was way in over his head and did not have a clue as to how to get the work under control. The manager was promptly relieved; a task force was established, with heavy involvement by the Bettis Laboratory, to deal with the radioactivity issues that were severely impacting the reactor plant work; a realistic schedule was established; and several other management steps were taken. The overhaul eventually took nearly a year with a significant cost overrun and with considerable and unaccustomed embarrassment to Admiral Rickover and the Naval Reactors program. The components removed from the plant showed no signs of deterioration in the radioactive environment, but lessons were learned, the hard way, in working on a radioactive reactor plant. As a result, both of the Naval Reactors Laboratories, at Bettis and at KAPL in Schenectady, established radiation engineering groups to deal with future nuclear ship overhauls and repairs. When I returned to Washington after our visit to Portsmouth and after Panoff's oral report to Rickover, I received a taste of the Rickover medicine. I had obviously not been on top of the *Nautilus* work at Portsmouth. Rickover called me into his office, with Panoff seated in a chair near his desk and let me have it - "Claytor, you are really a big disappointment. I thought you had something in you. Ah, shit!" Although I survived, this was the low point of my years in the NR Program.

# USS *SEAWOLF* - OPERATING WITH A SODIUM COOLED REACTOR

In the embryonic stages of the nuclear propulsion program, Admiral Rickover was faced with the decision on what type of nuclear reactor plant to select for the first submarines. Based on the very limited data then available, a decision was made to select a dual approach, not knowing which, if either, would be successful. He recognized that a full-scale prototype plant would need to be built and operated for each of the reactor types. Accordingly, he decided that the first prototype and ship would be designed utilizing a pressurized water reactor and that the second prototype and ship would be based on a liquid sodium plant.

The *Nautilus* and its prototype plant were built and operated successfully using the pressurized water concept. In parallel but slightly behind the *Nautilus* schedule, the liquid sodium approach was pursued. A prototype plant was constructed, and later operated at the Atomic Energy Commission's West Milton Site near Saratoga Springs, New York, and the follow-on ship, *USS Seawolf*, was built, as was *Nautilus*, at General Dynamics' Electric Boat Division in Groton, Connecticut.

The sodium plant, at least theoretically, appeared to have several advantages over the water plant. The fluid used to transfer the heat from the nuclear reactor to the steam plant that propelled the ship was liquid sodium, a much more efficient heat transfer medium than the high-pressure water used in *Nautilus*. Moreover, because sodium is a metal, its metallic properties could enable it to be moved through the reactor without being driven by a pump with moving parts; in other words, electric windings surrounding the steel encased sodium would act like the stator of a motor with the liquid sodium behaving like the rotor of an electric motor thus pushing the sodium along through the reactor where it would capture the heat for transfer to the steam propulsion system. Finally, the sodium could be operated at much lower pressure than the water plant thus enabling thinner walled containment and lighter components, weight being a major consideration in the design of a submarine. However, the laws of physics – and engineering – served to offset these apparent advantages. Sodium, as any high-school chemistry student knows, is solid at room temperature, but, during operation, it was necessary to keep the sodium <u>liquid</u> so that it would <u>flow</u> through the reactor system. This required that the sodium be heated by electrical heaters wound around the sodium pipe adding significant additional electrical power requirements and added weight. Moreover, again as the young chemical experimenter knows, sodium and water do not mix well resulting in a chemical reaction with the release of heat. Accordingly it was necessary to keep the liquid sodium separated from the steam and water in the propulsion system while still allowing the sodium's heat to reach the water and cause it to boil into steam; this resulted in a double-walled system which injected a third fluid – inert to sodium – between the sodium and the steam/water. Thus the plant had another added engineering complexity. Nonetheless, these advantages and disadvantages were accepted, and one of the most outstanding engineering achievements of the Navy's Nuclear Propulsion Program was realized in the successful

development of the sodium-cooled plant.

The prototype plant was operated successfully, and the *USS Seawolf* put to sea in mid-1956. The operating record of *Seawolf* for a period of nearly two years was indeed remarkable. Despite some serious engineering problems with *Seawolf*'s steam generation components that limited the reactor from reaching its full-power capacity, the operational reliability of the propulsion plant and the ship itself was outstanding. The ship set a record by remaining submerged for 60 consecutive days thus confirming the viability and vastly superior military advantage of nuclear power for submarines.

Another feature of *Seawolf*, recognized at the outset, but accepted as something to live with while determining the plant's capabilities, was the relatively high radiation levels of liquid sodium during plant operation. It was necessary to restrict access to the pier alongside which *Seawolf* was moored if the plant was operating at even moderate power levels. During its sea trials, a rather spectacular effect was noticed at night by personnel on the ship's bridge when the ship was steaming on the surface: radiation from the reactor plant caused the phosphorous in the sea water to emit light resulting in an eerie glow adjacent to the ship as it moved through the water. These, however, were not considered to be major detriments to the success of *Seawolf*. Much more significant was the relatively long half-life of the radioactivity of the sodium. The water used in the reactor plant of Nautilus had a radioactive half-life of a little over seven seconds once the reactor was shut down; this meant that the water would lose one-half of its radioactivity every seven seconds, and the result of this was that access could be gained to the reactor space for maintenance or repair within about 15 minutes. Not so for Seawolf! The radioactive half-life of the sodium was many hours such that it could be several days before a member of the ship's crew could enter the reactor compartment. To solve this problem, the ship was provided with so-called sodium "hold tanks" which were shielded and separate from the reactor space; in order to gain access to the reactor space (for some necessary inspection, repair or maintenance) within a reasonably short period of time, the sodium would be pumped from the system in the reactor plant into these hold tanks thus eliminating the high radioactivity in the reactor space. This, of course, added to the complexity of the *Seawolf* sodium reactor plant. Fortunately, during the operation of *Seawolf* for nearly two years, it was not necessary to gain access to the reactor space, and accordingly this space remained sealed throughout the life of the plant (despite the development of a small steam leak which was ingeniously repaired by *Seawolf* sailors at sea by freezing the steam/water mixture in the pipe on both sides of the leak and then welding the leak closed between the freeze seals).

I began reporting to Admiral Rickover about midway through the operating life of the *Seawolf* sodium reactor plant and thus became responsible for overseeing its operation along with that of *Nautilus*. Since *Seawolf* performed so well during this period, most of my attention, as previously discussed, was devoted to Nautilus. However, this began to change with the Admiral's decision to replace the sodium plant in *Seawolf* with a pressurized water plant similar to *Nautilus*. The decision was not made because of poor performance by, or dissatisfaction with, the *Seawolf* sodium plant, although some of the problems previously discussed certainly were of some consideration in the decision.

Rather the Admiral's decision was based primarily on the great success of the pressurized water plant in *Nautilus* and its prototype. It was clear that the Admiral much preferred the pressurized water plant to the liquid sodium plant, but he could not be sure that water was much the preferred approach until there had been proven success with *Nautilus* and its prototype. By mid-1957, he had concluded that there was now sufficient experience to justify abandoning the sodium approach for pressurized water for all nuclear powered ships. In fact, much earlier, even before the *Nautilus* sea trials, all other nuclear submarine new designs were of the pressurized water type. As he said to me, " I want to get rid of the *Seawolf* sodium plant as soon as possible because it's dangerous. Sodium in a naval ship at sea is just not a safe thing. When we started out, we simply didn't know which approach would work so we had to try them both. Now that we know water works and is safe, we've got to stop operating *Seawolf* and get her converted to a pressurized water plant as soon as we can. Your biggest problem, Claytor, is to figure out what to do with the sodium and the sodium reactor plant. Now, get on with it!"

When *Seawolf* arrived at Electric Boat at the end of its tour on the sodium plant, there was still a little useful life left in *Seawolf*'s reactor core. Moreover, at the Atomic Energy Commission's Oak Ridge Laboratory in Tennessee there remained several unused reactor fuel elements for the *Seawolf* reactor core. These could conceivably be used to partially refuel *Seawolf* and keep it operating for at least several more months. The Admiral, however, had decided to proceed at once to begin the dismantling of the *Seawolf* sodium plant and get on with its conversion to a pressurized water plant. He did not, however, reckon with the vivid imagination and creativity of the *Seawolf*'s skipper, Commander George B. Laning. Laning had a reputation as one of the Navy's brightest and best minds. Laning, never short of ideas, felt that it was a mistake to stop operating *Seawolf* and that it could be used as a test bed for sodium cooled reactors, where there was potential use in commercial reactors or even in military aircraft or other naval ship applications. One of Laning's supporters reportedly was Rear Admiral Albert Mumma, then Chief of the Navy's Bureau of Ships, nominally Rickover's boss but a long-time adversary of the Admiral. Laning, characteristically, had carried forth his ideas to those in the upper echelons of the Navy bypassing Rickover whom he knew opposed him. Rickover, when he learned of Laning's actions moved quickly. As his Project Officer for *Seawolf*, I was called into Rickover's office. He told me to call Art Francis (Commander Arthur Francis, Admiral Rickover's representative at Electric Boat) and tell Francis to have Electric Boat workmen go down to the ship and remove the reactor control mechanisms from the reactor without delay. (These mechanisms, used for the control of the reactor power level, were a vital part of the reactor plant; without them the plant could not be run.) Rickover's next instructions to Francis, via me, were to have these mechanisms put on a truck and sent to the Naval Reactors Facility in Idaho where they were to be physically smashed to pieces. This was done. Simultaneously, Rickover directed that the remaining *Seawolf* fuel elements at Oak Ridge be melted down. Thus further *Seawolf* operations on its sodium plant were now out of the question, and the conversion to a pressurized water plant could now begin.

## THE *SEAWOLF* CONVERSION

Electric Boat, the builder of *Seawolf*, was the obvious choice as the shipyard to carry out the conversion from a sodium-cooled plant to one cooled by pressurized water. A long-time Electric Boat manager, J. William (Bill) Jones, was selected by EB management as the ProjectManager for the conversion. Bill Jones, later to become the General Manager of Electric Boat, was admittedly not noted as a top-flight engineer but made up for any technical shortcomings by an extroverted and imaginative personality. (Some years later when he became General Manager, I recall his thrusting out his right hand to me, saying, " How would you like to shake this hand? Yesterday it shook the hand of the President of the United States! " Lyndon Johnson had visited the yard the day before.). Jones had some creative ideas about how to dispose of the *Seawolf* sodium plant; these ideas were translated into a plan that was carried out without a hitch.

Whereas there was no evidence that Admiral Rickover had planned to convert *Seawolf* into a pressurized water plant when the *Nautilus* and *Seawolf* were first conceived, nonetheless the Admiral had ordered that all of the *Nautilus* major reactor plant components, including the large pressure vessel that contained the nuclear reactor core, were to be produced in duplicate. Presumably this was done in keeping with the conservative Rickover engineering philosophy that he would be prepared to replace a major Nautilus component should something go wrong with any of the installed equipment. Thus it was fortuitous that the normally long-lead components for the *Seawolf* water plant were already available in storage. The *Seawolf* submarine hull and reactor space dimensions were of an equivalent size to *Nautilus* and thus could readily be installed in *Seawolf* without a major redesign of the ship or the *Nautilus* plant.

It was of course necessary to negotiate a contract with Electric Boat for the conversion. Since no other shipyard was ever considered to carry out this effort, the conversion became a sole-source procurement by the Navy. This put EB in the driver's seat with respect to pricing the contract. As project officer within Naval Reactors, I had the responsibility for providing the Bureau of Ships negotiators with the technical arguments to refute any excessive manhours that EB had proposed for the various shipyard work activities in the conversion. In this I was notably unsuccessful. The EB negotiating team, led by Carleton Shugg, the EB General Manager, came armed with foot-thick tomes justifying all of the various work activities. Every challenge I made to the EB estimated manhours in a specific activity was immediately refuted by the EB negotiating team using this voluminous data. It was a very frustrating experience. The EB team's contract specialist was a very bright young man who had a photographic memory. In my frustration, I appealed to Rickover, telling him that I felt the EB contract negotiator was not willing to concede an inch and that he was arrogant. Rickover, supportive as always when a subordinate brought to him what he believed to be a legitimate problem, immediately picked up the phone, screamed at Carl Shugg, the EB General Manager, telling him that Carl's man was "arrogant" and that EB was not to treat "my" representatives with such disrespect. This had no effect whatsoever; the EB negotiators continued to make very few concessions resulting in the eventual acceptance by the

Bureau of Ships contract specialist of the EB price. Despite my frustrations in not making any significant negotiating headway on behalf of the government, in retrospect I believe it was probably a reasonably fair price considering that no one had ever undertaken the removal and replacement of a nuclear reactor plant.

Admiral Rickover had told me that the one of the biggest problems with the *Seawolf* conversion was what to do with the sodium reactor plant. I had asked our Project Manager at Electric Boat, Bill Jones, to come up with some ideas for dealing with this problem. With his colleagues at the shipyard, he devised a relatively simple plan that appeared to have essentially no environmental impact.

The *Seawolf* sodium plant contained residual radioactivity in its corrosion resistant stainless steel equipment but no loose surface radioactivity that could be dispersed to the environment. It was therefore concluded by the Atomic Energy Commission waste disposal experts that sea burial of the plant would be entirely safe and would in no way harm marine life.

Accordingly, the sodium pumps, valves, steam generators, reactor vessel, and miscellaneous pieces of equipment from *Seawolf*, including the "hold" tanks filled with solid sodium, were removed from the ship and loaded into a large cylindrical vessel with tapered ends (called a "barge"). As planned, the "barge" was towed out into the Atlantic Ocean far beyond the continental shelf; a valve on the barge was opened to allow the entry of sea-water; and the entire array disappeared beneath the surface of the sea to its burial spot on the ocean floor where it surely remains safely contained to this day. Electric Boat then proceeded to convert *Seawolf* into a new submarine – same name and same hull number (SSN575) – but now with a *Nautilus*-type reactor plant.

# THE CONVERTED *SEAWOLF* SEA TRIALS

It was Rickover's custom to go to sea on the initial sea trials of each new nuclear ship. While the *Seawolf* had already had its initial sea trials on its sodium reactor plant, the ship now had a pressurized water plant and thus fell into the category of a "new" nuclear submarine for purposes of its first trip to sea on the new plant. Accordingly Admiral Rickover arrived on Saturday night at Electric Boat prepared for the ship to get underway the next morning. It was invariably his practice to begin these sea trials on Sunday, thus minimizing his time away from his working schedule; Sunday was the only day in the week in which he and his staff – both in Washington and at his field activities – normally were not expected to be in the office.

When he arrived at Electric Boat, his instructions were to have a set of Navy khaki working clothes, a uniform without insignia, available for him to wear aboard ship. He, of course, never appeared in a Naval uniform wearing the insignia of his flag rank (except on some rare occasion such as when he represented President Eisenhower at the welcome-home ceremony for the *Nautilus* after completion of its polar trip). On this occasion it is most likely that he arranged to have the ship's barber give him a haircut; this was his normal practice, and I am not aware that he ever visited a commercial barbershop.

The commanding officer of *Seawolf* was Commander Al Whittle, a most congenial and intelligent naval officer, whom I had come to know quite well during his tenure in Naval Reactors headquarters as prospective commanding officer of *Seawolf.* (All prospective commanding officers – known as PCO's – were routinely ordered to Naval Reactors at Rickover's insistence so that they could be indoctrinated into the ways of the Rickover organization, and I am sure, to allow the Admiral to observe and reject them for ship command if he chose.) Whittle, who later achieved four-star rank as the Chief of Naval Material (thus becoming Rickover's nominal "boss"), managed to ride through the Naval Reactors headquarters experience without incident but unfortunately encountered a maelstrom soon after he arrived at Electric Boat prior to taking command of *Seawolf.* It was the custom for the commissioning crew (*Seawolf* had been decommissioned during its conversion), with its PCO in charge, to put the ship through its dockside propulsion testing under the close scrutiny of the Bettis and EB technical people. During this testing, one of *Seawolf*'s sailors made an operational blunder which, as always, was reported to Rickover by his representative at EB. Rickover, outwardly enraged but perhaps more to teach a lesson to his PCO, demanded to know immediately what corrective action Whittle would take. Whittle developed a course of action, most likely commensurate with the gravity of the incident, and reported it to Rickover who instantly rejected it. Whittle tried again with Rickover to no avail. This back-and-forth between Whittle and the Admiral went on – without resolution – for several days. Finally, Whittle came to me and said he knew of no other solution to the problem than to withdraw as commanding officer of *Seawolf.* I told him I was sure that this was not what the Admiral had in mind. He may have tried this "solution"; if so Rickover rejected it. Somehow, after trying again a few more times, he came up with an approach that the Admiral was

willing to buy. This, no doubt, was a graphic example of the Rickover "training", as he himself liked to describe his methods. Whittle went on to become CO of *Seawolf*, followed by a distinguished career in the Navy.

We went to sea that Sunday morning in 1958 to test the performance of *Seawolf*'s new propulsion plant. As the Naval Reactors project officer for *Seawolf*, I was responsible directly to Rickover for the performance of the trials that were actually conducted by the ship's crew. After a very long day of routine tests and other evolutions, I retired to my berth about midnight to get a few hours of needed sleep. However, I made the mistake of getting into my bunk while Rickover was still roaming about the ship although no further tests were planned until the next morning. While fitfully dozing, I heard the harsh voice of the Admiral: "Claytor, goddamnit, what the hell are you doing? I thought you were supposed to be in charge of these trials. Grigg (this was Jack Grigg, Rickover's chief electrical engineer on his headquarters staff, who was sleeping in a bunk above me), take charge of the trials!" I was now relegated to the post of observer during the rest of the trials and thenceforth tried to help Jack Grigg as best I could.

It was the practice on all the initial sea trials to conduct a four-hour full power run while submerged, this being the ultimate initial test that the propulsion plant was fully operational and would support the newly commissioned submarine in carrying out its mission. Just prior to the commencement of this test, a small steam leak was noticed emanating from a small drain pan beneath the starboard main steam turbine. Both of the main turbines operating at full throttle were required to carry out the four-hour full power run. The General Electric representative who was riding the ship on the sea trials was immediately consulted, GE having designed and manufactured the main turbines. He advised that we should not conduct the full power run but that we should abort the sea trials and return to EB to repair the steam leak. The GE representative said he feared that the leak might propagate and cause a real catastrophe, filling the engine space with live steam with the ship submerged. Rickover, frail but at 58 years of age still quite spry and active, decided he would need to see for himself. He crawled down underneath the turbine with a flashlight and had a good look. He concluded that the small crack in the drain pan, causing the leak, was of insufficient size to cause concern if the turbine were operated at full throttle. He then ordered that the engine room be cleared of all personnel including the normal roving watch-standers and that the ship proceed with the full power run. To demonstrate his confidence, he alone remained in the engine room, placing a chair between the two main turbines, whereupon he sat, reading a book, for the four hours it took to conduct the full power run. Naturally, given Rickover's uncanny knack of having things go his way, all went well; the full power run, as well as the sea trials themselves, were successful. It all added to the Rickover mystique and his reputation of having an "engineering sixth sense".

# LIFE IN NAVAL REACTORS HEADQUARTERS

From October 1957 to April 1963 I reported to Admiral Rickover as the Project Officer for Commissioned Nuclear Submarines. As more submarines beyond *Nautilus* and *Seawolf* were completed and joined the fleet, my job expanded to take on the added chores of monitoring more and more ships - *Skate, Swordfish, Seadragon, Scorpion, Halibut, Skipjack* and others – all in the long-standing Navy tradition of naming submarines after fish – later to be expanded to be named after famous Americans, then U.S. cities, and finally, with the advent of the huge Trident missile submarines, states (names previously reserved only for battleships).

NR was staffed with several competent engineers, and, as the scope of my job increased, I was fortunate that a few of them were added to my staff. Most notable were Bill Young, Dennis Durnan, and Gene Rogers, all of whom were major contributors in the commissioned submarine project office. Young resigned from NR somewhat disillusioned after the difficulties with the first overhaul of *Nautilus* but returned, at my invitation, several years later to rise to several top jobs in the program. Durnan later moved to senior positions at NR program offices in Schenectady, New York, finally retiring from the government in 2003 having served NR for 46 years which set the NR record for years served. Rogers, tough and demanding, always a Rickover favorite, took my job when I was reassigned to Pittsburgh in 1963, and later held other top jobs remaining in the program until after Rickover himself retired in 1982.

The "care and feeding" of all these ships brought me into contact with the submarines' prospective commanding officers (PCO's) who were assigned for several months duty in NR headquarters. They were uniformly among the finest Naval officers of their time. Rickover, with mock sarcasm, referred to them as "heroes"; one of the Admiral's WAVE assistants had a lovely soprano singing voice, and he often called on her to stand in the NR main corridor and sing to the PCO's, "My Hero", being one of the featured selections. The PCO's were an interesting bunch, many destined for prominent roles in the Navy and beyond. There was gruff-talking, cigar-chomping Jim Osborne, the skipper of the first Polaris missile submarine, *USS George Washington*; Lando Zech, the third CO of *Nautilus*, a class act who later became Chief of Naval Personnel and subsequently Chairman of the Nuclear Regulatory Commission; Wes Harvey, an engaging young officer whose promising career ended with the loss of his ship, *USS Thresher*, with all hands during post-overhaul sea trials in April 1963; Hal Shear, one of the first Polaris skippers, who later became Vice Chief of Naval Operations and then Chairman of the Maritime Commission; and Jim Watkins, the only PCO, up to that time, to reach the top of the Navy as CNO and who later became the first Naval Academy graduate to serve in a Presidential Cabinet post, as Secretary of Energy.

My assignment also brought me into frequent contact with my associates within the NR headquarters organization. Although I reported directly to the Admiral along with about 25 other people in headquarters (a span of control that would have shocked the Harvard

Business School), some of us were more equal than others. I was not among the "more equal" group; in fact at times, I was not sure of survival - or even, sometimes, that I wanted to survive! During my seven-year tenure in NR headquarters, there were about a half-dozen in the select group who were closest to Rickover: all were technically highly competent and could have held top jobs in industry. This group included Ted Rockwell, the nominal Technical Director; Harry Mandil, in charge of reactor design; Bob Panoff, Project Officer for New Construction Submarines; Milt Shaw, and Dave Leighton, the latter two sharing technical and project responsibilities respectively for nuclear surface ships (the first of which was the aircraft carrier *Enterprise* with eight nuclear reactors). Rockwell, who has written the only definitive "insider" book on Rickover, along with Mandil and Panoff left the Admiral's program in the mid-1960's to form their own consulting firm, MPR. Milt Shaw went on to become a very effective, although controversial, director of the AEC's civilian nuclear power program; he was subsequently fired by the equally controversial last chairman of the AEC, Dixy Ray Lee. Dave Leighton continued in the Admiral's program as one of the few key people during the later years of Rickover's tenure.

The Admiral said to me soon after the MPR group had left his program and founded their own company, " Mandil was respected and liked – Panoff was respected and disliked." As usual, the Admiral had it right. Bob Panoff was easily one of the most interesting people on Rickover's staff. Without question he was also one of the best engineers in the program - highly creative but eminently practical. He was the driving force behind much of the early submarine reactor plant designs and he knew how to get things done. He was clearly respected and also feared by many. He could be decidedly intimidating, and of all the people I encountered on the Admiral's staff, he was most like the Admiral in his style and methods. Five feet tall, stocky and bald, he could with a direct, withering, in-your-face look spot a phony argument or dismantle a questionable technical approach in seconds. One encounter with Panoff that I will always remember involved a direct threat to me. I had advised Rickover that Bill Young, the former NR engineer who had worked for me, wanted to return to NR, having found the commercial engineering world not to his liking. The Admiral told me that I should first find out what Panoff thought of Young before offering him a job, which I did. Panoff said, "The man you want to bring back is OK, but he's not good enough to ever hold a top job here." I thereupon rehired Young after which Panoff asked me if I had told Rickover his view about this man never holding a top job here. I told Panoff that I had advised the Admiral that Panoff had OK'd the rehiring but had not mentioned his other comment to the Admiral. He looked up at me from his full five-foot height and said, "By God! I'll fix your wagon!" Our relations after that were strained. I did respect him, but he was hard to like. I must confess some hidden amusement some time later when one of the Bureau of Ships flag officers, at a social occasion at the Pearl Harbor Shipyard, patted Panoff on the top of his bald head and said, "Now, now, Shorty Pantsoff!" (Incidentally, Bill Young not only later became one of the top people in NR reporting directly to Rickover but also in 1989 became Assistant Secretary for Nuclear Energy in the U.S. Department of Energy.)

Much has been said about Rickover's unusual management techniques but some of them bear repeating. The Admiral required that everything typed on any typewriter in NR must

have a pink carbon copy included (this was in the days before word processors and desk-top computers, and multiple copies were made with messy carbon paper). The pink copies were immediately removed from the typewriter and sent to the Admiral's office where they were compiled by each NR section for the Admiral's review. Any secretary who failed to make a pink copy and send it on to the Admiral was subject to dismissal. I do not recall anyone ever being fired for failure to follow this rule, but the threat was always present and secretaries dutifully complied. The rule applied to *anything* typed including rough drafts. (The only exception of which I was aware, very likely unknown to Rickover, was that no pink would be made when Bob Panoff instructed his secretary to type a "rough, rough draft".) The Admiral used the pinks as a powerful control device. He read all of them, always within the space of 24 hours, usually sooner, and called the authors to his office sometimes for questions but more often to scream and yell at the writer for his mistakes or his stupidity. (Speaking of "stupidity", Dave Leighton once said to the Admiral at an open NR meeting, "We don't mind your calling us an 'S.O.B.', but we can't stand it if you call us a "*stupid* S.O.B.!" I do recall the Admiral's referring to his subordinates "stupid" actions, but I never heard him call anyone an S.O.B.)

Another extraordinary management control tool was the "Jean item". This appellation was derived from the first name of Jean Scroggins, a young WAVE enlisted woman, who appeared to have a lifetime assignment at Naval Reactors. The system worked in this way: Rickover would receive a letter from one of his numerous field representatives or some other source, of which there were countless, which identified a problem such as, in my case, a problem with one of the commissioned submarines. The Admiral would scribble the letter "J" followed by the letter of the section head involved (in my case the letter "C") at the top of the correspondence that would then be sent to the section head for a written reply to the Admiral identifying the course of action to resolve the problem. The difficulty with all this was that Rickover almost never considered the proposed solution to be satisfactory, and the "Jean item" continued to be returned to the section head for further action. Someone, probably Jean, kept track of the open Jean items that could remain unresolved for months, all the while being used by Rickover to keep the heat on people to take care of the problem. The net effect of these accumulating Jean items was a time-consuming annoyance to the recipient; but it did serve Rickover's purpose of forcing attention to details albeit sometimes of a trivial nature. After several years working in NR, I got to know Jean pretty well and was able to talk her into canceling some of the old Jean items by telling her the issue had been resolved. "Trust me", I said, and she did, although I am sure Rickover never learned of this circumvention of his system.

# LIGHTER MOMENTS IN NR HEADQUARTERS

It was not all business in NR Headquarters. There were occasional light moments, some of them engendered by Admiral Rickover himself. At one point he posted a list of "excuses" on the outside of his office door. Each excuse on the list was numbered, e.g., 1. I forgot, 2. I didn't have time, 3. I was working on something else, 4. I didn't think it was due yet, 5. I'm sorry, 6. My baby daughter tore it up, 7. My dog ate it, etc., etc. The object of all this was to save the Admiral time when one of his subordinates failed to complete an assignment – the guilty individual was instructed to give the Admiral a number instead of a lengthy oral explanation for his failure.

The Admiral loved to tweak the bureaucracy. A typical example is a memorandum he sent to the Assistant to the Atomic Energy Commission's General Manager dated 2 February 1968, which is quoted below in its entirety:

> "This will acknowledge receipt of your memorandum and attachment dated January 26, 1968, requesting my review and comments on your Guide for the Preparation of Special Analytical Studies. I have spent much time reading this document; unfortunately, I cannot understand it. Its statements on how to conduct Special Analytical Studies sound extremely impressive -- these statements include many large and unusual words in complex syntax and obviously are the work of an intellectual. However, many such statements are beyond my comprehension; for example: 'The concept of a parallel internal list of topics in addition to those which are specifically identified for near-term submission to the BOB recognizes an Agency need or interest for initiation of study activity in areas in which it is not clear prior to completion that discussion with BOB will be warranted, or which may represent possible early phases of more formal studies later or which may require an extended period for completion.'
>
> As you know, my training is in Engineering and not in Analysis and is thus deficient to enable me to understand your Guide. I asked several of my leading engineers and scientists to help me, but they also found your Guide beyond their comprehension. My conclusion is that we in Naval Reactors are not sufficiently sophisticated to understand it; in order for us to ascertain if your Guide has any practical use, it would have to be rewritten in simple English, that is, in language we 'plumbers' in Naval Reactors could understand.
>
> On August 23, 1967, before the Senate Subcommittee on National Security and International Operations of the Committee on Government Operations, Mr. Schultze, Director of the Bureau of the Budget stated that 'the whole procedure for analytical studies is set up to generate counter-analysis by other advocates (or adversaries)'. To do this he said, 'Admittedly, an agency is dependent primarily upon its own analytical staff.'
>
> Because your Guide is beyond my comprehension, I considered referring it to my 'analytical staff' for appropriate analysis and simplification. Unfortunately, my 'analytical staff' is presently engaged in preparing several 'counteranalyses' to analyses prepared by the Department of Defense concerning application of nuclear propulsion to surface naval warships. In addition, someday I would like to have my 'analytical staff' available to perform some technical work for the Naval Reactors program if I am not forced to continue to study and report on these more esoteric matters. Accordingly, I have deposited your Guide in my special file. When and if you rewrite it in a form I am able to understand and when and if my 'analytical staff' finishes his present analytical 'counteranalyses', does some of his technical work, and has time to analyze your Guide, I will provide you my comments, if

any."

With the reference to surface ship nuclear propulsion and to an analytical staff in the singular, I strongly suspect that Dave Leighton was the author of this piece with a few edits by Rickover. It is the sort of mischief the Admiral enjoyed from time to time.

There were other light moments in the hectic day-to day grind. One day appearing on my desk was a copy of a two-page document entitled "NR Crew Quiz". Rereading it now 45 years later still evokes laughter. To fully appreciate its humor, one has to understand the rigorous examinations of the officers and men of commissioned nuclear ships that were undertaken by the Admiral and members of his headquarters senior technical staff. These became known as the NR Crew Quiz and involved several days of oral and written examinations of the ships' crews to determine their knowledge and understanding of the operation of the nuclear propulsion plant under both normal and emergency conditions. Such examinations of operating commissioned ships by mostly civilians from the Navy's shore establishment were unprecedented but were justified by the Admiral's responsibility within the Atomic Energy Commission for assuring the safety of Naval nuclear reactors. Later these "quizzes" were undertaken by a Naval Examining Board made up of technically qualified naval officers experienced in nuclear propulsion plant operations. The questions which were asked were tough, and failure by some ships' crews was not unknown.

Thus the following parody that was circulated within NR headquarters one day:

NR CREW QUIZ

Instructions:

Read each question carefully. Answer all questions. Time limit: 4 hours. Begin immediately. Work in numerical order (equipment remaining from question 1 may prove useful with questions 3 and 6).

1. Medicine. You have been provided with a razor blade, a piece of gauze and a bottle of Scotch. Remove your appendix. Do not suture until your work has been inspected. You have 15 minutes.

2. History. Describe the history of the Papacy from its origin to the present day, concentrating especially but not exclusively on its social, political, economic, religious, and philosophical impact on Europe, Asia, America, and Africa. Be brief, concise and specific.

3. Public Speaking. Two thousand drug-crazed aborigines are storming the classroom. Calm them. You may use any ancient language except Latin or Greek.

4. Biology. Create life. Estimate the difference in subsequent human culture if this life form had been created 500 years earlier, with special attention to its probable effect on the English Parliamentary system.

5. Music. Write a piano concerto. Orchestrate and perform it with flute and drum. You will find a piano under your seat.

6. Engineering. The disassembled parts of a high-powered rifle have placed in a box on your desk. You will also find an instruction manual printed in Swahili. In 10 minutes, a hungry Bengal tiger will be admitted to the room. Take whatever action you feel is appropriate. Be prepared to justify your decision.

7. Sociology. What sociological problems might accompany the end of the world? Construct an experiment to test your theory.

8. Management Science. Define management. Define science. How do they relate? Create a generalized algorithm to optimize all managerial decisions. Assuming a 7600 CPU supporting 50 terminals, each terminal to activate your algorithm, design the communications interface and all necessary control problems.

9. Economics. Develop a realistic plan for refinancing the national debt. Trace the possible effects of your plan on these areas: Cubism, the Donatist controversy, and the wave theory of light.

10. Psychology. Based on your knowledge of their works, evaluate the emotional stability, degree of adjustment and repressed frustrations of each: Alexander of Aphrodisias, Ramses II, Gregory of Nicea, Hammurabi; support your evaluation with quotations from each man's work. It is not necessary to translate.

11. Epistemology. Take a position for or against truth. Prove the validity of your position.

12. Classical Physics. Explain the nature of matter. Include in your answer an evaluation of the impact of the development of mathematics on science.

13. Modern Physics. Produce element 107. Determine its half-life.

14. Energy Resources. Constuct a working fusion reactor.

15. Philosophy. Sketch the development of human thought; estimate its significance. Compare with the development of any other kind of thought.

16. General Knowledge. Describe in detail, briefly.

17. Extra Credit. Define the universe; give three examples.

I often wondered who authored the "NR Crew Quiz". It looks like the work of Dave Leighton, but I am sure Rickover had a hand in it in view of its literary and intellectual overtones. The Admiral in spite of his 80-hour work-weeks was extremely well read and was probably the only true intellectual in our midst. Most of us barely had the time to read the Sports section of the Washington Post. In any event, we all enjoyed this well conceived satire which helped to lift the burden of our long hours and deadly serious work – if only temporarily.

The Admiral did enjoy other light moments to break the hectic work pace for himself if not for his subordinates. At almost any point in the day, he might stroll down the hall and visit with his favorite WAVE officer, LT Rae Sarbaugh, an extremely bright and perceptive young lady who was not afraid to speak bluntly and forthrightly to the Admiral. He used to kid her frequently, and she took it all with great good humor. I recall that the NR internal phone directory included her extension under both her own

name and that of P. Galore (derived from the James Bond paramour, Pussy Galore, in the film "Goldfinger"). The Admiral also assigned other fictional names in the phone directory to others on his staff with whom he enjoyed occasional moments of playful banter; I was not among them.

Although Rickover complained that most of his people fell into two categories: “TV Watchers” or “Nest Builders” (the latter being those who spent time repairing and upgrading their homes), he nevertheless did recognize – rarely – accomplishments by members of his staff. Ted Rockwell, among a relatively small number in NR who were deemed to write with clarity and lucidity, had a framed citation on his wall, signed by the Admiral, which recognized Rockwell as a “Word Engineer”; I recall the citation also noted that it was awarded on Ground Hog’s Day. I never received this recognition, but he did say to my wife at one of the rare NR parties that I had started out in the program as a routine naval officer and that he had “made your husband into something useful”. This compliment may have been made to sooth the bitter resentment my wife often felt toward him and could well have occurred shortly after he had delayed by several days my planned vacation because I was unable to write an adequate letter for his signature which he had requested; it took five versions for me to get it “right”, at least two of which he had tossed on the floor of his office when I presented them to him – no “Word Engineering” degree for me!

I did however enjoy the dubious pleasure of being the Admiral's chauffeur from time to time. Rickover, who lived in a high-rise apartment building on Connecticut Avenue, did not drive and occasionally sought transportation to and from his apartment and his office on Constitution Avenue by soliciting rides from members of his staff who drove to work. I had purchased as a second car a rather dilapidated, used 1950 Studebaker; this vehicle suited the Admiral just fine. On more than one occasion, he would call me on Friday evening before close of business and ask me to pick him up at his apartment on Saturday morning about 8:00 AM thereby assuring that I would not only be at work on Saturday (which I invariably was) but also that I would be there early (which was often not the case). Some of these "rides" were memorable. As I was to learn clearly a few years later when assigned to duty in Pittsburgh, being confined in an automobile with Rickover not only risked an automobile accident by a nervous driver but also could lead to conversations that would better have not been held. I recall on one Saturday morning in Washington I mentioned that I was having difficulty with one of the Navy Supply officers on the NR staff whose job it was to support me in my role as project officer for commissioned nuclear submarines. I never intended to have this young officer expelled from the NR program but this was precisely the result of my intemperate remark. The Admiral pursued my initial comment aggressively both with me and others and decided that the young man, slated for an important field assignment, should be sent back to the fleet, probably with less than a satisfactory fitness report. In retrospect this incident revealed the need to be most cautious in commenting to the Admiral especially if impugning a third person; it also revealed Rickover's impulsive nature and his proclivity to act quickly. But in fairness to the Admiral, he seldom took an action such as this without first making a determination – albeit a swift one – that he had taken the right course. In this instance, he probably did the right thing, and certainly thereafter my

support from the Supply officer community in NR improved substantially.

Invariably, during those mornings I picked up the Admiral at his apartment for the journey down Connecticut Avenue toward the Main Navy Building, he would read the Washington Post (except for an occasional conversation such as the aforementioned). His consistent habit in reading the paper was to tear out articles of interest, stuff them in his coat pocket, and throw that part of the paper he had read into the back seat. By the time we reached the office, my car resembled a trash heap.

One evening the Admiral asked for a ride home. On this occasion I had previously arranged to pick up at the Main Navy gate my brother, Bob, for an overnight stay at our home in suburban Maryland. When Bob got in the car, I introduced him to the Admiral, who characteristically demanded to know what my brother did. Bob replied that he was a lawyer. Rickover said, "Do you know what Shakespeare said about lawyers?" My brother, a well-read graduate of Princeton and Harvard Law School, was quick to respond: "Yes sir. Shakespeare said the first thing we do is kill all the lawyers!" Rickover's response to this was a classic and was often repeated by my brother in the years ahead: "Well I'll be goddamned! That's the first time I ever met an educated lawyer!"

## USS *SKATE* SHOCK TESTS

Those years (1957-1963) in which I served as project officer for commissioned nuclear submarines were never boring and were invariably filled with memorable Rickover anecdotes. The 60-hour weeks took their toll on my family life (a young wife who never came to terms with the Admiral's demanding regimen and three small children, who no doubt suffered from neglect by their father). Nonetheless, the alternative to staying on with the NR program was resigning from it and thereby admitting failure.

So, I stayed on and endured both the unpleasantries and less frequent bouts of euphoria brought on by the excitement of being involved in a program that was indeed important to national security. One event I recall represented both of these emotional states. Having just climbed into my bed at home in Washington for a needed night's sleep before facing another day in the Admiral's hectic headquarters environment, I was awakened by a telephone call from Karl Swenson, my former first boss in the NR program, who on this occasion was the NR representative at Key West, Florida where the nuclear submarine, *USS Skate*, was undergoing shock tests to measure the integrity and operability of the ship and its equipment under battle conditions. Shock tests involve the detonation underwater of explosives, such as TNT, to simulate depth charges that might be experienced by a submarine under attack by a surface ship or airplane; in this instance the explosive charge was a timed detonation several hundred feet distant from the submarine as the latter passed through a marked range at periscope depth.

The tone of Swenson's voice in his middle-of-the-night call revealed his obvious concern. Earlier that day *Skate* had completed one of a series of shock tests and had returned to port at Key West in preparation for another more severe test on the following day. Half-awake I listened as Swenson said, "We have a strain gage reading on the main coolant pipe which appears to indicate that the pipe has undergone deformation as a result of the previous shock test. The Bettis representative on the tests recommends that we do not go to sea tomorrow for the next test and that instead we evaluate this reading and determine its significance before any more tests are performed." I readily understood the technical importance of what Swenson had told me. The propulsion plant had been outfitted with various measuring devices to determine any irregularities resulting from the shock tests. Among these devices were strain gages affixed to the main coolant pipes to register any stretching of the pipe walls; these pipes contained the pressurized radioactive water which took the heat from the nuclear reactor and transmitted it to the steam generators where the steam was extracted to drive the ship's turbines. Thus, there appeared to be some legitimate technical questions involving a vital system that required resolution. I was now fully awake and told him I agreed with his recommendation that the shock test scheduled for the following day should be cancelled.

Having now returned to bed (it was about 2:00 AM) with my mind churning, I found it hard to get back to sleep. After a bit of this fitful attempt at sleep, it suddenly occurred to me that I ought to advise the Admiral of Swenson's report and the decision we had made. I thereupon called the Atomic Energy Commission switchboard (the only way to reach

the Admiral when he was at home) and asked to speak to the Admiral. He came on the line and asked me how much was the reported deformation of the pipe. I advised him that it was in the thousandths of an inch, but that nonetheless in the view of our reactor plant designer (Bettis Laboratory) it was considered significant and needed to be evaluated before we undertook another shock test. With that the Admiral began to scream, thus guaranteeing no further sleep for me that night. He yelled, "You have no authority to keep a Navy ship from going to sea! Who the hell do you think you are? Now you call Swenson back right away and tell him that the Skate is to get underway tomorrow and go ahead with the next shock test. Tell him you were wrong to authorize the ship to remain in port!" "But, Admiral", I protested, "the Bettis representative said..." The Admiral immediately interrupted with an even higher decibel level than before, "Do what I tell you!" With that he hung up. I dutifully called Swenson and gave him his instructions despite his pleas -"Does the Admiral understand?" The next day Rickover called me into his office for what I thought would be a further chastisement. He simply said quite calmly, "Claytor, you did the right thing by calling me. The ship will be OK."

The Skate shock tests continued, but that is not the end of the story involving Rickover in these tests. For the last and most severe test, the Admiral decided that he himself would be the NR representative on board. There had been a recurring problem during these tests with some of the circuit breakers in the propulsion plant. When the shock wave hit the ship, some of the circuit breakers had tripped thus shutting off electric power to affected equipment and at least in one case causing the nuclear reactor to "scram" or shut itself down. For the final test Rickover decided that too much information was being lost by the tripped circuit breakers and thereupon made the decision to block out the breakers. I understood that this was against the advice of his top electrical engineer because of the danger of overheating and fire, but he clearly believed with his long electrical engineering experience (he headed the Bureau of Ships electrical desk during World War II) that it was safe to proceed in this manner. The test was accordingly run with blocked circuit breakers with satisfactory results and no incidents.

# THE NAVAL REACTORS TECHNICAL BULLETIN

Early in my tenure as project officer for commissioned nuclear submarines, Admiral Rickover voiced an idea that obviously had been on his mind for some time. He worried that the officers and men in the operating nuclear ships were too insular and not aware of problems occurring on other nuclear ships or of lessons learned from such problems. When the first nuclear submarines began operating, Rickover established a system for the reporting of unusual occurrences or "incidents", as they were called, in the operation of nuclear power plants, both at the land-based prototypes and aboard the operating ships at sea. These reports were to advise NR headquarters of events such as material or equipment failures, unusual technical conditions in plant operations such as abnormal primary and secondary water chemistry, and human errors in the operation of the reactor plants. These reports were invaluable in monitoring performance and served as a basis for important corrective actions such as physical changes to the plants or changes to operating manuals.

What bothered the Admiral the most is that these reports, more often than not, ascribed the events reported to design or equipment deficiencies. As more of these reports arrived in headquarters with the expanding fleet of nuclear submarines, he became increasingly infuriated with what he judged to be "passing the buck" by the submarine commanding officers and their officers. In almost every report received (and he received - and reviewed - all of them), he would scribble in his illegible handwriting: "Not design - operator error!" or even stronger language. He was not always right in these assumptions, as some of us tried to explain, unsuccessfully, to him. I think it particularly galled him when the report said "design error" as the cause of an incident because of course this reflected directly on his own organization which designed the plants. He would often call me into his office to tell me to call the submarine CO when the ship was next in port to "chew" the latter out for irresponsible reporting or he would tell me to have the CO call *him* so he could deliver the message personally for the most egregious cases.

The Rickover admonitions, despite their delivery in choice language, did not, in Rickover's view, result in any more "objective" reporting. Thus he came up with the idea that there needed to be some kind of permanent written record of getting the word out to the submarine skippers without impugning them personally. Such a publication could also serve as a way to tell all of the skippers about incidents of particular concern and provide lessons learned. Although the idea for this approach was born, I believe, out of his frustration with incident reporting, he gradually became more enamored with having an informal vehicle to get the word out to "his" nuclear ships about technical and plant operational matters of importance. So he said to me one day: "I want you to put together a volume of technical information which we can send directly to ships. But it needs to have clear statements that this information does not in any way supersede official documents for the operation of the propulsion plants." I initially looked on this as another one of Rickover's many ideas that he would soon forget about. After all, I reasoned, this would be an extraordinary document - outside of official channels - and

would likely be another opportunity for the Admiral's many enemies to criticize him for communicating with the ships outside of the chain of command. As usual I underestimated the Admiral. This was one idea he did not forget. He was already receiving periodic letters directly from the submarine CO's; therefore, he reasoned, why should he not provide feedback directly from him to them?

Thus was born The Naval Reactors Technical Bulletin, which became another one of my assignments. I became writer, editor and the pest for almost all of the busy NR technical section heads urging them to contribute to the Bulletin. Rickover, of course, reviewed everything that went into the publication and wrote a good deal of material himself, including a lecture on the proper cause (read "operator error") of most reported incidents. Rickover's reviews of material submitted to him always led to the need for substantial rewrites, often by me because I could not get my colleagues in NR to do so under pressure from Rickover's tight timetables, especially for those things of keen interest to him. The Bulletins were each serially numbered, classified appropriately, and had a formal change control system. As expected, the senior Navy people grumbled about another special Rickover activity outside of the normal loop and requested that they be placed on the distribution. The Admiral steadfastly refused and always countered such requests by threatening to cancel the Bulletin and thus shut off valuable technical information to "his" ships; the Navy requests were invariably withdrawn. The Technical Bulletin became another useful technique for promoting excellence throughout the Naval Reactors Program.

# THE FUEL ELEMENT DEFECT IN USS *SHARK*'S REACTOR

Probably the most fascinating technical problem I encountered when I served as commissioned submarine project officer was the fuel element defect discovered in the reactor of *USS Shark*, one of the earlier attack submarines.

The water chemistry of the primary reactor coolant in all of the naval reactor plants was checked periodically to assure that it remained within specification. Any abnormalities were immediately reported to NR headquarters. Through these reporting requirements, we learned that the *Shark*'s primary coolant water contained a small quantity of radioactive fission products. These "fission products" could only have come from a defect of some kind in a fuel element in the ship's reactor. Fission products are radioactive materials resulting from the breaking apart, or fissioning, of the uranium in the fuel elements – a process that produces the heat that ultimately provides the energy to drive the submarine.

While the amount of radioactivity was small without any imminent danger to the ship or its crew, there was obvious concern with the possibility that the defect could propagate and cause damage to the ship's reactor plant. Accordingly, a Westinghouse Bettis task force was established headed by a superbly well-qualified engineer, Bill Hamilton, who had already established himself as one of the preeminent engineers in the NR program and who later became the Bettis General Manager. Hamilton's task force was charged with determining the source of the fission products and a course of action to assure safe and continued operation of the ship. Admiral Rickover tasked me with being his personal representative to oversee the work of the task force and to report to him daily on progress.

The *Shark* was berthed for this exercise at the Newport News shipyard in Virginia and we all gathered there to carry out the work of the task force. Rickover sent to the shipyard two senior technical representatives from his Washington staff, Ted Iltis and Murray Miles, each rotating the assignment for one week at a time. Although Iltis and Miles were both competent and experienced in the water chemistry and radiation aspects of Naval nuclear reactor plants, they could not have been more different in personality and approach. Iltis was outgoing, imaginative, and sometimes, in my judgment, a bit “off the wall”, while Miles was serious, intensely detail-oriented, and highly opinionated. This created an occasional confusing situation with each telling Hamilton how to do his job. Hamilton, steady, purposeful, and invariably tactful, politely acknowledged this NR “technical direction” and then went about directing the task force in his own thoroughly methodical and analytical approach. Meanwhile, as the work continued for several weeks, I watched over the process trying to balance the sometimes conflicting Iltis/Miles comments and assist Hamilton (who needed little), keeping Rickover informed through daily phone calls.

The defect in the fuel element was precisely located within the reactor by means of a highly complex – and classified – process. Rickover decided it was safe to continue

operation of the ship until its refueling scheduled within the next two years while measuring the water chemistry to determine if there was any indication of an increase in the size of the defect. Fortunately the water chemistry remained stable, and *Shark* continued to operate successfully until it was refueled.

Although my role in this was minimal, I was rewarded by the Admiral for spending several weeks away from home and keeping him informed. When I returned to NR headquarters at the completion of the *Shark* testing, he called me into his office and handed me a tie clasp bearing the initials "NR" with a submarine replica surrounded by the traditional symbol of atomic energy (circulating atomic particles). I remember his saying something like, "You've arrived!", and of course I treasure this, the only personal gift I ever received from him.

Some years later after the *Shark* refueling when the defective fuel element had been removed and examined, it was determined that an x-ray of the fuel element made during its manufacture revealed a tiny flaw which had been overlooked during routine inspection of the x-ray. This flaw, which should have been detected, was clearly the cause of the defect detected during operation.

There is an interesting sequel to the discovery of the defect revealed in the original x-ray. Subsequent to my assignment at NR headquarters, I was transferred to NR's Pittsburgh office where one of my duties was to coordinate NR's quality control program for reactor cores and other reactor plant equipment. At the conclusion of a quality control audit, at the Babcock & Wilcox (B&W) reactor core manufacturing plant in Lynchburg, Virginia, Admiral Rickover decided to attend the audit critique with B&W management. This facility had manufactured the *Shark* reactor core, among many others, and had a well-deserved reputation as one of the highest quality suppliers of equipment to the NR program. At the time, the Lynchburg plant was managed by an autocratic and demanding but technically very competent individual named Nick Jessen; Nick was very proud of his plant and did not suffer easily even minor criticisms of his operations. He could be very intimidating even to the government's audit team, including me. Rickover knew all this about Jessen and respected him not only for his strong leadership but also because his plant produced quality products. Nonetheless the defect in the Shark fuel element had been missed by the diligent B&W inspectors, and Rickover decided this would be a golden opportunity to teach the arrogant Jessen a lesson. The Admiral's "discussion" with Jessen in front of all of us on the audit team went something like this: "Jessen, I know you like to give everybody hell, and you think you can get away with it because you turn out high quality reactor cores on time. Well, let me tell you that YOU SCREWED UP! One of your cores failed and we could have lost a submarine because of your sorry performance. Now stop giving everybody a lot of crap because you think you are so goddamn good!" Jessen was visibly wounded and was speechless. He really didn't deserve such treatment, but I detected in future dealings with him that he had become a tad less arrogant.

## ESTABLISHING A SHIPYARD NUCLEAR SUBMARINE REPAIR CAPABILITY

With the growing number of nuclear submarines, it soon became apparent that additional shipyards would need to have capabilities to repair, overhaul and refuel nuclear submarines. Five private shipyards had been awarded contracts to build nuclear submarines but only two, Electric Boat Division of General Dynamics Corporation and Newport News Shipbuilding and Drydock Company, were ever considered as shipyards capable of performing overhauls, repairs and refuelings of nuclear submarines. Two Government shipyards who built nuclear submarines, Mare Island in California and Portsmouth in Maine, were also designated as overhaul and repair yards. It was the Navy's long-standing practice to have its major combatant ships (submarines among them) overhauled and repaired in government owned yards; accordingly, four Government yards were designated by the Bureau of Ships, with Admiral Rickover's concurrence, to develop this capability. These were Norfolk Naval Shipyard in Portsmouth, Virginia; Puget Sound Naval Shipyard in Bremerton, Washington; Pearl Harbor Naval Shipyard in Hawaii and Charleston Naval Shipyard in South Carolina.

Rickover had the task of setting up this capability at these yards. As the project officer for commissioned submarines, I became the point man in NR for this undertaking. The initial step in this process was to have three or four senior NR people, including me, visit the yard and interview prospective civilian engineer candidates to staff a newly formed Nuclear Power Division. Near the close of this visit, Rickover would arrive on the scene to endorse the findings of his staff and, if all seemed in order, he would give the shipyard commander his blessing to proceed with developing the capability to service nuclear submarines.

Invariably, most of the candidates to staff the shipyard's Nuclear Power Division were rejected by the NR Headquarters team since the best engineers were kept hidden away by the various shipyard managers who did not want to give up their good people to a Rickover-controlled group within the shipyard. At Charleston, I recall, all of the shipyard's designated candidates were rejected although I had protested the exclusion of an engineer I knew and who had worked with me in NR where he had been assigned earlier as a trainee from the yard; I thought he was qualified and capable but I was overruled by my more senior colleagues, including Bob Panoff. Later, before we left the shipyard, I accidentally encountered this engineer and said hello – he simply kept walking straight ahead and said nothing to me; obviously he had been informed of his rejection. I know he felt I had stabbed him in the back and deprived him of a career in the nuclear business. At the close of the Charleston visit, Rickover, as was customary, arrived and met with us first and then with the shipyard commander, Rear Admiral E. Alvey Wright. Rickover told him that all the yard's candidates were rejected as not meeting the standards he sought. Admiral Wright, a highly regarded officer in the Navy's engineering duty community, protested, citing especially the engineer who had served as a trainee in NR. With that, Rickover stood up and told all of us that we were leaving and that further discussions at Charleston were useless. This was a frequent tactic the

Admiral used when he did not get his way. The tactic worked and the shipyard commander pleaded with the Admiral not to leave, assuring Rickover that he would try to come up with candidates acceptable to NR. Later successful candidates were presented, as occurred at the other yards, resulting in the development of an effective Nuclear Power Division at each yard.

The visit to establish a nuclear submarine repair capability at the Pearl Harbor Naval Shipyard in 1960 was especially memorable for me since it was the first time I had ever seen Admiral Rickover relax socially. At the conclusion of our visit to interview candidates, Rickover was slated to arrive for his customary meeting with the yard commander. The arrival of the now famous – and of course controversial – Admiral Rickover was given a good deal of publicity in the naval community in Hawaii. The red carpet was out, if not literally at least figuratively. A driver was at the airport with a car bearing a three-star license plate (Rickover was then a vice admiral) accompanied by a very senior captain, representing the yard commander, to welcome Rickover. Meanwhile, Rickover had contacted one of the skippers of a nuclear submarine that was berthed at Pearl Harbor and had arranged to be picked up by this officer (whom he had selected for submarine command and knew well). Although the Navy at that time allowed employees to travel first class when flying beyond the continental United States, Rickover elected, characteristically, to travel economy class and thus rode in the back of the plane. This was 1960 and there was no single walkway from the plane to the airport lobby as exists today at all major airports. Instead there were separate stepladders at the first and economy class exits from the plane at the Honolulu airport. While the official delegation waited at the foot of the first class ladder, with the senior captain and other dignitaries plus the official car and photographers, Rickover quietly slipped unnoticed down the economy class ladder and drove off in the private car of the nuclear submarine skipper.

Following the meeting with the Pearl Harbor shipyard commander, which in this instance went well, the Admiral together with the rest of us who had made up the advanced team, together with the nuclear submarine skipper and his wife, relaxed at a Waikiki Beach restaurant and watched the sun set. The Admiral, who had two drinks, was the most relaxed and sociable I had ever seen him.

After establishing this repair capability at the four government shipyards, I would periodically visit to check up on how work was proceeding. The last visit I made was to the Norfolk shipyard, but on this occasion, Admiral Rickover decided to join me at the conclusion of my trip. Unfortunately, I made the mistake of only spending a few hours with the NR representative, Commander Art White, before Admiral Rickover arrived. White did not have any burning issues, and I did not have the time to quiz him sufficiently to develop any. We really had nothing to tell the Admiral when he arrived. The Admiral was infuriated that he had made the trip and did not have anything he could take up with the shipyard commander, White's local boss. Rickover thereupon improvised. He told the shipyard commander that an apprentice program in nuclear repair work should be established for shipyard workers and that NR would support it. He was clearly winging it but seemed pleased with his creativity. As far as I know, the idea for an apprentice program quietly died.

# RICKOVER AND NUCLEAR SUBMARINE TENDERS

As the number of nuclear submarines in commission increased, the need for servicing these ships outside of shipyards became apparent. It was the Navy's practice to service some of its smaller combatant ships such as submarines and destroyers by a sort of larger "mother" ship; these were known as tenders. Although the submarine force had several of these tenders to service conventional (non-nuclear) submarines, none of these tenders was equipped with nuclear repair facilities – that is facilities capable of repairing radioactive components and dealing with the highly specialized requirements of reactor plant equipment such as stainless steel welding and the need for exceptional degrees of cleanliness.

Admiral Rickover was preoccupied with the design and construction of the nuclear powered ships themselves and all of the attendant political considerations, such as assuring adequate congressional appropriations and dealing with his adversaries in the Pentagon and elsewhere who thought he should be designing lighter and cheaper propulsion plants (another great story which I will leave to others who were embroiled in those issues). Tenders capable of servicing nuclear submarines were simply not – in the vernacular of the computer age – high on his screen. It was pressure from the first skipper of the Nautilus, Rear Admiral Eugene P. Wilkinson, that forced Rickover to devote some NR resources to modifying some of the existing submarine tenders so that they could perform minor repairs on submarine nuclear power plants. Rickover called me into his office one day in the late 1950's and told me to get together with "Dennis" Wilkinson (as he was called) and look into all this noise he was making about submarine tenders. Wilkinson was at that time in command of the first squadron of nuclear submarines based in New London, Connecticut and had his flag in the tender located there (*USS Fulton*). I invited Wilkinson to my home for dinner following Rickover's charge to me, and I was somewhat overwhelmed by Wilkinson's powerful and persuasive personality – he was widely known in the nuclear Navy as probably its greatest intellect among the operating forces. Having been appropriately impressed with Dennis' arguments for putting nuclear facilities in at least this first tender, *Fulton*, I agreed with him that I would get Admiral Rickover's endorsement of the necessary action steps. Dennis meanwhile, as only he could do, put the heat directly on Rickover himself.

Rickover then told me to go ahead, and I was assigned a bright young NR engineer, Joe Signorelli, a recently hired graduate of Webb Institute of Naval Architecture, the same school where the Navy had sent me for graduate work. The problem was that we did not have any appropriation for this work nor did Rickover have any particular enthusiasm for the work; we talked to the submarine design people at Electric Boat and got them to do some ad hoc work on nuclear submarine facilities for the *Fulton*. It was not the way to do the work, and, in hindsight, I should have known better; we were not going about this using the demanding high standards that all of NR's design work had always adhered to. Nonetheless we went ahead, and Signorelli did a good job with the limited resources available to him – he did most of the design work himself (unlike the normal NR approach where a highly qualified contractor, such as Westinghouse or Electric Boat, did

the detailed design, and NR headquarters engineers reviewed, commented on and either approved or disapproved the design). The design of these facilities were completed; some funds were found, and the *Fulton* was modified. Mostly they were adequate, but later Bob Panoff, as will be recalled clearly one of NR's very best engineers, happened to take a look at the design of the *Fulton*'s facilities. Panoff quite correctly noticed that tanks in the *Fulton* designated for collecting radioactive liquid wastes were of an inappropriate material – they were made of carbon steel, thus subject to corrosion – not a proper environment for radioactive liquid wastes. As a result of his review, all future radioactive liquid waste tanks in submarine tenders were made of corrosion-resistant stainless steel. Also he told Rickover that technical responsibility for these facilities should not be under my purview as a project officer, and that properly this responsibility should be assigned to a technical section head in NR responsible for fluid systems and arrangements. Of course he was right – I should have thought of it myself; Rickover agreed; and Signorelli was assigned to report to Howard Marks, the very competent head of fluid systems and arrangements for nuclear surface ships.

I continued as project officer for commissioned nuclear submarines and now also as project officer for nuclear repair facilities in submarine tenders. The next activity in the latter role was to oversee the task of designing these facilities for new construction submarine tenders to service the Polaris missile nuclear submarines. These tenders became very important ships for the Navy because they were to be designed and built to service the growing fleet of ballistic missile nuclear submarines and would be based at remote overseas locations, the first of which was to be at Holy Loch, Scotland. With the strategic importance of these tenders, Admiral Rickover now took an active interest in the design of their nuclear repair facilities.

Although most of his senior technical people were skeptical, the Admiral became convinced that the Polaris tenders should be capable of refueling at least part of the reactor cores of nuclear submarines in the event some of the nuclear fuel should fail during operation. Although such a failure was deemed very remote, nonetheless many of the reactor designs in the operating submarines could be partially refueled – that is one or more of the individual nuclear fuel assemblies could be removed and replaced by a new unit. Accordingly, he instructed me to work with the people designing the new Polaris submarine tenders so that the tender would have the capability of this partial refueling. This was far more complicated than it sounded: the ship would now have to contain a very massive and heavy container, called the M-130, which was then in use in submarine refuelings for receiving and transporting spent reactor cores to the Idaho facility where the cores were disassembled. In addition, it would be necessary for the tender to be capable of handling highly complex and bulky refueling equipment. This of course would be in addition to the other nuclear and ballistic missile capabilities that the ship would need to carry out its mission.

Admiral Rickover's idea now became one of his classic zealous missions. There was considerable opposition to including this refueling capability in the tenders because of the amount of space and weight which the M-130 and related equipment would take up at the expense of other needed facilities in the ship. To attain his objective, it was necessary

first to convince the operating Navy's Ships Characteristics Board which convened in the Pentagon and pronounced its judgment as to what and what not to include in any ship's design; this judgment then became the basis for the Navy's design agent, the Bureau of Ships, to proceed with ship design.

Rickover recognized he would need someone with more horsepower than an inexperienced young Navy lieutenant – me – to convince the august Ships Characteristics Board that they should include his pet project in the new Polaris tender. Fortuitously at that time he had on his staff, on temporary assignment, the prospective commanding officer of the first two-reactor submarine, *USS Triton* (later to circumnavigate the world submerged); this was Captain Edward L. Beach USN, former aide to President Eisenhower and author of several popular books on submarines, including "*Run Silent, Run Deep*". So Rickover called both Ned Beach and me into his office with the charge to convince the Board to put the partial refueling capability into the Polaris tender. And so off we went to the first of several meetings in the Pentagon. I did the homework and Beach did the talking, and we succeeded in convincing the Board to add this capability – probably for at least three reasons: first, by emphasizing the serious situation of a nuclear submarine disabled by a failed reactor fuel element unable to get back home from a faraway base in Scotland; second, by the sheer presence of Ned Beach, one of the most revered officers in the Navy; and third, and probably most important, opposing Admiral Rickover on something he strongly wanted was a usually a "no-win" situation for the opposition. Even though the Board voted our way, it still took a two-hour presentation by Phil Clark, NR's top reactor designer and one of its very best engineers, to convince Admiral "Red" Raborn, who headed the Polaris Special Projects Office (and later the CIA) that Rickover's project for the tender was justified.

Years later, after many successful missions by the Polaris submarines and no fuel element failures, the partial refueling capability, including the huge M-130 containers, was removed from the tenders freeing up valuable space for other needed submarine support functions.

# SHOCK TESTS OF USS *THRESHER*

The nuclear submarine fleet continued to grow following the initial success of Nautilus. Many historic events took place, all providing excellent publicity for the Navy and especially Rickover's nuclear Navy. *Triton*, skippered by Ned Beach, circumnavigated the globe submerged (except for a brief emergence with decks awash to remove a sailor with acute appendicitis); *Skate* surfaced at the North Pole where her crew played softball on the ice; *Seadragon* made its way through a northwest passage north of the main Canadian land mass from the Atlantic to the Pacific. The nuclear propulsion plants performed magnificently on all the ships attesting to Rickover's unswerving demand for excellence in every aspect of the ship's performance including the design and engineering of the propulsion plants and the selection, training and operational performance of the officers and crew. Twenty years after the *Nautilus* first went to sea, we were still able to say that no nuclear ship had missed an operational commitment because of a problem in the nuclear reactor plant.

One of the earlier submarines was *USS Thresher*, the first of a new class of so-called "Attack Boats". *Thresher* deserves mention here, having gone down with the loss of all hands off the New England coast in April 1963. This tragic event is discussed later.

In the summer of 1962, *Thresher* was ordered to proceed to Key West, Florida to undergo shock tests to measure the ship's, and its equipment's, vulnerability to depth charge attacks to which it might be subjugated in time of war. Previously mentioned were shock tests on an earlier submarine, *USS Skate*, where Rickover himself had arrived on the scene to take charge and block out recalcitrant circuit breakers that were causing the reactor unnecessarily (in Rickover's view) to shut down or "scram". As for *Skate*, the tests for *Thresher* were planned as a series of "shocks" from high explosives placed in the water a few hundred yards away from the ship that would then proceed through a marked range at periscope depth. The *Thresher* shocks, however, were to be more severe than those for *Skate*. Each shock test would be followed by one of greater intensity. It was Rickover's practice to have a representative from his staff on board for the tests as well as representatives from the shipbuilder, Electric Boat, and the reactor plant designer (in this case, Bettis). For the final two tests – the most severe ones – Rickover sent me to Key West to ride the ship. My only responsibility was to observe and report back to Rickover and his technical staff in Washington. The ship's commanding officer had his normal responsibility for the operation of the ship.

The first four Thresher tests had gone off successfully. The fifth and penultimate test that I witnessed went off satisfactorily also, but it was exciting to witness in person. There was a countdown to detonation of the explosive charge, and when it went off, it was as if a huge underwater creature standing next to the ship had struck the hull with a gigantic hammer – a loud "bang" followed by instrument dials swinging wildly and sprays of hydraulic fluid squirting from fittings. The reactor did not scram, and the power plant continued to operate as the ship lurched a bit but continued on course. There was only minor damage, but the overall effect of being submerged in a submarine undergoing

detonation of high explosives nearby was eerie. As I found out later, it was an experience that some of my fellow observers found downright frightening.

When we surfaced following the fifth test and headed back to port at the Key West Naval Base, we noticed a number of small craft with small nets scooping up something on the surface. Later we found out that the shock wave from the tests had killed (or possibly stunned) a large number of fish in the vicinity of the test - these were Red Snapper - which were duly collected by local Navy folks and after being appropriately baked became the main course for an all-hands feast that evening. After this unexpected and delectable event, most of us retired early to sleep in anticipation of the sixth and most severe test the following day, which as I recall, was the most powerful explosives test the Navy had ever undertaken on an operating submarine.

In the morning, as we prepared to board the ship, I did not see the Electric Boat and the Bettis representatives. Finally I located both of them, still in their sleeping quarters. The Bettis representative, who had already endured five tests, refused to go out again, having apparently acquired a sort of peace-time "battle fatigue"; the Electric Boat representative had been drinking so heavily the previous evening that he could barely stand up. Knowing that Rickover would not stand for the tests to proceed without the technical representatives of the shipbuilder and reactor plant designer, I acted accordingly. When I told the Bettis rep that I would have to call his boss, the Bettis General Manager, and ask for a replacement (delaying the tests meanwhile), he acquiesced and reluctantly boarded. As for the Electric Boat rep, a couple of sailors, one on each arm, hauled him down to the ship where we plied him with a large dose of coffee. The ship departed for the test range, and the final shock went off with the same frightening side effects but without incident.

The test series was pronounced successful, and *Thresher* was ordered to proceed to Portsmouth Naval Shipyard in Kittery, Maine for an overhaul. Although an inspection of the ship at Key West following the tests took care of any obvious problems, the Navy wisely elected to restrict *Thresher* to running at or near periscope depth on its run to Portsmouth so that a full inspection and any consequent repairs could be handled as part of the overhaul.

## SINKING OF USS *THRESHER*

One of the primary technical concerns with the all of the earlier nuclear submarines, including *Thresher*, was the large number of brazed or silver-soldered joints in the salt water piping systems that ran throughout the ship. It had been the Navy's practice for many years to solder instead of welding these joints primarily because of cost considerations. It was thought that an ultrasonic test performed on the brazed joint would be sufficient to insure its integrity; those joints that did not pass the ultrasonic examination would then be re-soldered and retested until integrity was assured. The shock tests probably weakened the bonding of at least some of the joints, and one of the activities during the overhaul was to test the joints and repair those that did not pass; I do not know if all of the joints in the salt-water systems were tested.

The *Thresher* overhaul at the Portsmouth yard proceeded, and by April the ship was ready to carryout its post-overhaul sea trials. One of the underway tests planned was to take the ship down to its test depth – several hundred feet below the surface – to check out all the operating systems. At this test depth, the hull and the salt-water systems that penetrate the hull and run throughout the ship are subjected to very severe water pressure, and thus the piping system joints are in turn subjected to extreme stresses. A weak joint could conceivably break apart and allow tons of seawater to enter the submarine.

About a week before the ship was to leave Portsmouth, I received a call from Commander Wes Harvey, the *Thresher*'s skipper and someone for whom I had a high regard. Wes was one of the many outstanding young Naval officers whom Rickover had selected for the nuclear Navy and had compiled a splendid record in nuclear submarines. Wes asked me if I intended to ride the ship as Admiral Rickover's representative during its post-overhaul sea trials. It had been my practice, with Rickover's endorsement if not his insistence that I, as his commissioned submarine project officer, ride the ship during the sea trials after overhaul. With the growing nuclear Navy and the many overhauls that were now being scheduled, it was becoming apparent that it would probably not be necessary for a Naval Reactors representative to go on each trip. In the telephone conversation with Harvey, I asked him if there were any problems with the reactor plant; he replied that there were none. I subsequently checked with Rickover who agreed I did not need to ride the ship, so I called Harvey back and advised him accordingly.

*Thresher* left the Portsmouth yard on Tuesday April 9th, 1963 for its sea trials off the coast of Massachusetts and proceeded beyond the continental shelf to arrive in deep water to carry out a variety of tests including diving down to its test depth. On April 10th, the next day, the monitoring ship on the surface above *Thresher* heard over its sonic equipment sounds of the submarine breaking up, and the ship plunged to the sea floor, over 8000 feet deep, with the loss of Wes Harvey, his gallant crew and a number of shipyard and other personnel, including a close friend and colleague, Commander Bob Kreg, the Maintenance Officer for Atlantic Fleet submarines. Elements of the broken ship were later found on the bottom by a deep-submersible submarine. There was never any evidence of a reactor accident as the cause of this tragic accident.

# THE PITTSBURGH YEARS

# INTRODUCTION TO BETTIS AND QUALITY CONTROL

In January 1963, Admiral Rickover told me that he had decided I was to have a career change within the NR program. One of the early stalwarts of the program, Navy Captain Edwin E. Kintner had decided to retire from military service and would need to be replaced as the Atomic Energy Commission's Assistant Manager for Operations at the Bettis Atomic Power Laboratory in Pittsburgh, Pennsylvania. I was to relieve him in the spring of 1963. Kintner had arrived in NR in 1950 and was a key player in the development of naval nuclear propulsion, including the *Nautilus* and *Seawolf* reactor plants. A gifted writer and speaker with a highly imaginative and creative mind, he was a skilled leader, and, in Bob Panoff's words, "generated enthusiasm". I knew Ed would be a tough act to follow.

The AEC Assistant Manager position at Bettis had a two-fold mission: First, the job entailed being the technical "eyes and ears" for Admiral Rickover watching over the engineering and R&D work of the Bettis Laboratory's operating contractor, Westinghouse Electric Corporation, recognizing, however, that Bettis's technical work was really directed and controlled by the Rickover staff in NR's Washington headquarters. A second mission, developed over many years, was the overall direction and coordination of the quality control of equipment and materials destined for installation in the Navy's nuclear propulsion plants. Although these were two separate and distinct jobs requiring different skills, they proved to be a perfect fit for the versatile Kintner.

My first professional encounter with the man I was to replace was at a quality control meeting Kintner had convened in January 1963 in Pittsburgh with the quality control managers from Bettis and the other NR R&D laboratory, Knolls Atomic Power Laboratory (KAPL) in Schenectady, NY. Also included in this meeting were the quality control managers from NR's two principal procurement contractors: Westinghouse's Plant Apparatus Division (known as PAD) and General Electric's Machinery Apparatus Operation (known as MAO). Bettis, KAPL, PAD, and MAO were known collectively as the NR Prime Contractors. At the Pittsburgh meeting, Kintner, characteristically, was probing the best quality control brains among the Prime Contractors to explore how to achieve some kind of step-change to improve the quality of NR propulsion plant equipment and materials. The meeting participants concluded that existing inspections and audits were not achieving the kind of results desired, and there seemed to be a strong need to impress the suppliers' plant managers as to how quality failures could seriously jeopardize the safety of nuclear reactor plants and the ships themselves. Kintner hit upon the idea that managers of the plants producing NR equipment should be invited to go to sea for a few days on nuclear submarines and thereby get a first-hand understanding of the operations of these ships; these plant managers would then be motivated to push harder to assure the quality of their products.

The Prime Contractor quality control managers all agreed this was a great idea. I, as a visitor and newcomer to the quality control community, also was impressed with this

seemingly creative idea. Perhaps it *was* a good thing to do, but it clearly was *not* in the view of Admiral Rickover, who, when he learned of Kintner's recommendations, promptly vetoed them. "This is another of Kintner's 'hair-brained' schemes", he screamed at me. "And I suppose you agreed with him", he added. I confessed that I did. After thoroughly chewing me out, he went on to rant, "I am *never* taking vendor managers out on submarines, period – that's not their business". Rickover ordered Kintner to expunge the entire subject of vendor managers riding submarines from the minutes of the meeting, continuing to give me a stern lecture in the process.

In April 1963, I left my job in NR headquarters and reported to Pittsburgh as Kintner's relief. Kintner's retirement date was scheduled for late in the summer; thus we had an unusually long turnover period, indicative to me, at least, that the Admiral felt I needed a good deal of training in how to perform as an effective NR field representative and that Kintner (despite Rickover's worries over his "wild" ideas) would be a good teacher.

And indeed Ed Kintner was a good teacher who became something of a role model for me. He was well respected by the senior Westinghouse managers at Bettis and was very effective as the government's representative on vendor quality control audits that I witnessed as a trainee. During one of the audits, I recall one supplier plant manager asked Kintner to give an extemporaneous talk to his shop work force on why it was so important to have high quality equipment on our nuclear submarines. Kintner delivered a typical, off-the-cuff, tour de force (without notes) that brought sustained applause from the workers. Because he thought so fast on his feet and was such a quick study, at the conclusion of these audits, he was able to present an effective critique of audit findings to vendor management without very much written down, a technique which I soon learned did not work well for me.

Watching Kintner's stellar performance and becoming increasingly aware of the complexity of my new job, I developed serious misgivings about my ability to carry it all off. In a telephone conversation with Rickover shortly before I was to take over, I told him of my concerns. I will never forget his reply to me – "Claytor, I have every confidence in you." It was a rare moment of encouragement from the "Kindly Old Gentleman" as we often disrespectfully referred to him.

My next few years at the Pittsburgh Naval Reactors Office turned out to be a challenging and exciting time, away now from the aggravation of daily direct contact with Admiral Rickover but as, we shall see, never really out from under his "spell".

## THE MANAGER

As Assistant Manager of the Pittsburgh Naval Reactors Office, I recognized I would have an immediate boss, the Manager. His name was Lawton D. Geiger, and he had been with the NR Program almost from its inception, moving from the Chicago Operations Office to head the Pittsburgh office when Rickover first established it in the early 50's. Lawton was the next thing to a genius at contracting and financial control and personally negotiated the AEC contract with Westinghouse for operation of the Bettis Atomic Power Laboratory. This was a cost plus fixed fee contract for a term of five years, renewed at the end of each 5-year period. He always drove a hard bargain on the fee; the government's interests were well served.

Although nominally my boss, Lawton left me entirely alone to be Rickover's overseer ("eyes and ears") over the technical work at Bettis and never interfered with my activities. He was quite happy to let me deal directly with Rickover and simply not get involved. The Admiral had great respect for Geiger's contracting and financial acumen, and generally did not bother him.

Geiger was an introverted loner and a bachelor who loved his nightly double martini that never affected his job performance. He spent hours poring over handwritten ledgers filled with financial data that he never discussed with me. He was all business who kept his cool when others, including Rickover, were losing theirs. I don't recall seeking his advice very often, and if I sought it, he would be rather circumspect and vague in providing it. We were on good terms, but we pretty much went our separate ways during my decade at Bettis.

The greatest single impact of Geiger's presence was in fact his absence each year for the month of December when he went to Florida on vacation. I somewhat dreaded these periods because I became involved in areas of his responsibility that only added to the burden of being Rickover's "eyes and ears". I recall two experiences that made the Christmas period less than tranquil.

The first occurred when a congressional investigator called the day after Geiger departed on vacation explaining he was coming to Bettis to review the complaints to the Congress of a disgruntled employee in Pittsburgh Naval Reactors Office's Security Division against the Division head, who reported to Geiger. This was totally outside my realm but as Acting Manager in Geiger's absence, I had to deal with it. No doubt there was some truth to the allegations, but I decided to throw my full support behind the Security Division head, whom I respected as a solid professional. After several days of probing, the investigator departed having been satisfied that the charges were not sufficiently serious to merit any disciplinary action. Somehow Rickover never got involved, and the problem subsided but not without my incurring the enduring wrath of the employee for supporting his boss.

The second involved a contract dispute with an engineering firm that would have been Gieger's cup of tea. Rickover was well aware of this issue as it arose from some seriously unsatisfactory welding of a support of a major reactor plant component at the

Shippingport Atomic Power Station, the world's first commercial nuclear power plant. The engineering construction firm responsible for the reactor plant work in the plant had acknowledged the defective weld that had been visually discovered by a maintenance worker performing routine painting in the plant. I called the responsible contractor's representatives to a meeting in our offices, insisting that the contractor make some restitution to the government. After a lengthy negotiation, the contractor agreed to waive his entire fee (about $600,000 as I recall) on this cost reimbursable contract. I felt this was a good settlement as the repair costs were far less than this amount and felt Geiger, the negotiating master, would be quite proud of my effecting this settlement. After recessing the meeting, I decided I had better talk to Admiral Rickover before finalizing the settlement since the Admiral was aware of the defective weld, something I doubt that Geiger would have felt compelled to do. Rickover's outrage was immediately apparent in the phone call. He screamed that I was absolutely *not* to accept the contractor's offer – that this was totally inadequate in light of the contractor's poor quality work. I dismissed the contractor's representatives, telling them we could not accept their offer and would get back to them later. So I left this one up to Geiger to resolve when his December vacation ended, ruminating again about his long vacations.

It was an interesting arrangement. Both of us did our own things and did not feel the need to keep each other informed. Perhaps the best example was my decision to retire from the NR program in 1973. My interactions with Rickover on this decision are separately recorded in this memoir. Unbeknownst to me, Lawton Geiger also had told Rickover that he was planning to retire by the end of this same year – 1973. Although this now resulted in simultaneous vacancies in the two top positions in the government office at Bettis, the program had adequate replacements available and I am sure the oversight of Bettis, both technical and contractual, was relatively seamless after we left.

Lawton Geiger was indeed one of the key people in the development of the Naval Reactors program, was instrumental in helping to develop the industry for the production of hafnium and zirconium, key materials required for successful operation of naval nuclear reactors, and in the development of the several reactor core manufacturing contractors. This was all in addition to his contractual oversight of the Bettis Atomic Power Laboratory and many other contractors. Although Ed Kintner, whom I relieved at Bettis, quoted his predecessor as saying that "Lawton Geiger doesn't have a bone of leadership in his body", this was a reference to his personal relations to his staff and not to his professional skills which in my judgment were almost without parallel.

## THE BETTIS ATOMIC POWER LABORATORY

As Assistant Manager in the AEC's Pittsburgh Naval Reactors Office (known by the acronym, PNRO), it was my job to oversee the technical work of the Bettis Laboratory which, since the Laboratory's inception, was operated by Westinghouse. As noted previously, the technical work of Bettis was directed and controlled by Naval Reactors headquarters personnel in Washington, thus posing for me something of a dilemma as to what I was really supposed to do. I soon learned that my main mission was to figure out what Bettis was doing wrong and tell Admiral Rickover about it. And there were clearly times when I was in trouble because I wasn't fulfilling this mission adequately in his judgment. Rickover had said so often, "I don't want you guys (in the field jobs) to tell me about good things that are going on – I can't do anything about that! I want to know what are the *problems* so I can see to it they get solved!"

Of course Bettis, with over 3000 employees, did sometimes do things that were wrong and had problems. But, by and large, Bettis was an outstanding organization with superb technical skills and was staffed with just about the best engineers and scientists that Westinghouse had to offer. After all, Bettis people designed the successful nuclear reactor plant for *Nautilus* and for most of the rest of the growing Navy nuclear fleet including the first nuclear powered aircraft carrier, *USS Enterprise*. Moreover Bettis was the designer and developer of the world's first commercial nuclear reactor plant at Shippingport, Pennsylvania. Bettis indeed had developed a magnificent physical plant with all of the highly sophisticated laboratories required for nuclear reactor design and development, including state-of-the-art computer facilities and reactor physics experiments.

A few years later when I had retired from the NR program, I gained a new appreciation of Bettis's capabilities when I interviewed for a job with Bob Panoff's firm (I wasn't hired) when Panoff said, "You don't know how lucky you were, working with the outstanding labs at Bettis and KAPL (the sister NR lab to Bettis, operated by General Electric) when one sees what the labs outside the NR program are like!"

Inasmuch as there was a good deal of physical activity going on within Bettis, the staff in PNRO that I inherited conducted a variety of appraisals in such areas as health and safety, fire protection, radiological controls, and nuclear materials management. Generally Bettis performance was of a high order, and it was rare that a finding in these appraisals rose to the level requiring Rickover's attention. My staff was experienced and generally competent, and I was blessed with one invaluable "star" – Dick March – who was a first-class engineer, understood well the then emerging world of computers and data processing, had the respect of the Bettis scientific community, and could unearth substantive problems with Bettis performance. Dick and I both realized we needed some new bright young people and thought we had found one when we hired John Koury. It turns out we were right; some 30 years later, he had my job as Assistant Manager reporting to one of the several successor 4-star admirals who succeeded Rickover.

My principal contact at Bettis was the General Manager, a Westinghouse Vice President, who ran the laboratory. Rickover insisted that I meet with him frequently – Rickover would have preferred daily – but I chose to make these contacts when I had something

substantive to discuss. I always went to the General Manager's office rather than have him come to mine in deference to his responsibility for running this large laboratory. During my 10-year tenure at Bettis, there were three General Managers, Phil Ross, Nick Beldecos, and Bill Hamilton, in that order of succession. All were capable managers and engineers and well respected by their subordinates. I did not get along well with Ross who seldom volunteered to me anything of substance and usually responded minimally to my requests for information. I had good relations with the other two General Managers. Hamilton, it will be recalled, successfully ran the tests to detect the fuel element defect in the *Shark*'s reactor. Rickover dealt frequently and directly with the General Managers, treating them in effect as members of his staff, but I was often not privy to these discussions.

One of the biggest issues I had with Bettis occurred early in my tenure when Ross was General Manager. Nearly every contractor in the NR program assigned a senior person to serve as the organization's Quality Control Manager with the latter reporting directly to the contractor's plant manager (or in a few instances to the plant manager's boss). Our experience told us that this arrangement provided both the objectivity and management attention needed to assure product quality. Not so at Bettis. The laboratory had two relatively junior quality control managers – one for reactor core procurements and one for other reactor plant equipment. Neither reported directly to the General Manager but rather through other managers. Ross repeatedly resisted making any changes to this arrangement, pointing out that he already had enough people reporting to him and wanted no more. I then decided to perform an in-depth quality control evaluation of Bettis using the talents of the top quality control people from the other prime contractors (PAD, MAO, and the rival laboratory, KAPL). We found enough deficiencies in Bettis performance to make the case for reorganization and a single senior quality control manager reporting directly to Ross. With Rickover's backing, the changes were made, and Walt Hurford was given the job – a job he never wanted but one he did exceedingly well to the benefit of the entire NR quality control community.

One of my most interesting assignments at Bettis was a two-week task from Rickover to review the performance of the Atomic Energy Commission contractor responsible for conducting long-term irradiation tests on naval nuclear reactor materials. These were performed in test reactors at the AEC's Idaho site. Since the tests were important to NR but not under direct NR control, Rickover suspected – correctly, it turned out – that the design laboratories (Bettis and KAPL) responsible for ordering the tests were not monitoring contractor performance very carefully. Rickover required that I call him at the end of each day with my findings that indicated a distinct lack of formality and lack of rigorous compliance with such procedures as existed. With each telephone conversation, he yelled at me to call Beldecos and Kesselring (the then serving General Managers of Bettis and KAPL respectively) and tell them what I found. (I assume that he followed up with each of the General Managers in his own special way!). At the end of the visit, I met with the senior AEC Idaho office manager responsible for the test reactor contractor and reported the inadequate controls and the kind of informality we would not tolerate in our NR program. He merely replied, "We haven't been trained the way Admiral Rickover does things, and you can't expect the contractor to do things your way." I of course

reported immediately to Admiral Rickover the AEC manager's response to me. I never learned what happened to this issue except I was aware that Bettis now began to pay much closer attention to how the irradiation tests were carried out. One pleasant feature of this trip to Idaho was a free Sunday, unencumbered by a telephone call to the Admiral, during which I rented a car and hiked alone on a warm, cloudless October day in the Grand Teton National Park – the most serene and beautiful place I had ever visited at that point in my life.

Rickover applied constant pressure to both Geiger and me to assure that the money spent at Bettis was in the best interest of the government. For example:

- Bettis did need from time-to-time new laboratory equipment to keep up with state-of-the-art reactor design and development, but it was sheer hell getting Admiral Rickover's approval to purchase capital equipment for Bettis. As far as I know, he insisted on personally approving all such expenditures and would often delay his actions or not respond at all. I recall we often had to provide repeated additional justification; I even told the Bettis General Manager on more than one occasion that I had done all I could to get approval of an important piece of equipment, and that if Bettis really wanted it badly he should make a personal appeal to the Admiral.

- Holding down the Bettis employment level was always a major issue, and I was charged by the Admiral several times to find out if Bettis was overstaffed – an almost impossible task considering the constant demand by NR section heads for Bettis actions in their areas of responsibility.

- At one point, Rickover began to get concerned that Bettis employees were not putting in a full day's work and charged Geiger with monitoring the times that employees came to work. This did not sit well with the professionals at the Laboratory, and this effort was soon discontinued.

Admiral Rickover was always looking for issues to spur Bettis management to effect improvements in its performance. My colleague, Dick March, in his periodic reviews of Bettis, got an inkling of questionable Bettis standards in the hiring of newly graduated engineers and scientists. Dick and I personally undertook a detailed review of the academic records of these new hires, concluding that many of them were not high achievers in college. Rickover pounced on these findings, making it a major issue with the Bettis General Manager, and then ordered March and me to go up to KAPL and perform a similar review – with similar results. I like to think that this review had a salutary effect on both the Bettis and KAPL hiring practices.

Despite the occasional uncovering of Bettis problems such as the above, at one point late in my tenure, I became concerned that my dual job of monitoring Bettis and coordinating the NR program quality control activities was about to be split up. Rickover noted – correctly – that I was spending most of my time on what I enjoyed the most: quality control issues, auditing reactor plant equipment contractors and upgrading government

inspection at these contractors' plants. I was told that he was seriously considering bringing his capable representative at the Naval Reactors Training and Prototype Facility in Idaho, Howard Canter, back to Bettis to take my place as Assistant Manager in charge of overseeing Bettis, while I was to continue coordinating the quality control program. Someone on his staff in headquarters apparently considered this was a bad idea, and so I continued with the dual jobs until I elected to retire.

Near the end of my tenure at Bettis, the Laboratory became consumed with a promising commercial reactor concept called the Light Water Breeder Reactor (LWBR). Rickover had been able to convince both the Congress and the AEC that this concept deserved substantial funding and provided the possibility that theoretically more fissionable material would be produced in a light water reactor than would be consumed. This would be a boon to the commercial nuclear power industry since virtually all the commercial reactors in the world were cooled by light water. NR originally intended for industry to produce this developmental reactor core, but lack of interest led to Bettis itself not only designing but also building the core, including unprecedented fuel elements made of thorium and an isotope of uranium. When I retired from the NR program in 1973, Bettis was well on the way to building massive facilities for the manufacture of the LWBR core, another example of the versatility of Bettis to meet programmatic needs.

At the time I was assigned to Bettis, I recall Bob Panoff told me that Bettis – when compared to KAPL, the other NR design laboratory – had the best managers and produced reactor designs that were much easier to build. KAPL, on the other hand, was stronger in nuclear physics and was more technically creative. From my years at Bettis, I agreed with Panoff 's assessment of Bettis, but – without demeaning his view of KAPL (which I had never closely observed) – I believed that it would be hard to top Bettis in *any* technical area.

## THE NR QUALITY CONTROL PROGRAM

The quality control program I inherited from Ed Kintner proved to be a challenging assignment. In those days – the 1960's – we used the term "quality control" which has come to mean over the intervening quarter century actual physical "inspection" of products. At that earlier time we applied "quality control" to all the broader activities involved in assuring the quality of our products which today are broadly defined as "quality assurance". In this narrative, I will continue to refer to "quality control" as we then defined it.

At some point in the early days of the NR program, Admiral Rickover realized that he needed to have strong technical oversight of the quality of equipment and materials to be installed in the power plants of the Navy's nuclear ships. Clearly it was the job of the NR Prime Contractors – Bettis, KAPL, PAD, and MAO – who bought the equipment to monitor the quality controls exercised by the equipment suppliers. However, he recognized that more than one Prime Contractor often procured equipment from the same supplier; this could lead to confusion at a supplier's plant due to conflicts between the Prime Contractors as to how they monitored the supplier's quality controls. Also, a possible solution to this problem – coordinated audits of suppliers among the Prime Contractors – posed anti-trust considerations since the two corporate NR procuring agencies were Westinghouse and General Electric, both major competitors. These considerations dictated the need for overall coordination and direction of the quality control program by an NR controlled government entity. Moreover, it was Rickover's consistent practice, unlike nearly all other government managed programs in the defense industry, to have strong technical control by his government staff over *all* activities within his program.

Rather than set up a technical office within his Washington, DC headquarters (the practice for essentially all other areas of the NR program), Rickover had elected to make the AEC's Pittsburgh office at Bettis the focal point for directing and coordinating the NR quality control program. This decision to have this function performed at one of the NR Prime Contractor government field offices was due to its much closer involvement with the purchase of NR equipment for the ships; the government office at Bettis, the first of the Prime Contractors to buy equipment, seemed to be the logical location. Within the government office at Bettis, both a Navy entity and an Atomic Energy Commission entity were established, representing the two agencies involved in the NR program as well as the source of funds for the NR program. The Assistant Manager for Operations, the position to which I was assigned, was also the Navy's Bureau of Ships Technical Representative, Bettis. This "two-hat" position had become the head of the NR quality control program, reporting directly to Admiral Rickover.

The NR quality control program, as I first experienced it, was largely a program of quality control audits of the major suppliers of equipment, including nuclear reactor cores and reactor plant components for the increasing number of nuclear powered submarines and surface ships. There were also at suppliers' plants a cadre of government inspectors, under the Navy's Inspector of Materials service, who operated somewhat independently of the NR program and interacted occasionally with visiting Prime Contractors' quality control representatives; the exception to this arrangement was the reactor core manufacturers' plants where Bettis and KAPL had resident quality control representatives

who gave technical guidance to the government inspectors.

As I began to work in the Naval Reactors quality control world, it immediately became apparent to me that periodic quality control audits of NR manufacturers of nuclear propulsion plant equipment were a most valuable tool in assessing and improving quality performance of our suppliers. The NR Prime Contractors, under the leadership of Ed Kintner and his predecessors, had developed over several years an effective supplier audit program and had recently expanded it to encompass reviews of quality control programs at the shipyards building nuclear ships.

My first audit was as an observer and trainee with Kintner at a shipyard, Electric Boat Company, the main builder of our nuclear submarines. I remember it primarily because of a cantankerous argument at the closeout critique between Kintner and the team on one hand and Marv Curland, the Electric Boat quality control manager, on the other. I forget the issues, but it taught me a lesson for future audits that findings of fact, and resulting conclusions, need to be firmly established between the audit team and the contractor *before* the final critique with contractor management – a lesson we followed for the most part thereafter.

One other lesson I learned at the outset of my involvement in the quality control program was the need to get observations, discussions, recommendations and conclusions *in writing* before the audit was completed and the team dispersed. Kintner's teams generally worked from rough notes – Kintner himself, as noted earlier, being the kind of person who was sharp enough to "wing it" and who could easily articulate the issues to the contractor without a written script. Then later the report would be pulled together by the team leader based on individual contributions from each audit team member - often a difficult task and an added impediment to completing a coherent final audit report.

After a few early experiences in working with rough notes and struggling to put together a final report, I vowed to change the process to require a complete written draft report, including summary and conclusions, which was presented to contractor management at a closeout critique. This took a much greater effort *during* the audit itself but it forced team members to do a more thorough job and resulted in generally favorable acceptance of the audit results by contractor management. I then would follow the long-standing practice of sending a formal letter to contractor management requesting a written reply identifying corrective actions in response to the report's recommendations.

Over the ten-year period of my assignment at the Pittsburgh office, quality control audits of NR suppliers numbered in the several hundreds. The teams consisted of four or five quality control specialists from the NR Prime Contractors with one of the Prime Contractor Quality Control Managers as the team leader. Always participating was a government representative, either a member of my staff or me. Working every evening, including occasional visits to the plant on back shifts, the audits usually lasted from three to five days. There is no question that the audit program had a major positive impact on the quality control programs of our equipment suppliers.

As I became increasingly involved with our vendors, my biggest surprise was the poor quality performance frequently encountered. We often found such deficiencies as sloppy inspection records, ineffective programs for defect prevention and corrective action, lack of subcontractor control, poor tool and gage calibration, failure to perform internal audits, and weak quality control management. I had expected that companies making equipment for a high technology program like Naval Reactors would have very high standards of excellence. This often was not the case and thus presented a daunting challenge to the Prime Contractors and to me. However, we all worked hard – through our audit program, frequent visits to vendor plants by Prime Contractor representatives, an aggressive government inspection program, and strong letters to supplier management – to elevate the performance of our suppliers. In most cases our efforts achieved some results; where we did not, Admiral Rickover was always available to take up issues with top vendor management at the CEO level, including using the threat of not awarding future business. (The only exception to this that I recall was an issue I referred to him for his action: an audit of the General Electric Company's plant in Schenectady that manufactured reactor coolant pumps revealed that the quality control manager reported to the manufacturing manager and not the plant manager – a clear conflict of interest for the quality control manager like the fox guarding the chicken coop. Rickover uncharacteristically did not raise the issue with GE management, revealing to me something I had always suspected – that, unlike his relations with Westinghouse, he did not have the same power of persuasion over the General Electric Company.)

Following some of our audits where we felt the supplier was not responsive to our findings, I would write to Rickover soliciting his support. Following is an excerpt from a memorandum I sent him after an evaluation of an equipment supplier to one of our nuclear shipyards:

> The chief force to be reckoned with at the contractor's plant is the CEO who started, owns, and runs the entire company. He is a dynamic man in his 60's, speaks English with a distinct accent, and takes great pride in the operation. He is intelligent and clever, has strong opinions, does not take criticism easily, and tries to overwhelm his opposition with verbiage. I was told that he is "brilliant engineer" with many degrees who has personally designed many of his products; he is obviously familiar in detail with manufacturing and design including the contract specifications. *His reaction to our audit findings was generally negative*, and it was apparent that he was opposed to reporting what he termed were "minor" contract specification violations to his client (the shipyard) since he clearly felt his company had the engineering know-how to disposition such violations on their own. He attempted to demean our report by saying we had found only *minor* deficiencies; I replied that it was a *major* deficiency that his inspectors did not formally report all out-of-specification conditions that they found and a *major* deficiency when his client was not advised of such conditions that his inspectors *did* report. He did not argue further, but implied he would seek contract relief for some of these requirements. He was obviously displeased by our findings and maintained that he personally could audit any of his competitors and find similar conditions to what we found. A proposed letter from you to the shipyard president is being forwarded complaining about the deficiencies in the shipyard's monitoring of this supplier and requesting corrective actions including steps to

assure both delivered and undelivered products to the shipyard from this supplier are satisfactory.

Rickover did in fact show up for some of our vendor audits and of course made his presence felt. Several times he joined us for audits of the nuclear reactor core manufacturers and for selected other suppliers. Rickover's comments to vendor managers were candid and effective but sometimes unnecessarily lacking in tact – I recall his comment to the president of one of our heat exchanger suppliers after we had completed an audit revealing significant problems: "I have two words for you: drop dead!"

Throughout my tenure in the quality control assignment, the key individual who guided – and in fact *trained* – me was the quality control manager of one of the NR Prime Contractors, Westinghouse Plant Apparatus Division. His name was Daniel Garland, a highly intelligent individual thoroughly versed in every element of quality control. It was always very comforting to have Dan in charge of the 40 or 50 quality control audits where we worked together – he got the most out of his audit team and always had the respect of the vendors being audited.

## THE GOVERNMENT INSPECTION PROGRAM

In 1963 when I relieved Ed Kintner as "czar" of the Naval Reactors quality control program, government inspectors at Naval nuclear suppliers' plants provided some

measure of oversight over the quality performance of these suppliers. Some of these inspectors, mostly assigned to the Navy's inspection service but sometimes attached to other branches of the armed services, were of help to the NR Prime Contractors responsible for supplier performance. However, many of these inspectors were ineffective and lacked the technical competence to do a proper job. At that time the NR program was heavily dependent on Prime Contractor personnel and the technical capabilities of the equipment suppliers themselves to assure the quality of products delivered to the nuclear Navy. Despite excellent reputations, many of these suppliers needed constant pressure to perform to the required level needed in the NR program.

It soon became apparent that there would be significant benefits to having independent, dedicated, and technically competent government inspectors at equipment suppliers' plants both to augment Prime Contractor quality control personnel and, more important, to help elevate supplier quality control performance. Finding the "good" inspectors, training them and getting them established at our plants would prove to be a formidable task, but this soon became one of my primary goals with the strong endorsement of Admiral Rickover. Fortunately, at the plants manufacturing nuclear reactor cores – the most highly sophisticated and complex element of our nuclear propulsion plants – there was in place a group of government inspectors who had evolved as a competent force over the years under the technical direction of Bettis and KAPL. These Navy inspectors were well trained and dedicated, and, with the tacit understanding of the Navy Inspection Service management, were maintained as a relatively permanent group not subject to the normal transfers experienced elsewhere in the government inspection service. This reactor core inspection force thus served as a prototype for the government inspection service that we hoped to establish broadly at other NR program suppliers' plants.

Shortly after I took on the management of the quality control program, the Defense Department undertook the consolidation of the contract administration functions of all of the branches of the armed services including each branch's inspection services. This became known as the Defense Contract Administration Services (DCAS). This consolidation made life easier for us by providing a single point of contact in our efforts to upgrade the government inspection program.

With the help of Admiral Rickover's top contracts manager in Washington, over many months and in many meetings - some occasionally acrimonious - we hammered out written agreements with DCAS management for a special government inspection program dedicated to supporting Naval Reactors. We agreed to maintain a list of major NR suppliers of equipment and that government inspectors once assigned to these major suppliers' plants could not be replaced or transferred without the approval of the Bureau of Ships Technical Representative, Pittsburgh (BSTR, my position). We also agreed that periodic audits of the government inspectors would be performed by BSTR, Pittsburgh, which would be identified as Product Oriented Technical Visits. This gave these audits a euphemistic name, disguising the fact that these were in reality in-depth reviews of the government inspectors' performance.

The Product Oriented Technical Visits became the primary vehicle for upgrading the NR

government inspection program. The visits, led by a naval officer reporting to me, included experienced Prime Contractor quality control people, identified individual inspectors' training needs and, more significantly, the need on many occasions to replace an inspector with someone with significantly better qualifications and potential. As a result, many inspectors *were* replaced with significant benefit to the oversight of our vendors' quality control programs and consequent upgrading of vendors' performance. The move to replace inspectors often resulted in conflicts with DCAS management; however documented results of Product Oriented Technical Visits along with the power and prestige of Admiral Rickover (always available if needed) almost always achieved the desired results. The government inspection group at the reactor core plants proved to be a fertile training ground for inspectors to be moved to other plants. The net result of all this effort was a unique NR government inspection service staffed with some of the best inspectors in the government.

The success of the NR government inspection program owed a great deal to the high quality of the personnel assigned by NR to my office as BSTR, Pittsburgh. These were military officers known as Limited Duty Officers (LDOs), commissioned from enlisted ranks, all with nuclear propulsion plant experience and with the hands-on practical know-how of very competent technicians in the mechanical, electrical and electronics ratings. During my tenure, two in particular stood out – these were Lieutenants Neal Benson and John Espy. For several years, Benson was the senior person reporting to me, directing quality control activities, including especially the government inspection program. He combined hard work, intelligence and good judgment with a knack for getting the job done, resulting in just about the best support I have ever received from a subordinate. John Espy, working for Benson as his top assistant, was solid, dependable, and technically competent. These men and their colleagues were at home in the factory shop environment where our nuclear plant equipment was being manufactured and related well to the government inspectors whom they indoctrinated in the high standards of the NR program.

Two additional techniques were put into place to enhance the role of the government inspectors and increase their effectiveness with the supplier management at the plants where they were resident. The first was the requirement for the senior government inspector at a supplier’s plant to write me a periodic letter - typically bi-weekly - describing any significant problems with the supplier's quality control program and what was being done about the problems; a copy of the letter was provided to the supplier's general manager. The simple fact that these letters were being written often resulted in corrective action. The second technique, strongly endorsed by Rickover, was to require that the senior resident government inspector meet weekly with the supplier's general manager; this was an exceptional elevation of the inspector's position inasmuch as government inspectors rarely dealt at a level above the supplier's quality control manager. Establishing this weekly interaction did not come easily as there was often reluctance by both parties to meet, but we forced the issue when necessary – again with positive results in getting top management attention to correcting problems.

Admiral Rickover, who literally received many dozen reports either weekly or bi-weekly from NR representatives at NR field activities, decided to have the senior government

inspector at the reactor core manufacturing plants send his bi-weekly report directly to him instead of me (I received a copy); this of course often resulted in direction to me to do something about what the inspector reported – additional chores which required my response to the Admiral. I was able to convince him not to make this a requirement of all the other government inspectors by promising to write him periodically summarizing any significant issues arising from the other inspectors' bi-weekly reports that I received.

Maintaining a strong government inspection program at NR suppliers' plants required cooperation from the administrative management within DCAS. Despite the written agreements we had established with DCAS, we needed to have a good relationship with senior DCAS managers, many of them Army or Air Force Colonels or Navy Captains. Accordingly every two or three years, I invited these senior officers to visit Bettis where Bettis Laboratory managers would put on an impressive technical presentation on nuclear reactor plants and the importance to the safety of the nuclear ships and their crews in achieving the highest possible quality of reactor plant equipment.

I have continued to refer to government “inspectors”. DCAS employed the term “quality assurance representatives” and we soon embraced this appellation as it more correctly represented the upgrading of this important government service. Near the end of my tenure, with the approval of DCAS management, we consolidated our NR government quality assurance requirements in two separate volumes – Special Instructions and Process Surveillance Guidance – and undertook training programs in these requirements for all of the NR government quality assurance representatives.

Of all the work I performed in 17 years in the NR program, I am most proud of my role and that of my dedicated staff in establishing an effective government quality assurance program at reactor plant equipment suppliers’ plants. However, it would no doubt have been very difficult to put all this in place without the power and prestige (and the ever present backing) of Admiral Rickover.

## INTERACTING WITH RICKOVER AS A FIELD REPRESENTATIVE

The move from Washington to Pittsburgh was big change for me. No longer did I have to deal face-to-face with Admiral Rickover on a daily basis and no longer did I have to fight the commuter traffic in Washington, DC. We decided to build a house on a lot in Pleasant Hills, a good place to live, as its name implied, and only about 15 minutes driving time to the Bettis Laboratory. I now had responsibility for a government staff of about 25 professionals and technical oversight of about 3000 Westinghouse employees, mostly white-collar engineers and scientists with a significant number of PhDs – a big change from the half-dozen engineers who reported to me in Washington.

I soon learned, however, that "freedom" from daily contact with Rickover was not all it implied. Consistent with all of his other field representatives, he required that I write him a biweekly letter telling him what was going on at Bettis, particularly telling him what was *wrong* with the contractor's performance. He often complained that his field representatives typically wrote him nothing but platitudes – "Pollyanna fluff", he termed it – drawing a "rosy" picture of events at the contractor's site and seldom identifying problems with the contractor's performance. He said such reports were worthless; what he wanted to know was what was *wrong* so he could he could personally do something about the problem. He was also constantly worried that his field representatives were getting too "buddy-buddy" with the contractor.

It was shortly after I transferred to my new job that Admiral Rickover's frustration with his field representatives – including me, I'm sure – reached a crescendo prompting him to reissue his famous letter on the responsibilities of NR representatives at field offices. The letter is quoted in its entirety below:

> From time to time, I note evidence that NR representatives at field offices such as a shipyard or at a laboratory do not fully understand their primary mission.
>
> It is amazing to me how representatives new to these positions uniformly get themselves into a frame of mind where they conceive of themselves as intermediaries between NR and the contractor; that is, that their job is to judge who is right – NR or the contractor, and then to make the decision on their own, in many cases not even notifying NR. In this way the NR representative becomes, in effect, NR's boss. Subtle pressures by a contractor such as making the NR representative feel that he is "good" and that he really understands the local problems and NR does not, contribute to this feeling of euphoria and omniscience. This situation has led to numerous difficulties, to considerable delay in NR's becoming apprised of the actual state of affairs and to millions of dollars of additional cost to the Government.
>
> Typical is the recent case where a NR representative decided on his own to countermand a technical order issued by me, but without notifying me in the premises. All NR representatives are, of course, encouraged to state their views to me at any time. The weekly Critical Items List is an excellent medium for this; telephone calls and letters are always in order. However, NR representatives do not have the authority to countermand my orders; in so doing, they are placing themselves above the Headquarters office. It is <u>not</u> their job to assume my responsibility.
>
> Another and more serious mistake arises when the NR representative decides what he should or should not report to me. Frequently he decides not to report things to me because he feels he can handle the matter better himself; he is afraid that by notifying me of the situation (which is his job), I will take ignorant, improper action and upset the

"apple-cart." Here again the NR representative, instead of representing me, has become my judge.

Nearly all NR representatives have had inadequate experience to handle the important and complex tasks they face; I do not expect them to be able to make wise decisions on all matters by themselves. Unless they are continually alert they can gradually create a situation where they become too "chummy" with the contractor; they thus tend to become, in effect, a member of the contractor's organization and to share his responsibilities; very subtly and imperceptibly they get themselves in the frame of mind where they really cease to be NR representatives, but feel themselves, instead, to be part of the contractor organization. Since they have permitted themselves to become emotionally involved with the contractor, they feel that they owe a "loyalty" to his organization. Once they reach this frame of mind they become practically useless to NR, doubly so because I am relying on them to represent me to the contractor, whereas they are actually representing the contractor to me, or judging me, but without my being aware that this is the case; if I but knew this, I could take the necessary action. As a matter of fact, under such circumstances it is better to have no NR representative at all, because I would then not be lulled into thinking the NR interests are being taken care of.

Frequently you must sit back and judge the contractor and his performance. Minor events or troubles are frequently clues that show up deficiencies in contractor management, in organization, in ability of personnel, in practices. This will require a great deal of clear thought, but can result in great improvements in the contractor's organization and the resultant performance of NR business. Let me know, promptly, of observations such as this.

**Please bear in mind always that you are the NR representative; that you are to carry out the policies of NR; that you are not to judge NR, or represent the contractor to NR. To achieve the status of a true NR representative requires the acquisition of God-like qualities; but you can try.**

/s/ H. G. Rickover

I must admit I took this letter very seriously having never before been an NR field representative. I was always wary of the Westinghouse management I was required to monitor, but I must also admit that I was not always forthcoming with Rickover in my letters and telephone calls because I did indeed fear that he would "upset the apple-cart" with his characteristically impulsive behavior. So I took what I believed was a prudent approach: telling him what I thought he needed to know without getting him too excited. Generally over the ten years at Bettis, this process worked well, but on occasion I was thoroughly chewed out for not telling him something he later learned of from other sources.

I do recall a pertinent point, of course excluded from his famous letter, that he made to me some time later regarding the contractor's primary interests. He said, "Remember if you were to catch on fire, the contractor would not piss on you to put it out!"

In addition to the biweekly letters, Rickover required his NR field representatives to make periodic telephone calls to him whether they had anything of interest to report or not. In my case this was every Monday, Wednesday, and Friday. You actually were required to speak to him personally and not to a secretary in his office. Generally this was

not a pleasant experience. One had to think of something useful to tell him without creating a crisis, and one could not get away with continuously reporting nothing at all. I was always amazed that the Admiral would take the time to receive calls all day long from his various NR field representatives (numbering as many as 20 or 30), but that was his style in keeping control of his vast enterprise. The calls indeed did become burdensome to him as evidenced by the directions provided by one of his staff assistants. At some point in my tenure, I was told that saying, "I have nothing to report" when I spoke to him was taking up too much of his time, and, accordingly, when I had nothing to report I was directed to say simply, "Nothing!" Later, I was told that even this was too time-consuming and therefore when I had nothing to report I was told to say to him simply, "No!" However, too many "No's" in succession would cause me grief so it was necessary to come up from time to time with *something* of interest to tell him.

In addition to the periodic letters and phone calls, I did have face-to-face contacts with the Admiral on occasion due to my visits to NR headquarters, primarily to interview candidates for the NR program, and to pick him up at the Pittsburgh airport on his trips to visit the Bettis laboratory, generally at such inconvenient times as Friday night. (Rickover liked to travel to his field activities leaving Washington late in the day so that he could get in a full day of work at headquarters and at the same time keep his contractors and NR field representatives busy in the evening so as not to interfere with *their* working days.) Picking him up at the Pittsburgh airport and driving him the one-hour trip to Bettis was always an adventure, often not pleasant. These auto trips ran the gamut from terrifying (because I had to safely steer the car through traffic while often being vilified) to occasionally entertaining; examples:

- During one trip, he became thoughtful and philosophical telling me that he believed that there were three very serious problems impacting world civilization. These were *inability of the earth to support the expanding population*, *the need to protect the environment*, and *the rapid depletion of our limited supply of fossil fuels.* In reflecting on this, I note that the Admiral was certainly prescient since these are indeed widely recognized today as serious problems affecting our planet but clearly were not so recognized when he spoke of them in the mid-1960s.

- On another occasion, he was uncharacteristically depressed over a clash he had with a powerful U.S. senator from Mississippi. He had encouraged one of the major California aerospace companies to consider building a reactor core manufacturing plant, with government financial assistance, to provide needed competition for the only two remaining companies then producing reactor cores. The aerospace company decided to build the prospective plant in Mississippi with that state's low-cost labor. However, after reviewing the proposal for the plant, Rickover decided that the costs to the government for the new plant were excessive and could not be justified at taxpayer expense. The Admiral told me that he had never, in his entire career, felt such strong political pressure as that coming from the Mississippi senator who was trying to force him to proceed with building the plant. He went so far as to say that he could be forced out of his job because of his resistance to the senator. He clearly was not going to cave in to the pressure,

but I had never seen him so downcast. (The outcome was that Rickover, as usual, prevailed and continued on as head of the NR program for more than a decade.)

- Not all the automobile rides from the airport to Bettis were as interesting. In fact many were singularly unpleasant. I recall one occasion where we seemed to be having a matter-of-fact low-key conversation when I provided him with some information about Bettis management that elicited an orally violent reaction. I forget the details but I do recall his statements: "You talk to me on the phone and write me letters but you never tell me anything important! Why in hell are you just now telling me this? Don't you see what harm you are doing by not keeping me informed?" And on and on. It was with great difficulty that I was able to keep the car on the road.

- I remember the specifics of another highly unpleasant exchange where I disagreed with an action that the Admiral endorsed. My predecessor as the PNR Assistant Manager, Captain Ed Kintner, had returned to NR as a civilian employee after a few years managing a shipyard in Maine. In his new position reporting directly to the Admiral, Ed was responsible for the manufacturing of nuclear reactor cores for the Navy's ships. Ed had concluded, either due to the Admiral's urging or based on his own idea, that the Bettis and KAPL quality control engineers at the core manufacturing plants should be removed and that we should rely solely on the federal government inspectors to monitor the core manufacturers' quality control program. I picked up Kintner and the Admiral at the airport, and before I had driven no more than a mile or so, Kintner brought up this subject, having warned me in advance that he had intended to raise it with the Admiral. I was therefore prepared and stated that I strenuously objected, arguing that the Bettis and KAPL engineers were needed at the plants to provide the necessary technical guidance to the government inspectors who were not highly educated and were not engineers fully familiar with the complexities of manufacturing reactor cores. As the official responsible to the Admiral for coordinating NR's quality control activities, I pointed out that I believed the proposed step would compromise the quality of our reactor cores. Rickover hit the ceiling (or roof of the car) and began to scream: "Kinter, I told you this wouldn't work. As I anticipated, Claytor is stubborn as always and is never receptive when you present him with a new approach, no matter what the subject is!" Then he yelled at me, "Claytor, turn the car around. We're going back to Washington!" I recall I pulled the car over to the side of the road and stopped. Eventually, Kintner calmed the Admiral down, and we drove on to Bettis in a silence filled with tension. (The ultimate outcome of all this was that, with the Admiral's full support, I was overruled and Kintner's idea was put in place despite my objections.)

Although, as I mentioned, it was my responsibility to call him at least three times per week, he would sometimes initiate the call himself, and, on several occasions would begin the conversation – if you could call it that – with the unsettling query, "Do you realize the harm you have done?" This was always delivered at a high volume. I had no

idea of the subject nor of the harm I had done but I was assured from the question and his tone that I was in trouble – again.

One specific example was a call from him about eight o'clock on a Saturday morning while I was still asleep at home in bed. (My standard Saturday visit to the office was usually scheduled to begin about 9 AM.) Following the usual, "Do your realize, etc.", he immediately provided the answer. He said, "I've learned you have written letters to the Bureau of Naval Personnel and others, highly commending Commander Thompson, one of your Supply Corps officers. That's the same guy that has criticized our reactor core contracting policies!" I am not sure what Thompson had said about NR contracting policies or how Rickover had learned about it, but I explained, "Admiral, it has been the practice here for years, starting with Kintner, to write such letters for our Supply Corps officers when they are transferred to other commands, thereby helping give their careers a boost. Thompson especially had done a very fine job here at Bettis." The Admiral's reply was typical, "Who gave you the authority to write such letters?" Not expecting an answer to that, he demanded, " I want all those letters recalled and destroyed! Do it now! Report back to me when you have it done!" Needless to say, I complied.

Another example: When Admiral Elmo Zumwalt became Chief of Naval Operations, he liberalized naval discipline including allowing officers and enlisted men to wear neatly trimmed beards. Rickover however strictly forbade military members of his Washington headquarters – a high percentage of his young engineering staff – to wear beards. Some of these young naval officers were routinely assigned to the Bettis Reactor Engineering School and a few of them had elected to grow beards during their 6-month stay at the school, which did not bother me at all. I routinely approved any weekend leave requests for trips by these officers out of the Pittsburgh area, including in one instance for a bearded young man to be a member of a wedding party in a nearby state. Rickover somehow learned that there were students at the school who were wearing beards. He revealed this knowledge in a phone call to me, surprisingly not demanding that beards be shaved but making it clear that none of these young officers were to leave the Pittsburgh area unless clean shaven. I called in the young man and told him he had a choice – stay here and keep the beard or shave it off and attend the wedding. The officer dissolved into tears, having become very fond of his facial hair. I approved his leave request but didn't bother to check whether or not he complied with the order.

My personal leave requests were always submitted to him on an official Navy leave request form. Hopefully he would sign and return them approved, but on more than one occasion he would call to complain that I was asking for too much vacation time, pointing out that he seldom took any time off because of the importance of his work on the NR program. There were at least three leave requests, however, that he chose to approve with comment, revealing his occasional puckish sense of humor. One of them was stamped with the inscription, "Have a good time. Don't take any wooden nickels or put peas in your ears". Another (a Thanksgiving leave request) commented in his hand-writing, "Don't guzzle too much or eat too much. Remain fit for work. Don't forget you are U.S. property." And a third was scrawled to his WAVE assistant, "Sarbaugh, take

care of your good-looking friend." These leave requests are framed and hang today on a wall at home.

There were of course some phone calls that he initiated that were not acrimonious. On several occasions, he called to ask me to obtain for him several rolls of black electrical tape. I always passed this along to the appropriate administrative manager at Bettis who promptly responded and sent the tapes on to the Admiral. I wondered what in the world Rickover was doing with these tapes, facetiously postulating that he might be "moonlighting" as an electrician. This sort of request was typical of Rickover, who routinely practiced cumshaw, not typically for his own benefit but as an often whimsical overture to his staff or others. For example, he once asked the Bettis General Manager to give him a framed Westinghouse safety award that he saw hanging on the wall outside the General Manager's office; I later learned he presented it to one of his WAVE staffers in Washington. A few years after his retirement in 1982, there were published stories about Rickover receiving gifts from General Dynamics, resulting in a letter of reprimand from the Navy secretary being placed in Rickover's personnel file; my experience with the Admiral tells me that this was an unjustified blemish on his record – no senior government official, in my judgment, was less self-serving or more protective of the government's interests than Admiral Rickover.

## ESCORTING REACTOR CORE SHIPMENTS

One of my responsibilities at the Pittsburgh Naval Reactors Office was to provide escorts for the shipment of reactor cores. The reactor core was the heart of the nuclear propulsion plant containing the enriched uranium which, when undergoing controlled nuclear fission, generated the heat that was the basis for powering the ship. Newly manufactured cores were shipped from the core manufacturers' plants to the various government and private shipyards where they were installed in nuclear powered ships, either in a newly constructed ship or following refueling of an active ship. In addition, reactor cores that reached the end of their useful life were removed from ships during refueling and were shipped to the Expended Core Facility at the Navy's installation in the Idaho desert where they were subsequently dismantled.

Because of the high value and strategic importance of these reactor cores, security of their shipments was of paramount importance. The most practical method of shipping was via rail, and therefore this was the shipping approach always used. When I arrived in 1963 to assume my new job at the Bettis Laboratory, it was the practice to escort the cores with an armed guard of trained navy personnel headed by a commissioned officer and three or four enlisted personnel. The size of this group was important in providing protection of the shipment during transit especially in notoriously unsafe locations such as rail yards where itinerant tramps and other unsavory characters were likely to be encountered. Another important job of the escort team was to protect the cores from potentially damaging railroad practices such as "humping" where freight cars were moved by letting them roll by gravity from an elevated portion of track to a new lower location.

It was the practice to place the car carrying the reactor core as the penultimate car on the train followed by a caboose, which housed the escort team. By prior arrangement with the railroads handling the shipment, speed restrictions were placed on the trains. Also, the escort commander established communications with the train conductor to ensure that the speed restrictions were followed. Periodic telephone calls to the home office in Pittsburgh provided further assurance that all was in order during the shipment.

A large number of both "new" and "spent" reactor cores had thus been escorted successfully for a number of years. There had been one potentially serious accident involving a train carrying a reactor core, but the damage to the train was fortunately minimal, and the core and the escort team were not harmed. The escort team's presence clearly helped alleviate any problems from this incident and the home office was kept informed throughout.

At some point in the past, I am sure Admiral Rickover had approved this method of shipment although he may not have been aware of the details and the number of escort personnel involved. Rickover characteristically was always looking for ways to contain costs and often undertook campaigns to reduce expenses; for example, for years he did not permit the government's offices in Pittsburgh to be air-conditioned. Somehow the number of people escorting reactor cores came to his attention, and he decided that there were simply too many people involved. I recall this matter first came up in one of our typically unpleasant automobile rides from the Pittsburgh airport to Bettis. Without any

prior discussion, he calmly asked me how many people were escorting reactor cores. I replied with the number, attempting to explain the hazards and dangers in these shipments and the justification for the size of the team. Before I was able to explain, he exploded, “How in hell can you justify having all these people doing such a simple job? Don’t you realize how much this costs? You are acting irresponsibly! There should only be one person escorting the cores!” I tried to reach some compromise, indicating we could probably cut back to three and still get the job done.” “Absolutely not! One person is enough!” he stormed back. I then said I was worried about the security of the individual, especially with hoboes wandering around rail yards, and that, as an absolute minimum we needed two people to look out for each other.” He said, “Claytor, that’s an order. One person! I don’t want to discuss it with you any more, period!”

I knew that sometimes one could get Rickover to change his mind after he had made an apparently impetuous decision by presenting him later with a reasoned thoughtful request for reconsideration. This I did with a lengthy memorandum explaining the rationale for the successful approach we had taken for many years, but recognizing his desire to be more efficient and save money, presenting him with what I believed were very cogent arguments for having at least two persons escort the shipments. He chose to ignore me, and I did not ever receive a direct answer from him; perhaps, I postulated, he did not want to go on record as opposing what I had characterized as a safety measure. Several weeks later when I inquired, one of his senior staff told me the answer was still “No!”

## THE RICKOVER INTERVIEW SYSTEM

Much has been written about Admiral Rickover's interviews. As far as I know, there did not exist in his office a chair with foreshortened legs, causing the interviewee to slide off during the Admiral's interrogation. But he did indeed personally interview – and often grill unmercifully – almost everyone who was to have a connection to his program, among them: all the commissioned officers who would serve aboard nuclear powered ships in an engineering capacity, all prospective commanding officers of nuclear ships, and all candidates – military and civilian – who were candidates to serve on his headquarters staff. A chief source of those interviewed for jobs in NR headquarters were prospective graduates of NROTC programs at civilian colleges and the U.S. Naval Academy.

All of those interviewed by the Admiral were first subjected to three or four interviews, lasting about 20 to 30 minutes, by senior members of his staff. Each interviewer was required to write a short summary of his opinion of the candidate, assign a grade on a 4.0 scale, and make a recommendation whether or not to hire. For the most part, recommendations to hire were the norm inasmuch as the candidates almost all came with good records, and, for the young hires for NR, with outstanding academic records. Of course all those who did or did not excel in academics were asked by the Admiral, "Why didn't you do better?" - a question that prompted the title of Jimmy Carter's book, *Why not the Best?*

After I had worked in the program for two or three years, Rickover added me to the list of interviewers. This chore – and indeed it was since it took time away from my primary responsibilities in the program – continued during my tenure at the Bettis Laboratory. Usually these interviews were scheduled on Friday and Saturday, thus requiring travel from Pittsburgh and disrupting my weekends. (I did find a pleasant transportation arrangement from Pittsburgh to Washington – a sleeper I could board about 9:00 PM in Pittsburgh that was then attached to a train from Chicago that arrived in the nation's capital about eight in the morning, with me fresh and ready for the round of interviews.)

Although I did find interviewing a chore, there were some rewarding moments. Because the young men I interviewed were in almost every instance very intelligent, I was often stimulated with the intellectual challenge of the give and take. I recall a most interesting discussion with a young engineer about to graduate from an NROTC program at an Ivy League college who was taking a minor in architecture, a subject that was clearly his first love. In an interview that I am sure went well beyond the allotted 30 minutes, he provided me with a running commentary on the pros and cons of his favorite architects – Mies van der Rohe, Walter Gropius, and Ero Saarinen; I indeed learned something.

The Admiral took a particular interest in interviewing candidates from the Naval Academy; often obtaining information from them that reinforced his view that the Naval Academy was woefully deficient in its academic programs. A press report in 1974 quoted a Rickover comment on the Naval academy: "an East Coast Disneyland . . . a refuge and an asylum in which adolescence can be continued indefinitely." I was asked on several occasions to provide him with separate comments on what I had learned from interviews of Naval Academy midshipmen. Rickover indeed was instrumental in effecting major

improvements in the curricula and faculty at Annapolis, including the creation of the post of academic dean. From my experience as a student there in the late 1940's, I am convinced he was right on target, especially with regard to the unsatisfactory teaching of the engineering disciplines.

In total Admiral Rickover's personal interviews assuredly numbered in the thousands. In my case, I am sure over the 17 years I served in the program, I must have interviewed six or seven hundred young men, many of whom went on to serve distinguished careers in the NR program or in the Navy. Many years after I had completed my NR career, the then distinguished Chief of Naval Operations, Frank Kelso, told me that I had interviewed him, prompting me to respond that I was glad my comments on him – which I did not recall – at least didn't harm his subsequent rise to the top of the Navy.

Indeed sometimes my comments on a candidate did prompt a response by Admiral Rickover, usually with a remark like, "You don't know what you're talking about!" In the early days of my tenure in NR headquarters, Rickover continued the practice of placing medical doctors on the first nuclear submarines, and of course subjected them to the interview process like all other prospective nuclear submarine officers. I was among those designated to interview these candidates. My assignment in this role did not last long. Rickover reviewed my comments on the first set of doctors I had interviewed, immediately called me into his office: "Claytor, goddamnit! You are psychoanalyzing the doctors! From now on, you will not interview them!" Although I was obviously poor at psychoanalysis, I was allowed to continue with interviews of all others outside the medical profession.

## RICKOVER DISTRIBUTES A POEM

Occasionally, Admiral Rickover would send his field representatives information that he believed would be intellectually stimulating. One day in the mail I received this challenging poem along with the below forwarding memo from the Admiral:

**COLLECTIVE FARM**

By Felicia Lamport

In the best collective use,
Geese afoot are gaggles
(Even when one goose gets loose,
Falls behind and straggles);

Skein's the word for geese in flight.
Turtledoves form dools.
Barren's right (though impolite)
For a pack of mules.

Starlings join in murmuration,
Pheasants in a rye,
Larks in lovely exaltation,
Leopards, leap (they're spry).

Ducks in flight are known as teams;
Paddings when they swim.
Herrings in poetic gleams
Please the wordsmith's whim.

Cats collect into a clowder,
Kittens make a kindle.
Sloths of bears growl all the louder
As their forces dwindle.

Lapwings gather in deceit,
Apes convene in shrewdness,
Mares in stud (an odd conceit)
Bordering on lewdness).

Foxes muster in a skulk,
Squirrels run in drays
While collectives in the bulk
Make up word bouquets.

The following note to me from the Admiral forwarded the above poem:

The accompanying poem contains words
descriptive of birds and animals in
groups. By learning these words at
Christmastime you and your children
(if your wife had any) can be-
come more interesting conversationalists.
/s/ H.G. Rickover

One year, at Christmas time, he sent an excerpt from Dylan Thomas's "A Child's Christmas in Wales" with this forwarding note: "I was struck by the beauty of this little poem and thought you might enjoy it. Merry Christmas." (Recalling one past Christmas

Eve, during a required periodic phone call, I wished the Admiral "Merry Christmas" and he responded, "I wish you the Merry Christmas you deserve." – and who could possibly take exception to that perfectly reasonable wish?)

Along with items like the above, from time to time, small aphorisms ascribed to Rickover would appear in my in-basket such as, "The devil is in the details but so is salvation." and "If you're going to sin, sin against God, not the bureaucracy. God will forgive you, but the bureaucracy won't." In November 1967, I recorded the following quotes from the Admiral, but I don't remember why he chose to pass them along to me:

Heaven is blessed with perfect rest,
But the blessing of earth is toil.

Every hour has 60 golden minutes, each
Studded with 60 diamond seconds.

## DELIBERATE MALPRACTICE

During my ten-year assignment coordinating the Naval Reactors quality control program, one of the most challenging issues we faced was the evidence from time to time of falsified inspection results such as deliberately overlooking defects in radiographs of welds and similar activities that clearly had the potential to jeopardize the integrity of vital Naval Reactors equipment. I personally became aware of a particularly egregious example involving nuclear reactor core fuel elements being fabricated at one of our reactor core manufacturers' plants in New Haven, Connecticut.

Reactor core fuel elements contain the material that undergoes nuclear fission, generating the heat that provides the propulsion power for all of our nuclear ships. These fuel elements must also contain the highly radioactive products of this nuclear fission. During fuel element manufacturing, a variety of non-destructive inspections were prescribed to assure their integrity. One of these inspections consisted of an ultrasonic test by immersing each element separately in a water filled tank and recording the results on a paper trace. This activity required a series of repetitive steps, physically moving the element into the tank, fixing it in position, conducting the ultrasonic measurement, then removing the element from its fixture and the tank and then proceeding with the same steps for the next element. It proved to be a somewhat time-consuming and boring process.

Someone – either a government inspector or a member of the contractor's quality control staff – noticed a very peculiar anomaly in the ultrasonic trace results for about a hundred or more fuel elements that had undergone the test. Upon close examination, each individual trace always showed the same anomaly for each element tested – in other words, each element's trace would have its own "signature". The anomaly discovered was that a hundred or so elements all had the same "signature" even though they were reported in inspection records as different elements. What had obviously happened was that one element had been placed in the tank and not removed through at least a hundred tests of this same element. Correspondingly, about a hundred elements were never tested although records indicated they had been. Of course the significance of this was that untested elements could have contained undiscovered defects that could affect the integrity of a nuclear reactor core.

A preliminary investigation was immediately undertaken that pointed to two employees each working separately on successive back shifts who appeared to conspire to bypass necessary tests in the interest of avoiding the extra work of transferring elements into and out of the water tank. It turned out that the two employees were a father and son.

When Admiral Rickover learned of this problem, he promptly contacted the head of the Federal Bureau of Investigation and requested an investigation. The FBI's New Haven office was assigned the task, and the Admiral directed me to proceed to New Haven to serve as liaison with the FBI. I spent the next two weeks working closely with the agent in charge and several of his colleagues, who were working to confirm the preliminary investigation and determine if there was evidence of further falsified inspections. I developed a deep respect for the professionalism of the FBI who did an excellent job. The results of the FBI's work led to the prosecution and conviction of the two employees.

This episode led to sensitivity throughout the NR program of the potential for falsified inspection results. Under the leadership of the General Manager of the Bettis Laboratory, Bill Hamilton, a program-wide effort was undertaken to assure contractors and government inspectors were alert to what Hamilton termed “deliberate malpractice” and that they took necessary steps to mitigate it.

## THE SECRETARY OF THE NAVY VISITS BETTIS

From time to time, Rickover invited senior officials of the Atomic Energy Commission and the Defense Department to the Bettis Laboratory to impress them with both the strong technical basis underpinning the design and development of naval reactors and the technical competence of Bettis scientists and engineers responsible for this design and development.

Among the many distinguished visitors were Glenn Seaborg and James Schlesinger, both Chairmen of the Atomic Energy Commission, and Robert McNamara, Secretary of Defense. Usually these visits followed a routine format of tours of individual laboratories where Bettis managers put on a standard "dog and pony show" with impressive slides and other visual aides.

However, one visit by Secretary McNamara, turned out to be anything but routine. For cost reasons, the Secretary had been opposed to additional nuclear powered aircraft carriers beyond the existing eight-reactor *USS Enterprise*. Rickover had been promoting a four-reactor carrier that had been firmly and publicly rejected by McNamara. However, during the Bettis tour, McNamara learned it would be feasible to build a two-reactor carrier and, recognizing that there now may be a way of supporting nuclear power for a carrier without appearing to reverse his public position, urged that development proceed on a two-reactor carrier. It was the genesis for the design of all future nuclear powered aircraft carriers. In his biography, "*Rickover*", Francis Duncan quotes the Admiral as saying that the two-reactor decision was a prime example of a technical decision made on political grounds.

The visit that I must vividly recall was by a Secretary of the Navy about half way through my decade-long tour at Bettis Laboratory. Rickover liked to pull surprises on his subordinates, and this visit was no exception. The Admiral and I were standing in the rear of a presentation being made to the Secretary in the Bettis Thermal and Hydraulics Laboratory when the Admiral turned to me and said that he wanted me to give a talk to the Secretary explaining the Naval Reactors quality control program. Although I was responsible for and quite knowledgeable of this program, I was totally taken by surprise and was completely unprepared to give the talk. Rickover said that the Secretary would be back in the main Bettis conference room in about 20 minutes and that I should give the talk then. He then asked me to tell him what I planned to say. I began trying to explain the program when Rickover interrupted, saying: "Claytor, that's terrible – now get out of here and go prepare yourself - you have 20 minutes!"

At this point in my career, I had essentially no experience in giving a talk to a person at the level of the Navy Secretary, and I was nervous. I rushed off to my office, hurriedly made notes, and did my best to pull together a 10-minute talk. When I arrived at the main conference room, the Admiral introduced me to the Secretary, and I remember beginning, "This is not an extemporaneous but an impromptu talk since Admiral Rickover, without prior warning, told me 20 minutes ago that I was tell you, Mr. Secretary, about our quality control program." That got a laugh. Then I went on with some details on the program. I think I did pretty well, perhaps because I did not have time to worry about what to say. The next day, I received a telephone call from the Admiral who paid me one of his few

rare compliments, “ Claytor, that was a good job. You sounded just like a corporate executive!”

## “I’LL MAKE YOU AN ADMIRAL”

In early 1973 I decided to request retirement from the Navy having completed 24 years of commissioned service including the last four years of the obligated service required when I accepted appointment to the rank of captain. I had worked in the Naval Reactors program for 17 years, reporting directly to Admiral Rickover for all but the first year. I was now nearing completion of my tenth year in the Pittsburgh office. It was time to go. Working for the "kindly old gentleman" for all those years had taken its toll on my wife and children. Although it was a great privilege working for the "Father of the Nuclear Navy", it was a demanding experience, and at age 45, I was ready to try something else.

In one of my regular required telephone calls to the Admiral, I said I would like to come to Washington to see him the following Saturday, always a normal NR workday. He asked, "What do you want to see me about?" I replied that it was a subject that I didn't want to discuss over the phone. Typically, raising his voice, he demanded again to know what I wanted to talk about so I was forced to tell him that I had decided to request retirement from the Navy. He promptly hung up.

A few hours later, I received a call from Bill Wegner, Admiral Rickover's very capable deputy in the Washington headquarters. Bill said, " Rickover wants you to continue in the NR program and will make you an Admiral." This caught me by complete surprise. I told Bill I needed to seriously think about it and would call him back. I then called my wife and invited her to lunch to talk this over. As much as she disliked the Admiral and the thought of my continuing to work for him, she assured me that this was my decision and she would support whatever I decided. Very few engineering duty officers – of which I was one – attain the rank of Admiral, and those few that do usually have choice Navy billets such as commander of one of the naval shipyards. This seemed to me to be an incredible opportunity. After a quarter century in the Navy, making Admiral would be a rewarding culmination of my Navy career. So I decided to accept the offer.

I called Bill Wegner and said I would remain in the program if I made Admiral. He said he would talk to Rickover and get back to me. Later he called to say that Rickover wants you to sign up to remain one more year, and he will make you an Admiral. I began to see the typical Rickover manipulation in all this and replied to Bill that **if** I am selected for Admiral, I will indeed commit to at least one more year. Now I would find out how solid was Rickover's offer. "No deal" was the final answer from Rickover – I had to commit first and then he would act. Promotion to Admiral or any other officer rank occurs as a result of action by selection boards made up of senior officers (not including Rickover). I told Wegner I could not depend on the Navy selection board and therefore could not agree to Rickover's proposition. Wegner said Rickover had great influence over selection boards and could get his way. I didn't believe this, so I said I would now proceed with my planned retirement. If Rickover indeed could have caused the selection board to select me for Admiral, he would have done so and would have accepted my proposal. The fact that nothing further happened speaks for itself. Admiral Rickover appreciated that I had ten years experience in my current job, and it was to his advantage to have me continue. Thus he tried to lure me into staying on.

I did not see him again until years later when I visited him at his office in Washington just before *his* forced retirement at age 82 during the Reagan administration. Before I departed the NR program in August 1973, he awarded me the Legion of Merit (a fairly standard award for most Navy officers at some point in their career if they stayed out of trouble). There was no ceremony. Typical of Rickover, he sent it to me in the mail.

# EPILOGUE

**ADMIRAL RICKOVER AND BROTHER GRAHAM**

My eldest brother, Graham (William Graham Claytor, Jr.), figured prominently in the career of Admiral Rickover, although when I worked for the Admiral, I had no idea what lay in store in the years after I left the NR Program.

Rickover first mentioned my brother to me in a telephone call in the late 60's while I was visiting a Naval Reactors supplier on a quality control evaluation. He called to say that my brother had just been made president of Southern Railway; this was the first I had learned of this as Graham had not bothered to tell me in advance. Perhaps it is only my imagination, but I think Rickover seemed to take a renewed interest in me after he learned of my brother's elevation to this new position. I do know that the Admiral was fascinated by the Southern Railway's large "Old Fashioned" glasses that were inscribed with the Southern logo and a picture of a locomotive. I believe he first became aware of them when I gave him one that my brother had passed along to me. The Admiral asked if I could get him a whole set of glasses (a dozen or so), which Graham graciously provided and which I in turn gave to Rickover. Then, as I recollect, about six months later, the Admiral asked me if I could get him another set - Graham was a bit reluctant, but, recognizing that it might be a career-enhancing move for me, passed along this second installment of glasses for the Admiral.

When Graham became President Carter's Secretary of the Navy in 1977, Graham became Admiral Rickover's boss – never a pleasant position for a Navy Secretary. I had now retired from both the NR program and the Navy so my presence was never a factor in my brother's dealings with the Admiral. The major confrontation between Rickover and my brother that arose during Graham's tenure was the issue of major claims of hundreds of millions of dollars by private shipyards against the Navy in the construction of nuclear powered ships. Rickover took the position that the Navy should not settle whereas Graham decided that a settlement was in the best interest of the government. This struggle, principally involving Electric Boat and General Dynamics, was very complex and has been described in vivid detail in a lengthy book. Graham, exercising his superior position as Navy Secretary, settled many of the claims, thereby incurring the enduring wrath of Admiral Rickover.

Many previous, but certainly not all, Navy Secretaries, had taken the job as a stepping-stone to a higher position either in the federal government or in private life. My brother, on the other hand, had no such ambition; he was then 65 years old and had no other thought than to return to his law firm and resume his practice. He had absolutely no fear of Rickover and was determined that he would not be intimidated by him as had so many previous Secretaries. Graham told me of one luncheon meeting with the Admiral and Graham's boss, Charles Duncan, Deputy Defense Secretary. Rickover, then seething over some issue, perhaps the shipbuilder claims, accused my brother of being beholden to corporate special interests and saying something to the effect that, "We can't trust you businessmen to properly represent the government with your ingrained, profit-motivated business philosophy!" Graham responded by asking Rickover if he had ever heard of Louis Brandeis, of Felix Frankfurter, and of Dean Acheson? The Admiral reportedly said of course he had.

Then my brother, clearly angry, replied that those were the men from whom he learned his business philosophy and that he resented and totally rejected Rickover's accusation that he was not acting in the best interest of the government. My brother said that the Admiral had no more to say on the subject.

When my brother left his position as Deputy Defense Secretary in 1981 (having moved up from Navy Secretary in 1979), he passed along to me what he called his "terminal" correspondence with Admiral Rickover. The Admiral's memorandum of 24 December 1980 to the Deputy Secretary of Defense is worth quoting in part:

> "You may recall that during your tenure as Secretary of the Navy, when Mr. Hidalgo was Assistant Secretary, I submitted various memoranda to you and your senior staff pertaining primarily to shipbuilding claims and related matters. I am still experiencing the same problem that I had prior to your departure, namely, I rarely receive even an acknowledgement, let alone a substantive response, to memoranda I send to the Navy Secretariat.....The practice of not responding to my various recommendations started with your arrival in office as Secretary of the Navy. It has occurred to me, therefore, that perhaps Secretary Hidalgo, in not responding to my recommendations is simply carrying out a policy that you, as his superior, have imposed.....I am under no illusion that you or Secretary Hidalgo will, at this late date, answer all the memoranda I have sent you. However, action can and should be taken by the Secretary of the Navy - or by you, if you have imposed constraints upon him - to respond to enclosures (1) through (3) prior to your possible departure.....I would appreciate receiving a reply to this memorandum."

My brother's reply of January 16, 1981 is as follows:

> " Dear Admiral Rickover:
>
> I have read and carefully considered the memoranda to the Secretary of the Navy you forwarded to me of December 24. I am acquainted with the issues discussed in these memoranda, having been directly concerned with most of them both in my present capacity as Deputy Secretary of Defense and in my earlier capacity as Secretary of the Navy.
>
> I have passed along to my able successor, Frank Calucci, your memoranda as well as my recommendations with respect to them.
>
> Sincerely,
> /s/
> W. Graham Claytor, Jr."

Recognizing my great regard for Admiral Rickover, my brother always said to me that the Admiral undoubtedly made enormous contributions to the defense of the nation, but that, by the late 1970's that, in his judgment, it was time for Rickover to finally retire. Graham told me that this had been discussed with President Carter, but that the President, because of his early association with Rickover in the Naval nuclear program and his frequent reference to the admiral as a mentor in his life, he simply could not take the step of forcing the Admiral to retire. My brother said he urged his successor, Frank Carlucci, to set in motion the necessary steps to terminate Rickover's active service. This, of course, was done early in the Reagan administration, and as a

result Rickover retired.

During the period of the exchange of correspondence quoted above, I had the opportunity to visit Admiral Rickover at his office in Crystal City in Arlington, Virginia. He was most gracious, offered me coffee, and we chatted for a while. He did seem tired and old (now nearly 81) but his mind was clear. I did not bring up the subject of my brother, but he volunteered: "The trouble with your brother is that he just does not understand the Naval Reactors Program and what we are trying to do." It was my last meeting with Admiral Rickover.

The denouement of my brother's relationship with the Admiral came a few years later, not long before Rickover's death. This occurred at a social occasion when Graham and the Admiral were both present. Sometime during the evening, Rickover, sitting next to Graham's wife, Frances, leaned over and said to her: "You know, your husband was the best Secretary of the Navy we've ever had."