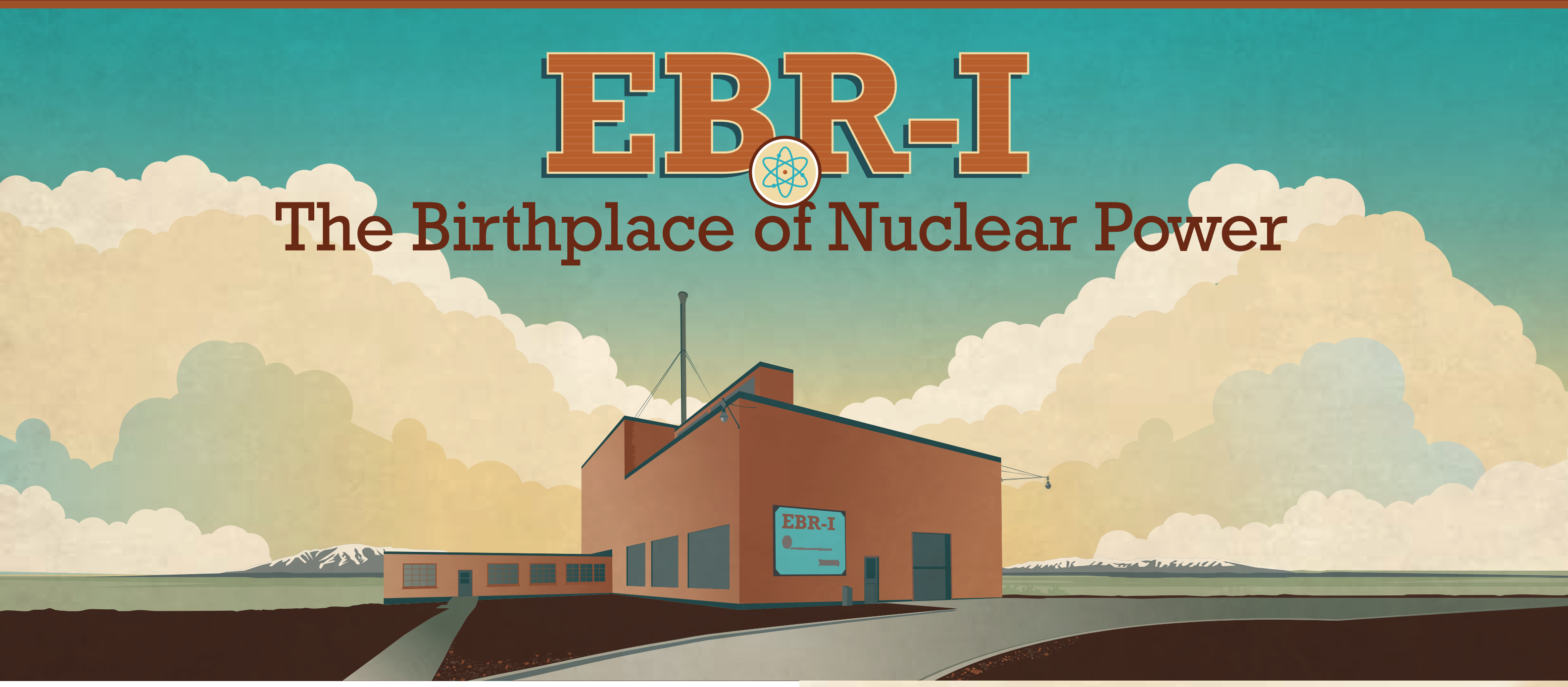
EBR-I
The Birthplace of Nuclear Power



Experimental Breeder Reactor-I

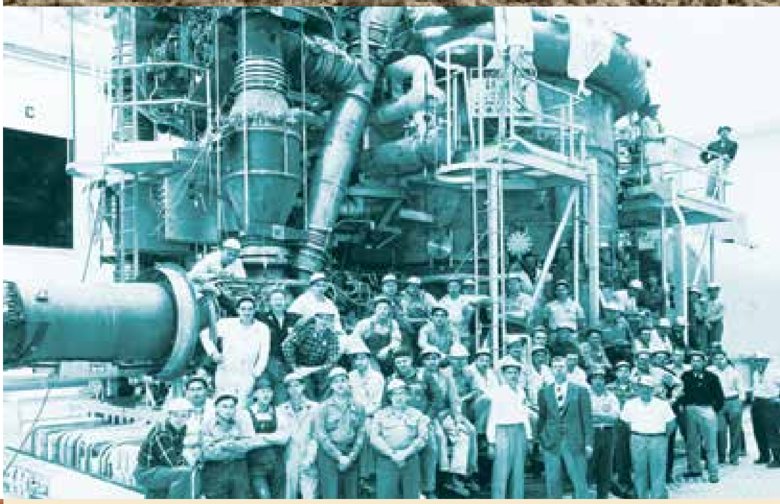
EBR-I was designed with two purposes: to generate electricity and – more importantly – to prove the concept of breeding fuel. Breeding fuel means that a reactor creates more nuclear fuel than it consumes – all while making electricity.

Light from Nuclear Energy

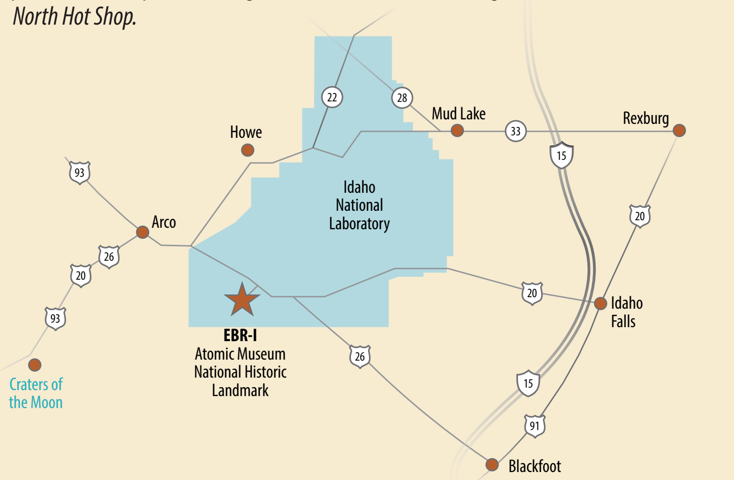
On Dec. 20, 1951, EBR-I became the first nuclear reactor to produce usable amounts of electricity by splitting atoms. EBR-I was the first reactor built at the National Reactor Testing Station (forerunner to today's Idaho National Laboratory). In 1953, testing at EBR-I confirmed that a reactor could create (or breed) more nuclear fuel than it consumes. This pioneering reactor operated for 12 years before being shut down in December 1963. President Lyndon B. Johnson dedicated EBR-I as a Registered National Historic Landmark in 1966.

Nuclear Flight

Early in the 1950s, the United States fully believed the Soviet Union had developed nuclear-powered aircraft. At that time, the U.S. did not have the ability to safely refuel long-range bombers in flight and had not developed intercontinental ballistic missiles. Early in the Cold War, a bomber capable of more than a week in the air was considered the first-strike deterrent that was needed. The logical site to build and test those reactor designs was the National Reactor Testing Station.



General Electric workers gather for a photo with one of the two nuclear aircraft reactor platforms developed for testing at the National Reactor Testing Station's Test Area North Hot Shop.



Welcome to the EBR-I Atomic Museum

This pamphlet will guide you through EBR-I and give you an idea of how atomic energy is used to make electricity. Along the tour route, many exhibits help tell the EBR-I story. If you have any questions, ask the tour guide on duty. We hope you'll enjoy your visit.

Open Memorial Day weekend through Labor Day

Seven days a week • 9 a.m. to 5 p.m.
Free admission

Self-Guided Tour

Climb the stairs to the first tour stop.

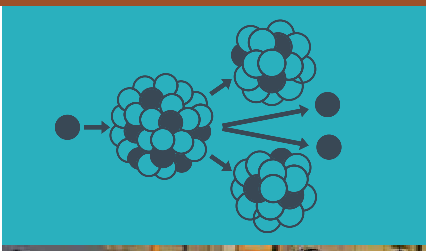
1 Nuclear-generated power is harnessed in the same way as other sources; heat is created to perform work. But instead of burning something – coal, oil, wood, biomass – atoms are split, which releases energy in the form of heat. Nuclear power plants use a sustained chain reaction of splitting atoms to generate heat, which turns water into steam. The steam spins a turbine and generator to make electricity.

The atom that easily splits, or fissions, is uranium-235. When a U-235 atom is hit by a neutron, it will fission, releasing energy in the form of heat. Two or three neutrons from the nucleus of the fissioned U-235 atom are released, and they go on to split other U-235 atoms. That is the fission chain reaction taking place to generate heat in a nuclear power plant.

When EBR-I was designed, the goal was to build a breeder reactor, which creates more nuclear fuel than it consumes, so designers needed to engineer a very particular fission environment. That environment makes it more likely that neutrons will be absorbed by uranium-238, the more stable form that comprises more than 99% of natural uranium. When hit by a neutron, U-238 is less likely to fission and instead tends to either deflect the neutron or absorb it.

When U-238 absorbs a neutron, it becomes uranium-239, which quickly undergoes radioactive decay and turns into plutonium-239. Pu-239 behaves like the more common reactor fuel U-235 (less than 1% of natural uranium), providing heat and sustaining a fission chain reaction.

Because this reactor actually creates Pu-239 fuel, it is known as a breeder. In 1953, EBR-I proved it was creating Pu-239, and by 1963 was creating 1.27 atoms for every atom used as fuel.



19-50066

Self-Guided Tour

To safely transfer heat from the fission chain reaction and allow the breeding to be successful, liquid metal was used as the coolant in EBR-I. The liquid metal was a combination of sodium (Na) and potassium (K) and was called "NaK." A primary coolant loop of NaK flowed through the reactor and transferred that heat to a second, separate coolant loop of NaK, which then heated water to generate steam.

NaK was great for heat transfer, but it would ignite and burn when exposed to air. In contact with water, it would explode. Great care was taken to keep NaK isolated, and EBR-I never had any issues.

Go out of the door and turn right to the control room.

2 This was the control room where operators started, controlled and shut down the reactor. Feel free to push buttons and turn dials. Facing into the room, the left side contains the panels to monitor coolant flow and temperature. The panels on the right look like any standard power plant, and at the front are the reactor controls. The most interesting button is the SCRAM button at the front. A SCRAM is a rapid, unplanned reactor shutdown.

The origin of the term SCRAM is printed above the button.

Also located in the control room is the logbook of Dr. Walter Zinn, the designer and director of EBR-I. The book is open to the first two days that EBR-I generated electricity.

Continue through the control room to the top of the reactor.

3 This is the top of the reactor. Through the plexiglass cover, the "head" of the reactor vessel is visible.

Beneath that were fuel rods containing U-235. The fuel rods were 10 feet long but contained only 8.5 inches of U-235 toward the bottom. The fuel rods were held inside of hexagonal "cans" called subassemblies. Surrounding the reactor vessel are 15-foot-thick concrete walls to shield workers from radiation when the reactor was operating. Replica fuel rods and subassemblies, including the region of fuel, are displayed.

Also shown in a photo is the breeder blanket. It was made of 84 bricks of U-238, each encased in stainless steel cladding, arranged in a cup shape. This cup was raised up around the outside of the reactor vessel to keep neutrons in the fuel region for the reactor to operate. When the breeder blanket was lowered to the basement, neutrons would escape to the shielding and the reactor would shut down.

Retrace your steps through the control room and turn to the right.

4 The first electricity generated at EBR-I illuminated four 200-watt lightbulbs like the ones here. The next day, on Dec. 21, 1951, the reactor produced enough electricity to power this building. On that historic day, the male EBR-I staff members, "project" personnel, chalked their names on the wall. In 1995, the female "support" personnel's names were added on a plaque to the right of the signed names. Take a minute to listen to the voices of people who worked here. The display case behind the strand of bulbs shows one of the original four lightbulbs from 1951. The smaller lightbulb in the case was lit in 1963 when EBR-I was the first to generate electricity from an all-plutonium core.

Watch your step going downstairs.

5 In this room, the heat from the second liquid metal system converted water into steam, which was then piped upstairs to the turbine/generator, where it produced electricity. Although there is no longer any NaK in the system, this room is locked because of the asbestos insulation on the pipes.

The next stop is around the corner to the left.

6 This plaque was installed by President Lyndon B. Johnson and Dr. Glenn T. Seaborg, chairman of the U.S. Atomic Energy Commission during the dedication ceremony in 1966 designating EBR-I as a Registered National Historic Landmark. New fuel rods were stored in the vault before going into the reactor. Before being used, the rods could be handled safely without shielding. After the fission process occurred in the fuel, the rods became highly radioactive. You can also see a 5-ton cask that was used to safely move the spent fuel rods to a washroom in the basement. The cask was filled with argon gas to prevent the NaK-coated rods from contacting oxygen as an additional safety feature.

Continue around the corner to the next stop.

7 When the fuel rods were removed from the reactor, some radioactive NaK remained on them. The rods were lowered into the basement through holes in the floor covered by the metal plates. The NaK was washed off with acetone and alcohol. When clean and dry, the rods were then stored in the rod farm – evenly spaced storage locations in concrete with individually numbered holes. The chalkboard was used to keep track of the inventory.

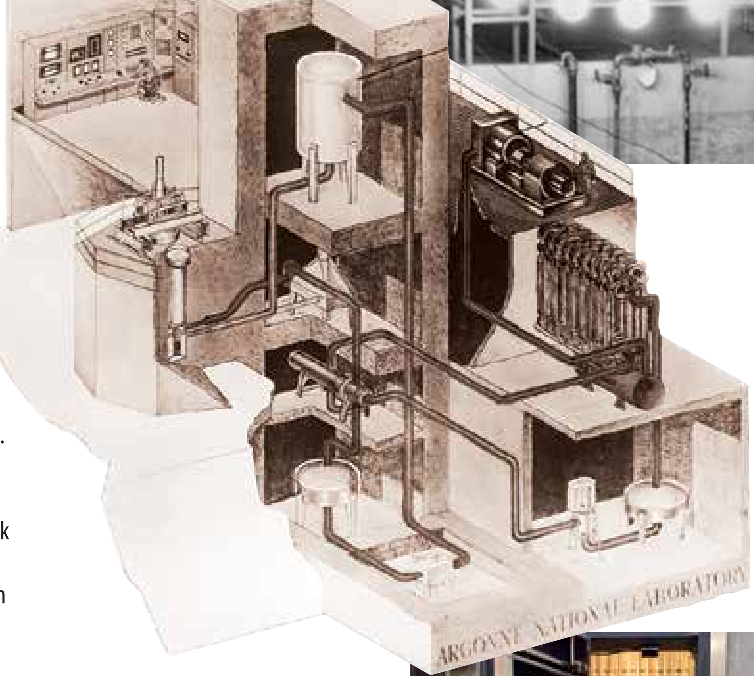
Past the rod farm you will see the hot cell. This was used to visually inspect the used fuel rods. Each window consists of 34 layers of lead glass, totaling 39 inches thick, with mineral oil filling the space between each layer of glass to provide clarity. Shine a light into the window to see a reflection of each of the layers of glass. The walls are also 39 inches thick for radiation protection. The manipulators are some of the first ever devised for handling radioactive materials. Mechanical "fingers" inside the hot cell duplicated the operator's motions.

The next stop is in the basement.

8 If you climb the platform stairs, you can look into the washroom. This is where operators cleaned the radioactive NaK coolant off the fuel rods after they came out of the reactor and before they were placed in the rod farm to cool.

The oil-filled window at the bottom of the platform stairs, allows you to see underneath the reactor. The large round platform you see on the right side of the room is the bottom of the elevator that would raise and lower the breeding blanket around the core of the reactor.

You can go inside the breeding-blanket repair room. Operators would work from the outside of this room through the glass window. They used manipulator arms to open the door at the top of the room and retrieve the breeding blanket. Because of the high heat inside the reactor, the bricks in the breeding blanket sometimes cracked. Here operators could replace those bricks and repair the blanket.



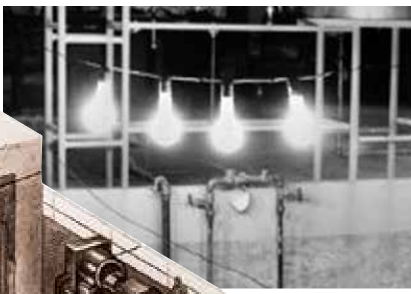
This is the end of the self-guided tour. But there is more to see…

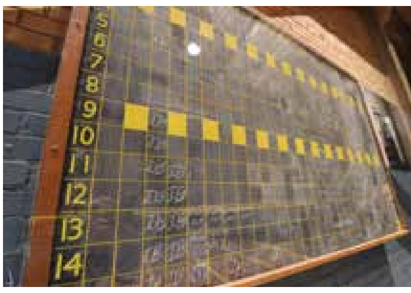
- Please sign the logbook and tell us about your experience.
- Enjoy the "containment vessel theater" to learn more about Idaho National Laboratory and nuclear topics.
- Visit the annex to learn about EBR-II, the continuation of what was learned here. EBR-II operated from 1964-1994.
- In the parking lot, you'll find two reactors built in the 1950s during the Aircraft Nuclear Propulsion project, an attempt to build nuclear-powered bombers for the Air Force.

Thank you for visiting EBR-I, the first nuclear power plant.

Follow us online: Twitter, Facebook, Instagram, YouTube

For information about touring INL facilities or arranging an INL speaker for your group, visit inl.gov or email us directly at tours@inl.gov or speakersbureau@inl.gov. You may also call (208) 526-0050.





INL is a U.S. Department of Energy (DOE) national laboratory that performs work in each of DOE's strategic goal areas: energy, national security, science and environment. INL is the nation's center for nuclear energy research and development. Day-to-day management and operation of the laboratory is the responsibility of Battelle Energy Alliance.