Ray: Portrait of an industry veteran

Southern California Edison executive vice president Harold Ray brings nearly four decades of nuclear industry experience to the ANS presidency.

When Harold Ray had entered the Navy in the mid-1960s, he would ride a Greyhound bus along the southern California coast between his home and his stationed ship. He was newly married and just out of college, and following in some family footsteps by at last beginning service in the Navy. Having more pressing concerns on his mind, he hardly noticed the tangle of cranes and earthmoving equipment on a particular site along the Pacific Ocean as the bus sped past. The giant white, beachball-like containment dome, which would be spotted from miles away, was not yet built. Its pressurized water reactor, which already had a proven record of performance in three major power plants in other parts of the country, had not yet been lowered into place.

Now, nearly 40 years later, Ray runs that site, San Onofre nuclear generating station, as well as several others for Southern California Edison, where he has worked since 1970. As the 48th president of the American Nuclear Society, he brings the experience that brought him from the nuclear Navy to his current position as executive vice president of Edison's Generation Business Unit, where he is responsible for all of Edison's power generating facilities. He has worked under Admiral Rickover; met the demands, over the course of a dozen-plus years, of licensing two nuclear power units; and then ran the units, as well as the utility's hydroelectric and coal plants.

"I've been in the business for a very, very long time," Ray said on a spring afternoon when asked about his interest in the ANS presidency. "But I haven't really had an opportunity yet to do a great deal in terms of support for those who will come along behind and continue the work that we began 40 years ago."

He met up with *Nuclear News* while on a layover during a trip to Washington, D.C., on his way to one of a series of meetings with the Nuclear Regulatory Commission he has made over the past five years on behalf of an industry group concerned with risk-informed regulations. Dressed in khakis and a button-down shirt, Ray munched on a green apple and often leaned back casually in his chair. At rest, his willful, no-nonsense personality is tempered by a laid-back manner, perhaps the result of a lifetime of southern California sun. (Although one longtime coworker respectfully calls him anything but easy-going.)

He said his interest in the ANS presidency over the next year extends to ensuring that its members continue to use the society to develop their skills. "My motivation in seeking the office and carrying it out is to try to help ANS be a professional society that provides value to its membership, that makes it attractive in terms of developing and maintaining the skill set that goes into being a nuclear professional," Ray said.

Early years

Harold Ray grew up in the same small town where he was born just before World War II—Lynwood, Calif., located just south of Los Angeles. With his father owning and running a service station and his mother working as a caterer for local banquets, there was no shortage of side jobs to occupy the teenager's time. He pumped gas and ran errands for his mother, among other tasks that trickled down to him. "From the earliest time I was able to, I worked. My parents provided a lot of opportunities to work the whole time I was growing up. So, that was mostly what I did."

With the United States having fought in two wars before Ray reached his teenage years, he grew up expecting to enter the military when he turned 18. California was host to major facilities for each of the military services, including a Naval base not far away in Long Beach. But his experience working on cars, as well as his curiosity in the burgeoning aerospace industry—which had an epicenter at the Jet Propulsion Laboratory in nearby Pasadena—had borne in him an interest in engineering. In 1958, Ray combined the two by joining Naval ROTC while entering his freshman year at the University of California, Los Angeles.

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"I didn't have an interest in becoming a lawyer because I didn't know any lawyers," Ray said. "There was a lot more that was being done in the '50s by way of engineering. Things were being built. Particularly in southern California, aerospace was a big, dominant part of the scene."

At the time, UCLA offered a bachelor of science degree in general engineering, which Ray pursued. He found that he particularly enjoyed his mechanical engineering classes, and especially those involving structural engineering, which was the subject of his senior thesis. A part-time job working for IBM as a systems engineer, in which he worked to convert analog, punch-card computers to digital, swayed his career decision away from computers. Ray said he was more interested in "things you could feel and see, and would be impressive when they were built."

In the Navy

In late 1963, several months after graduating from UCLA, Ray found himself in the South China Sea aboard the guided missile frigate U.S.S. *King.* The United States was ramping up support for anti-Communist forces in southeast Asia following the murder of President Ngo Dinh Diem, of South Vietnam, in a coup, to whom the United States had been supplying military equipment and financial aid. Ray's crew was providing naval air support from the Gulf of Tonkin to the troops on land. Less than a year later, North Vietnamese torpedo boats were alleged to have attacked two American destroyers on a similar mission in the Gulf of Tonkin, leading to the eponymous Congressional resolution that made way for U.S. military action in the Vietnam War.

But by that time, Ray had been whisked from Subic Bay in the Philippines to 18th Street and Constitution Avenue in Washington, D.C. He was among 30 people interviewed one day in the late summer of 1964. He and one other recruit passed the interviews and were chosen to join the technical staff of the program, a joint effort between the Navy and the Atomic Energy Commission to provide the Navy with nuclear propulsion plants. The two young officers had lasted through one of the most notorious experiences in the emerging era of nuclear power: an interview with the founder and chief of the Naval Reactors Branch, Adm. Hyman G. Rickover. Getting thrown out of his office was practically a rite of passage.

"It was bad," Dwight Nunn, a vice president with Southern California Edison who worked with Ray in the 1960s at Naval Reactors, remembered recently. "The admiral had extremely high standards. He would ask you questions such as, 'Did you feel like you were wasting your time when you weren't studying?' He would throw you out of his office if you gave an answer he didn't like. You would go and sit in a room and be asked to think about your answers before you gave them to the admiral. Then he would call you back and go through the interview process again."

In their 1982 biography *Rickover: Controversy and Genius,* Norman Polmar and Thomas B. Allen wrote, "Stories of Rickover's bizarre interviews became the most frequently heard yarns in the wardrooms of the nuclear navy. Some were apocryphal. Many were basically authentic. . . . All had a common image: Rickover the sardonic, pitiless inquisitor who often spouted obscenities and foul insults." One first classman was ordered out of Rickover's office when he said that he was not willing to give up his Christmas vacation, spring vacation, and every weekend until graduation to study for entering the nuclear program. Another highly qualified midshipman was rejected apparently because he refused to put off his wedding for a year.

Luckily, Ray had already wed by the time he interviewed with Rickover. That life-altering event, however, managed to slip his mind when the admiral asked if he was married. "He got me so rattled during the interview that I said no," Ray remembered. "Then about a minute later, I said, 'Wait a minute, admiral. I am married.' He got really mad at me then."

Although Ray said it was coincidental, he would occupy the office next door to the admiral for five years.

Baring a hand

Nuclear power had revolutionized the Navy. Following World War II, Rickover had convinced the service that nuclear sea power was feasible, and proceeded to direct the planning and construction of the world's first atomic-powered submarine, *Nautilus,* which was commissioned in

Sailor-to-be: The young Ray uniformed and (almost) ready for duty

Young engineer: Ray mastering the steering component of the Radio Flyer in 1947

1955. It was the first ship of any kind to reach the North Pole, and its maneuverability forever changed naval strategy and tactics. By the end of 1962, a few years before Ray joined Naval Reactors, the Navy had built a nuclear-powered aircraft carrier, missile-armed cruiser, and large destroyer, to go along with some 30 nuclear-powered submarines.

In 1965, after spending most of a year attending Bettis Reactor Engineering School in Pittsburgh, where Naval Reactors sent recruits to learn the specific knowledge needed to work for the Naval nuclear propulsion program, Ray took office at the Main Navy Building in Washington, D.C. The mammoth building where Naval Reactors was headquartered at the time, with its counterpart Munitions Building, stretched along the length of the Reflecting Pool between the Lincoln Memorial and Washington Monument—nearly one-third of a mile. Erected after World War I as temporary office space to support the vastly expanded military, the buildings held 14 000 personnel when the fighting ended and continued to house Navy personnel until it was finally torn down by presidential order in 1970.

Unlike the Pentagon and its hallways of gold-braided uniforms, there were no visible distinctions between officers and civilians at Main Navy. Although a lieutenant in the Navy, Ray came to his desk everyday in plain clothes. And the days, which began at 8 a.m., ended “at five or nine or 10 or 11 or midnight or 1 a.m.,” in the words of one of Rickover’s former secretaries.

“They were long hours,” Ray recalled. “It was a six-day week, and I guess about 10 hours a day. It was expected because at that time there was a war on. People who were fortunate enough to not be out fighting the war were expected to ‘bare a hand,’ as they say in the Navy, and work as if they were.”

While at Naval Reactors, Ray was assigned to several projects, including the overhaul and rebuild of U.S.S. *Enterprise*, the first nuclear-powered aircraft carrier. (More recently, aircraft from *Enterprise*, stationed in waters off southwest Asia, flew nearly 700 missions in Afghanistan in the weeks following September 11.) Ray also was involved in the replacement of the horizontal steam generators at Shippingport station, the first full-scale commercial power reactor. And he participated in an early development of loss-of-coolant code called the FLASH code.

Ray was also assigned to represent the Navy on the American Society of Mechanical Engineers’ committee on Section III of the Boiler and Pressure Vessel Code. ASME had first organized a special committee on nuclear power in 1955, and eight years later published the seminal Section III of the code, which covered nuclear compo-

Midshipman: Ray in the early 1960s while at UCLA

nents. The next edition, published in 1971, which Ray had worked on, was much more extensive and represented the transition of the code from a vessel code to one covering the piping and other pressure boundary components involved in the conversion of nuclear energy to steam power. It relied on the Navy document SDB-63 Structural Design Basis for Naval Reactor Equipment, first issued in 1963. "Because I was a mechanical engineer with a structural engineering background, I became involved in the application of SDB-63," Ray said. "So, when ASME set up a committee to develop Section III of the code, they took a lot of work that had gone into SDB-63. And I was assigned to work on the committee on that basis." Today, the section still provides requirements for virtually every aspect of nuclear power reactor pressure boundary component design, construction, and inspection.

In addition, Ray was one of three mechanical engineers who worked on the reactor design for Nimitz-class aircraft carriers, which remain among the largest warships ever built. Powered by two reactors and called a "floating airport," Nimitz-class carriers can carry more than 80 aircraft and are capable of launching up to four of them per minute off of their 4.5-acre flight deck. Although the information remains classified, Ray said he spent several years on development of the design of the reactor coolant system in the carriers, as well as on the manner in which the reactor coolant system is purified. He said he can still "point to a number of things in that reactor design that I was directly involved in."

U.S.S. *Nimitz* was put to sea in 1975, and the newest Nimitz-class carrier, CVN-76 *Ronald Reagan*, is set to be commissioned next spring. "[Nuclear-powered supercarriers are] definitely one of the reasons the United States is the sole remaining superpower," said John Pike, head of the Alexandria, Va.–based think-tank GlobalSecurity.com, in *The Seattle Post-Intelligencer* last January. "The U.S. and the U.S. alone has the capacity on a couple of weeks' notice to have a couple of aircraft carriers show up in your neighborhood . . . and immediately have the largest and most capable air force in that part of the world." The tenth and last Nimitz-class ship, CVN-77, is scheduled to enter service in 2008.

Back to school

Ray, by the end of the 1960s, had gotten sidetracked. Nearing the age of 30, one ambition he had set for himself that he had yet to fulfill was earning a graduate degree. Tiring of the political climate of Washington, D.C., Ray and his wife Penny headed back to southern California in 1969 immediately after Ray left Naval Reactors. "I was happy to get out," Ray said. "I had no interest in remaining in the government. I was ready to go do something else."

They moved into a house in Pasadena made available by some in-laws, and Ray attended the California Institute of Technology on an Oak Ridge National Laboratory fellowship. He soon earned a master's degree in mechanical engineering, with an emphasis on nuclear engineering. Being away from school for nearly seven years, Ray said he struggled some with the transition from the hands-on work he did at Naval Reactors to the lofty mathematical coursework required at Caltech. "It wasn't easy going up against the top engineers that had just gotten out of their undergraduate programs. It was really very challenging because I had been away from academia, particularly as practiced there, in which there wasn't a practical application at all; it was 100 percent theoretical," Ray said. "But I thought if I was going to do any good in the rest of my career, I needed to get back and get refreshed on reactor theory as practiced at Caltech."

Because he and Penny wanted to start a family, Ray canceled his plans to pursue a doctorate degree. He learned of an opening at Southern California Edison from an acquaintance who was an executive of the utility and also served on the Caltech board of trustees. Edison had already been one of the first utilities to develop nuclear power for commercial use, by building the 75-megawatt Santa Susana (Sodium Reactor Experiment) power plant in the mountains north of Los Angeles. Ray applied for the job.

Contention on the coast

The homes, farms, and factories of southern California received a surge of electricity on New Year's Day in 1968 when Unit 1 at San Onofre station was placed in commercial operation. The major reactor components were the largest yet built for any pressurized water reactor, and in some cases were double the size of previous units. Unit 1, which was located halfway between Los Angeles and San Diego (and not far from the summer home in San Clemente that President Richard Nixon would purchase the following year), had enough power to meet the electrical needs of a city of half a million people. At a dedication ceremony four days later, the commissioner of the AEC called the event "perhaps the most significant step in advancing the Power Demonstration Reactor Program" because successful startup of the larger-sized, 450-MWe plant would lead to utilities building larger plants.

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Newlyweds: Ray and his wife Penny shortly after their wedding in 1963

In training: Ray at Combustion Engineering's plant simulator in Windsor, Conn., during the mid-1970s

After a bumpy start in its first year, during which time the plant was shut down for six months due to a minor fire and a control rod bottoming in the core, Unit 1 went on to have a robust average capacity factor of 73 percent over its first 12 years of operation.

By 1970, Southern California Edison had decided to build two more units on the San Onofre site. That was when Harold Ray was hired on as a mechanical engineer. He was in the initial staffing group that was to begin preparing the license application for San Onofre-2 and -3. Moving up to the vice president in charge of all of San Onofre site activities by the time the two units went online, Ray would have his hands full for the next decade-and-a-half.

To begin, the new units were to be considerably different from Unit 1, a Westinghouse pressurized water reactor that was built as a demonstration project. San Onofre-2 and -3 were a new generation of Combustion Engineering design, and, at just under 1100 MWe each, were more than twice as large as the original reactor. "Everything was new and improved by that time," Ray said. In the 10 years from the mid-1960s—when Unit 1 was being built—to the mid-1970s, a number of significant improvements had been made in vital components such as reactor vessels, emergency core cooling systems, emergency diesel generators, and reactor coolant pumps.

"You wouldn't want to replicate Unit 1. It did its thing. It operated successfully for 25 years and was a good plant. But it was not something that you'd want to make a lot of," he explained. "Required backfits to meet evolving licensing requirements made it too complicated, too difficult to operate. And the newer generation plants were more efficient, had a lower cost per kilowatt-hour, and were a lot simpler."

The difficulty of siting power plants on the coast of California also became an issue in the licensing of San Onofre-2 and -3. Many power plants had been located on the Pacific Ocean, where water could be used to cool condenser heat from the plants. But residential, recreational, and conservation interests, as well as the shipping and fishing industries, also depended on the same coastal resources. In 1972, California passed Proposition 20, setting up the California Coastal Zone Conservation Commission, which was to develop a statewide plan for protecting the state's coastal resources and prevent commercial buildup along the ocean. Edison now had to obtain a permit from the commission before proceeding with construction of the new units.

With the original startup target date for commercial operation already slipping behind, construction of San Onofre-2 and -3 was blocked in December 1973 when the California Coastal Zone Conservation Commission refused to permit siting. The commission claimed the plant would both destroy a scenic coastal bluff and damage the marine environment with thermal pollution.

After reaching a compromise with the Coastal commission a few months later, which included plans to preserve the bluffs and canyon on the seaward side of the plant, Edison again began initial site preparation work in March 1974. Opponents, however, then obtained a stay order on construction, and Edison was back to square one. As reported in *NN* at the time, a spokesman for Edison had "declined even to guess when all the issues might be resolved."

"This was a very contentious issue," recalled Ray, who, as supervising engineer of licensing and safety for Units 2 and 3, was responsible for the construction permit. "It came up very late in the process for us. So, in addition to NRC licensing, we had state licensing and permitting activity to go through. And we had to demonstrate that the value of the plants was greater than the negative impact that they were going to have on the coast."

Finally, in May, the California Supreme Court denied the legal challenges to the construction of San Onofre-2 and -3, and Edison immediately resumed work. The units were now scheduled to begin commercial operation in 1979 and 1980, three years behind their original mark.

Snowed in: Ray indulging a favorite pastime at Utah's Brian Head ski resort

At the time, Ray was also involved in an Edison undertaking to build two high-temperature gas-cooled reactors in the eastern California desert. He worked on preparing the Preliminary Safety Analysis Report, the multivolume document describing and evaluating the geologic, seismologic, and hydrologic conditions for the proposed site. The plant, located near Vidal Junction, was slated to host two 770-MW HTGRs, each similar in design to the Fort St. Vrain reactor that was under construction in Colorado and that would begin commercial operation in 1979. Shortly after being deferred, however, the Vidal project was finally canceled in the fall of 1974, for both financial reasons and lack of need.

Shaking the ground

To a geologist, any offset along a fracture in the earth's crust can be called a fault. Some are best determined with a satellite, others with a microscope. In the spring of 1974, during routine surveillance of site excavation for San Onofre-2 and -3, Edison found what it would report to the AEC as "geologic features" and "slight offsets." And the scrutiny concerning the proposed reactors' ability to withstand an earthquake, which had somehow all but evaded Unit 1, began in earnest.

The AEC and U.S. Geological Survey geologists, who routinely inspected potential nuclear sites in California, confirmed that the offsets indicated possible faulting. The geologists also said, however, that the features were formed at least 100 000 years previous, if not millions of years ago, and were not likely to be sources of seismic activity.

Ray, who specialized in structural engineering at UCLA, was intrigued by the relationship of seismicity and nuclear power plants. "That was most interesting because it was new," he explained. "Trying to understand how the earth imparts forces to something as mammoth as a reactor containment building, and how that motion is then translated into all of the things that are inside . . . was a very new and developing area of engineering."

Once the potential of the onsite fault had been dismissed, safety concerns emerged over some more distant and not-so-distant ones. San Onofre station lies within 60 miles of four active faults, defined as such when they have moved within the past 11 000 years. A 1981 study determined that an earthquake along the nearest of those—the Newport-Inglewood-Rose Canyon fault system, which is five miles from the site—would have the greatest potential for ground-shaking the plant. The most recent of three recorded earthquakes from that system, and the only one that can accurately be assigned a magnitude, occurred in 1933 and measured 6.4 on the Richter scale. The other two, from the 1800s, are estimated to have had magnitudes of 6.5.

"It was an evolving technology at that time, which is basically, in the engineering world, field dynamics," Ray said of the effort to equip a plant to withstand an earthquake. "How to model the interaction between the reactor building and the ground, as well as, in the case of a very large earthquake, what the ground motion is really like: All of that was being developed. Seismic analytics, analytic techniques . . . we were quite active in all of that at the time."

When San Onofre-2 and -3 went commercial in 1983 and 1984, they were eventually built to withstand, with wide safety margins, a magnitude 7.0 earthquake along the Newport-Inglewood-Rose Canyon fault system.

Today's challenges

Today, Ray is responsible not just for Edison's power generation, but also the company's buying and selling of power at the wholesale level. Because of California's traumatic experience with deregulation over the past several years, he has been thrust into the debate over how a wholesale electric market should be designed in order to allow competition among generators.

"Because the California marketplace went through a dysfunctional meltdown as a result of deregulation and restructuring, I've been spending most of my time on that," Ray said. "If the special circumstance that's gone on for the last two or three years were not the case, I would be more involved than I am right now in our nuclear plants and our coal plant and our hydro plants. All of that would normally be what I would be spending most of my time on, in addition to what should be a routine function of buying and selling power in the marketplace."

Working with the Nuclear Energy Institute, Ray has also been meeting for the past five years with NRC commissioners and staff to encourage the use of risk models and risk insights in the regulatory process.

When not traveling to Washington, D.C., Ray makes his home with his wife Penny in San Marino, Calif., a small community near Pasadena. The couple, who will celebrate their 40th wedding anniversary next year, own a house up north in the Sierra Mountains, where Ray said they try to escape to once a month for a long weekend of skiing. They have two grown daughters—Claire, who is a schoolteacher, and Jill, a patent attorney.

Although he is old enough to retire, Ray said he keeps working because he still enjoys his work and the people surrounding him at Edison. "I think what I enjoy the most about my job today is the people I have an opportunity to work with, and I don't mean that glibly," Ray said. "I think also the challenges of restructuring the electric industry are sufficiently interesting. That motivates me to continue to be interested."

The once gleaming-domed Unit 1 of San Onofre nuclear generating station was forced to shut down prematurely in 1992 for financial reasons. It did, however, end its near 25-year career with a unit record run of 377 continuous power-producing days. In his introduction to a book on the history of Unit 1, Ray wrote that it "went out like a champion." With washes of silver now appearing in his hair and trim moustache, Ray will be looking to do the same.—*Patrick Sinco* NN