HISTORIC MILESTONE

Fifty years ago in December: Atomic reactor EBR-I produced first electricity

BY RICK MICHAL

The era of nuclear energy was ushered in with the throw of a switch that lit light bulbs strung at the National Reactor Testing Station, in Idaho.

THE FIRST PRODUCTION of electric power from a nuclear reactor occurred 50 years ago next month at the National Reactor Testing Station, in southeast Idaho, now home to the Department of Energy's Idaho National Engineering and Environmental Laboratory. On December 20, 1951, a switch was thrown that ushered in the era of nuclear energy—or atomic power, as was the vernacular of the time.

When project engineer Harold Lichtenberger threw the switch, liquid metal from inside the Experimental Breeder Reactor-I flowed into water-jacketed pipes to form steam that turned a turbine. The electricity that resulted lit up four 200-watt light bulbs that had been strung across the test area.

EBR-I's primary mission, according to the DOE, was to develop and test the concept of the breeder reactor—a vision pursued by Enrico Fermi and his colleague, Walter Zinn, first director of the Atomic Energy Commission's Argonne National Laboratory in Illinois. Zinn also led the team that built the EBR-I.

The EBR-I reactor building in the 1960s (Source: ANL)

The idea behind the breeder was to maximize the useful energy that could be obtained from natural uranium, only one form of which—U-235—is a useful fuel in today's nuclear reactors. U-235, however, makes up less than one percent of all natural uranium, with the rest being U-238.

Inside a nuclear reactor, U-238 atoms capture neutrons released during fission and are converted into plutonium (Pu-239)—a man-made element that also can fuel reactors. Thus, breeding makes it possible to use virtually all the energy from natural uranium.

Before electricity was ever produced by an atomic reactor, scientists and engineers from Argonne, under lab director Zinn, had moved to Idaho to work on the project. These professionals included EBR-I associate project engineer Leonard Koch, senior engineer Mike Novick, and physicist Newman Pettitt. Construction of EBR-I by Bechtel Corporation began in 1949 and criticality was attained in August 1951. When the bulbs were first lit, one scientist, in subdued exuberance, said simply, "This is it." There were no shows of open emotion, no hand clapping or whooping and hollering.

The day after that event, EBR-I's output was boosted to 100 kilowatts, enough to power all of the electrical equipment contained in the small brick building that housed the reactor. These events were recorded on a wall of the reactor building by those present.

The news media were not notified by the AEC until days following the first production of nuclear electricity. Lichtenberger was quoted in Idaho's *Post-Register* newspaper as saying, "It was one of those things for which you

President Lyndon B. Johnson and Glenn Seaborg (then chairman of the Atomic Energy Commission) in August 1966 attach a plaque to the EBR-I declaring it a National Historic Landmark. (Source: ANL)

have been preparing for months and years and you expect it to come through. When I turned the switch, I guess I was more interested in how the circuit breakers would function than I was the significance of the test. Of course, you have to work up steam for the test, and we had been busy all day checking this and that and getting prepared, and when it came, it seemed just like another routine."

During a car ride home after the first test, Lichtenberger said Zinn was concerned with the maximum load the reactor was capable of and how greater loads could be handled. Further testing helped the Idaho scientists and engineers obtain information about liquid metal coolant at high temperatures under radioactive conditions, and aided in compiling experimental data on extracting heat from the reactor in a useful manner.

Since the function of the EBR-I was to convert, or breed, nonfissionable material into fissionable material more rapidly than nuclear fuel was consumed, Zinn had emphasized that the power generation tests were being carried out only to secure experimental data, because the EBR-I could never generate large amounts of electrical power. In this regard, no comparison was made of the cost of producing atomic power with the cost of power from conventional sources. Newspapers of the day reported the EBR-I's construction price tag at $2.7 million, with another $2.5 million spent on research and development.

The EBR-I, as explained in the book *Fast Reactor Safety,* by John Graham, a Past President of the American Nuclear Society, was composed of 0.5-in. diameter pins of enriched U-235 in a single assembly that formed the entire 8-in. diameter core. Cooling was provided by a eutectic alloy of sodium and potassium (NaK) at a flow rate of 6 ft/sec increasing in temperatures from 250 to 350 °C. The vessel and piping all were doubly contained, a top inlet being provided to the vessel, going down through the blanket and up through the core. The coolant was pumped by electromagnetic pumps. Control was provided by bottom-operated rods and reflectors for fast control with a movement of the 5-ton bottom blanket to provide slow control. This latter control suffered from poor clearances.

The National Historic Landmark plaque (Source: ANL)

In operation, the EBR-I was normally stable, the power coefficient having a prompt positive response component and a delayed negative component. Instabilities could occur if the power-to-flow ratio were high.

If the flow were decreased, the power would first rise and then later decrease to a new level. The first power changes were due to mechanical variations and bowing of fuel rods. The second changes were not understood, according to Graham's book. A new restrained core was provided, composed of rods inside a hexagon can with a tightening rod in the center. This new core had only a prompt negative power coefficient, having lost both the prompt positive effect of bowing and its delayed negative effect.

The eventual explanation was that while the bowing provided a prompt inward bending, it also brought the upper end of the fuel rods into contact with a shield plate that subsequently expanded, levering the fuel rods backward away from the core and thus causing the negative effect delayed by the thermal time constant of the massive shield plate.

In 1953, it was announced that measurements had confirmed that EBR-I had proven the basic principle of breeding. And on November 27, 1962, the EBR-I produced electricity using a plutonium core.

Concern about fast reactor stability arose in November 1955 when reactivity runs for period tests at low flow were conducted. The order to scram was misunderstood, Graham's book stated, and a slow shutdown initiated rather than the fast scram. The core partially melted down in a few seconds. A subsequent core was built and tested at EBR-I, and these tests provided convincing evidence that stability problems of metal-fueled cores could be corrected by mechanical design.

The EBR-I operated for 12 years, and on December 30, 1963, it was officially shut down. On August 26, 1966, President Lyndon B. Johnson presided over ceremonies that designated the retired reactor a Registered Historical National Monument. Before 15 000 witnesses on hand at the facility's site in Idaho, Johnson said, "We have come to a place today where hope was born that man would do more with his discovery [of atomic fission] than unleash destruction in its wake." Johnson and Glenn Seaborg, who had done breeding research in the 1940s with Zinn and others, affixed a commemorative plaque to the reactor's small brick building, which still stands on the Idaho site.

The EBR-I spawned an international industry that now plays a major role in meeting the world's energy needs. Today, 103 nuclear power plants provide 20 percent of the electricity consumed in the United States. More than 435 reactors provide some 17 percent of the world's electricity.

Today, however, the federal government sponsors no breeder research.

At the 2001 ANS Winter Meeting this month (November), in Reno, Nev., the EBR-I's 50-year electricity production anniversary will be observed in activities. NN

Helping to save the EBR-I

The National Trust for Historic Preservation, the private partner of the federal Save America's Treasures program, is seeking contributions to help restore and maintain the Experimental Breeder Reactor-I and the facility that houses it. The EBR-I is a National Historic Landmark located near Idaho Falls, Idaho. Funds are being sought to match a $320 000 federal grant that would be used to preserve the EBR-I and educate the American people about the birth of the Atomic Age and the harnessing of nuclear energy for electricity.

The project's goal is to restore and maintain the EBR-I facility as a museum and develop exhibits on the history of nuclear power. To reach a national and international audience, the project will produce a film about the EBR-I (which produced the first nuclear generated electricity on December 20, 1951) and the following 50 years of atomic energy. The film is scheduled to be available through public broadcasting television stations, at the EBR-I and other museums of science and history, and possibly on the Internet.

Donors will be recognized in press releases and public announcements, on commemorative plaques at EBR-I, and as part of the film's credits, as appropriate. Contributions are tax-deductible. Checks (made out to "National Trust/SAT" with the designation "Atomic Age" in the lower left-hand corner) can be sent to Cindy Kelly, Save America's Treasures, National Trust for Historic Preservation, 1785 Massachusetts Ave., N.W., Washington, D.C. 20036. For further information, call 202/686-4069 or e-mail <cindykelly@erols.com>.