# HANFORD'S HISTORIC B REACTOR: PRESERVATION AND ENVIRONMENTAL RESTORATION

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## ABSTRACT

Hanford's B Reactor played a unique role in the history of the United States and the world. In 1944, B Reactor was the first production reactor ever built and was operated as part of the Manhattan Project and the Cold War until 1968. Today, the U.S. Department of Energy (DOE) periodically hosts public tours and has initiated hazard mitigation work to keep the reactor safe for visitors, workers, and the public.

B Reactor faces an uncertain future. As the Hanford cleanup progresses, it is clear that a decision must be reached regarding the long-term fate of the historic building. Will it be treated differently than Hanford's other production reactors that are slated for an interim safe storage configuration? There is strong stakeholder support to preserve the building as a museum, and the B Reactor Museum Association (BRMA), a non-profit group, is a strong advocate for preservation.

Along with cleanup regulations, the *National Historic Preservation Act of 1966* (NHPA) will be a regulatory factor in determining the fate of B Reactor. The options for preserving B Reactor will be debated in an open process. Although clearly not in the museum business, DOE has offered to work to find a partner, a non-profit or government group capable and interested in assuming operational responsibility, for a museum at B Reactor.

Fig. 1. Hanford's B Reactor today

This paper will provide the following:

- A look into the remarkable history and operation of B Reactor
- A discussion of the BRMA stakeholder group and its interests for B Reactor
- The unique regulatory status and challenges that face B Reactor as a part of overall cleanup of the Hanford Site
- Information about the condition of and tour status at B Reactor today
- A discussion of "if " or "when" B Reactor will become a museum.

## INTRODUCTION/BACKGROUND

The B Reactor, located on the Hanford Site in southeastern Washington State, played a unique role in the scientific and military history of the United States and the world. As part of the Manhattan Project, B Reactor was the world's first production-scale nuclear reactor.

Construction of the reactor began in June 1943, just 6 months after pioneering physicist Enrico Fermi demonstrated a sustained and controlled nuclear chain reaction at the University of Chicago. Fermi successfully started up B Reactor in September 1944. In its first 9 months of operation, it produced plutonium that was used in the world's first nuclear detonation at Alamogordo, New Mexico on July 16, 1945, and for the weapon used 3 weeks later over Nagasaki, Japan.

The reactor operated as part of the nation's nuclear defense complex until February 1968, when it was placed in standby mode, and was later shut down and retired in October 1979.

The DOE, Richland Operations Office (RL), its contractors, regulators, and the BRMA are now working through the cleanup requirements at B Reactor and are preparing to take the final step in determining the long-term future of this unique building.

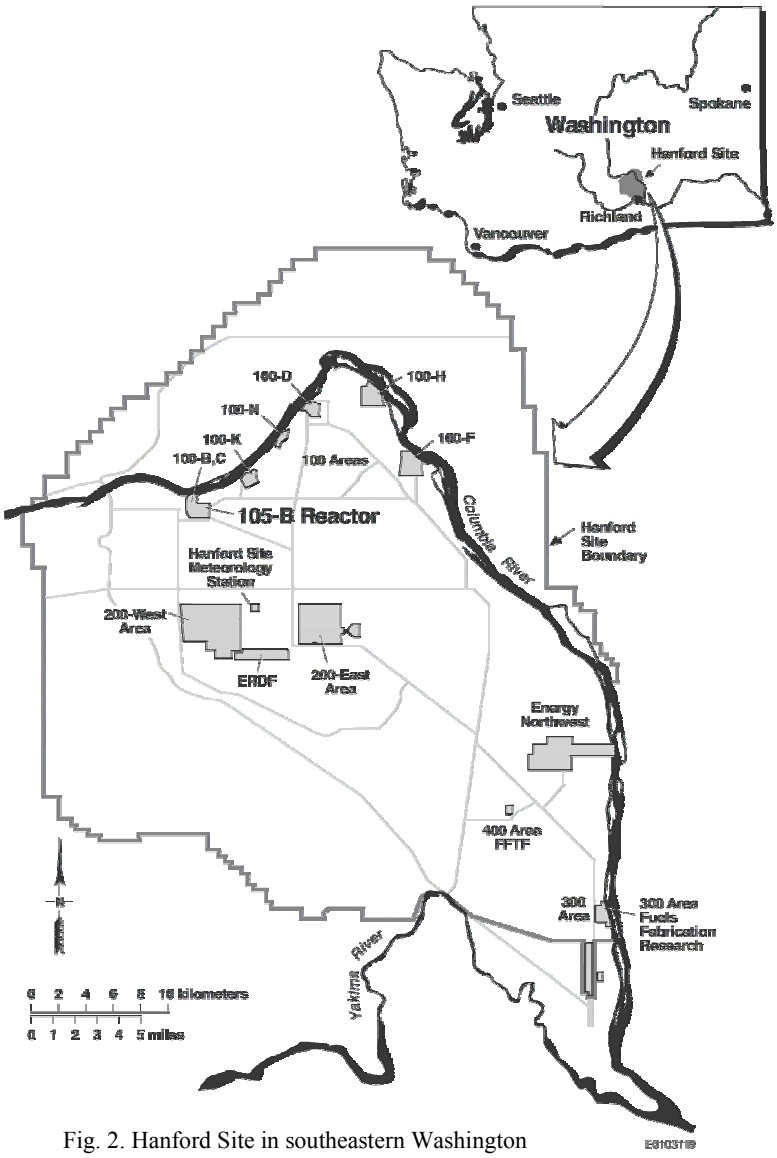


Fig. 2. Hanford Site in southeastern Washington State

### An Earlier "One Small Step. . ." the Birth of B Reactor and Beyond

There are moments in history that divide our lives into "before" and "after," such as when we learned to create fire on our own, carry goods in wheeled carts, and take to the air under our own power. There was a time when we thought the Earth was flat, the sun revolved around it, and serpents lurked at the edges of our oceans. Then we left footprints on the moon, an evolutionary milestone that forever delineates the "before" from the "after."

It might be a surprise that such a moment in history is enshrined in a building owned by the citizens of the United States in southeastern Washington State. It is no less than the site where

humanity first put the energy of the stars to use, where $e = mc^2$ went from theory to practicality, where the transmutation of matter was pulled from the dreams of the alchemist into the hands of the physicist and engineer, where humans finally found the key to limitless energy and the means of their self-destruction. It's the world's first full-scale nuclear reactor and the birthplace of the Atomic Age—Hanford's B Reactor.

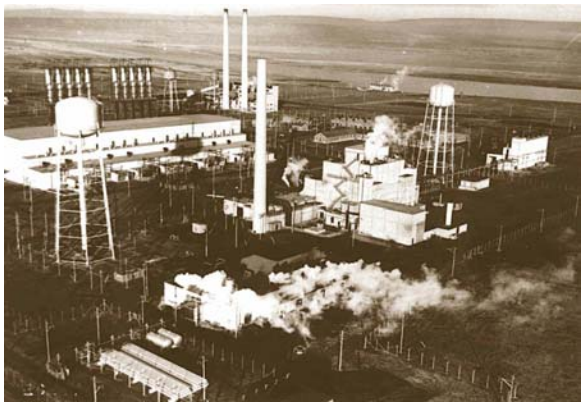

Fig. 3. B Reactor and its complex of support facilities circa 1945

That glorious lead-in may have ended in a resounding, anticlimactic "thud" with the name "B Reactor," as the story of where nuclear energy was first put to use is not widely known, nor is the reason why the DOE's Hanford Site was built in the first place. Hanford was not always the nation's largest environmental cleanup site.

B Reactor holds its place in history because it was the first of the three nuclear reactors put into service at the Hanford Engineer Works during the height of World War II, in the fall of 1944. Hanford was built as the plutonium-production plant for the Manhattan Project, the U.S. effort to build a nuclear bomb (preferably before the Germans could). This effort was led by General Leslie Groves of the U.S. Army Corps of Engineers.

The story of the Manhattan Project is often told in terms of Los Alamos and the building of the bomb. But there is every bit as much drama in the design and construction of Hanford and its reactors, and perhaps even more because the story is so seldom heard. The theory of creating a self-sustained nuclear chain reaction was proved in December 1942, by Enrico Fermi and his team with their famous "pile" of graphite and uranium in Chicago. While Fermi was producing single-digit watts of heat in his experimental pile, the construction plans for Hanford's 250-million-watt reactors were already coming off the drawing boards at the E. I. du Pont de Nemours & Co. in Wilmington, Delaware. General Groves had handpicked DuPont to build and operate Hanford. Without the knowledge of the government in the state of Washington—or even most of the U.S. Government—the nuclear reactors at the top-secret Hanford Project were under construction in June 1943, barely 6 months after the concept of a reactor had been proven.

This utterly new technology was completed in less than 18 months, with B Reactor going critical for production on September 26, 1944, and the D and F Reactors following in December and February. The startup of the world's first production-scale nuclear reactor is one of those undeniable milestones on the human timeline. The fact that the reactor operated flawlessly (after a suitably dramatic and nail-biting first few days) and was in use for another 24 years makes the event even more remarkable.

The nuclear fission that was tamed in the reactors at Hanford is no less remarkable. The resulting cloud of neutrons literally transmuted a fraction of the reactor's uranium fuel into the highly fissionable and only recently discovered element plutonium. At scheduled times, the irradiated uranium fuel was discharged from the reactors and taken to Hanford's 800-foot-long chemical processing plants, where the plutonium was chemically separated from the uranium and

then shipped to Los Alamos, New Mexico. It was Hanford plutonium that was fashioned into the world's first nuclear detonation, the Trinity test on July 16, 1945, as well as in the bomb that devastated the city of Nagasaki, Japan, helping to bring the World War II to a decisive finish.

Although the war ended, the need for nuclear weapons did not. B Reactor continued operation as part of our nation's quest for a nuclear arsenal that would be large enough to serve as a deterrent to the Soviet Union. Hanford's contribution ultimately totaled some 67,000 kilograms of plutonium. (1) While fulfilling its role as a plutonium-production reactor, B Reactor also served as a platform for research in the growing field of nuclear energy. Prior to final shutdown in 1968, enhancements to B Reactor's cooling system, controls, and operating procedures, along with the use of enriched uranium, allowed its power level to be increased from 250 megawatts (thermal) to more than 2,000 megawatts. (1)

The reactor has now been dormant many years longer than it was in operation. Since 1968, virtually all of its support facilities—themselves key to the reactor's operation—have been torn down as part of the cleanup efforts at Hanford. The bustling industrial complex that ushered in the Atomic Age has been reduced to a single building. Today, the B Reactor and its 200-foot-tall ventilation stack stand as a landmark to the first step on the path to controlling nuclear energy.

**Generating a Critical Mass – B Reactor Museum Association (BRMA)**

The only things missing from B Reactor's gripping story are the stage from which to present it and the audience to hear it. Few people know of the reactor's place in history, and even fewer have been lucky enough to tour the building. Our Congress has never directed the DOE to open the reactor to the public, and the building remains behind Hanford's barbed wire and badge-only security. Each summer, several busloads of citizens tour the reactor, and DOE-related groups also tour the building periodically throughout the year.

Such is the paradox and dilemma facing the DOE and its environmental restoration contractor, Bechtel Hanford, Inc. The presence of a world-class historic artifact in the midst of a massive cleanup site brings another set of regulations into play, presenting a whole spectrum of issues to be considered, resolved, or delicately stepped around. But the impetus behind the preservation and museum efforts for B Reactor came from people outside of Hanford's fences and outside of the government. Local individuals began to talk seriously of B Reactor's preservation in the 1980s, realizing that the reactor might very well just disappear along with the rest of the Hanford production complex. There were no government bodies, private organizations, or other individuals speaking out for preservation of the reactor.

In 1991, a small group of local B Reactor supporters organized the all-volunteer BRMA as a non-profit organization. Its founding mission was to educate the public about the historical and technological significance of the reactor, work to ensure its preservation, and eventually open B Reactor as a museum. This last aspect fell under the general theory of "the squeaky wheel gets the grease."

Since the BRMA formed in 1991, it has taken on a variety of efforts, including amateur lobbying, letter-writing, disseminating information via presentations, Earth Day exhibits, and generally being a conduit in support of B Reactor. The group is in regular contact with the DOE regarding issues at B Reactor, including maintenance, major repairs, and visitor access and

safety. The BRMA's 120 due-paying members are well aware of the role that the reactor played in history and of the science, engineering, and craftsmanship it represents. Many of the group's members spent their careers at Hanford, and several came to Hanford before B Reactor was completed. There is unmistakable pride in the work these individuals accomplished in defense of their country and for the technology they helped usher in. Others who have no connection with the nuclear industry or the DOE simply appreciate the far-reaching effects that came with the introduction of nuclear energy. All of the members understand the importance of learning our history and that B Reactor represents a locus of educational opportunities.

The BRMA strives to work arm-in-arm with the DOE to establish a long-standing and still-growing relationship. The BRMA's role as an outside stakeholder with a clear objective gives the DOE a chance to consider those possibilities without also having to generate the enthusiasm. They frequently remind the BRMA that their Hanford budget is for cleanup, not museums (although the BRMA does like to remind the DOE that it also has a role in educating the public about energy issues).

Fig. 4. Gene Weisskopf, President of BRMA, hosts a tour group near the reactor's front face

All of the BRMA's efforts are conducted on by volunteers, but in the past few years, two aspects of their work have turned into contracts with the DOE. The group has been providing tour guides for B Reactor tours for many years, and now has a small contract to provide that service. The funds go to the guides to compensate them for the long drive to the reactor and as a "thank you" honorarium. Between their knowledge of the reactor's workings and their enthusiasm for its story, the BRMA guides turn what could be a timid walk through a cavernous building into an educational stroll down history's lane.

The other contractual offspring from the DOE/BRMA consensual arrangement is the B Reactor Historic American Engineering Record (HAER), which is an in-depth look at the reactor based on Hanford archival documents and interviews with people who helped design, build, and operate the facility. (1) The BRMA wrote the document under a contract to the DOE, and the DOE has submitted the history to the National Park Service for inclusion in the HAER archives in the Library of Congress. The B Reactor's history can be found on the Internet via the table of contents for the DOE's Hanford history: http://www.hanford.gov/docs/rl-97-1047/index.htm. The HAER document can be accessed through the link for "Appendix B: Historic American Engineering Records."

Even though B Reactor is not yet a museum and is still largely off-limits to the general public, it has received broad recognition for its historical importance. In 1976, it was listed as a National Historic Mechanical Engineering Landmark by the American Society of Mechanical Engineers. In 1992, the National Park Service entered the reactor into the National Register of Historic Places. In 1993, the American Nuclear Society presented the Nuclear Historic Landmark Award to the reactor, and in 1994 the American Society of Civil Engineers named it a National Civil

Engineering Landmark. The BRMA would now like to get Congress involved in making this remarkable building available to the public.

The DOE has stated in its final land-use plan for Hanford that the historic building may someday become a museum, and the plan bestows the future status of "high-intensity recreation" to the reactor and the surrounding land. (4) With the reactor's future being somewhat secure for at least the next 10 years (as outlined in the engineering evaluation/cost analysis [EE/CA] process, which is discussed later), the BRMA is hopeful and ready to assist in the planning for the reactor's eventual debut as a world-class museum of international renown, and a monument to a human milestone of epic proportions.

**DOE Balances Historic Preservation and Environmental Restoration**

The DOE has recognized for some time that B Reactor is "different" than Hanford's other retired reactors and cleanup projects. However, the Hanford Site is on the U.S. Environmental Protection Agency Superfund National Priorities List and any cleanup actions at B Reactor must meet the regulatory requirements of the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA). The B Reactor contains the deactivated reactor core with 11,400 curies of radionuclides, and hazards such as asbestos, lead paint, and radon exist within the building. (2) In the near-term, historic preservation of the B Reactor facility is not precluded by the required cleanup, but care and attention must be given to the way in which the building is maintained. Maintaining the original appearance and character of the building is given a high priority as hazard mitigation tasks are undertaken.

The B Reactor was included in the September 1993 environmental impact statement and Record of Decision for the decommissioning of eight of Hanford's nine retired plutonium-production reactors. (3) The Record of Decision provides for the reactors to be placed in safe storage for up to 75 years, during which time surveillance, monitoring, and maintenance would be performed. The period of safe storage will be followed by one-piece removal of the reactor cores and transport of the cores to the Central Plateau area of the Hanford Site for final disposal.

In 1995, DOE began placing Hanford's retired production reactors into an interim safe storage condition, a process also referred to as "cocooning." This approach involves partial dismantlement of the buildings and structures at each reactor site, except for the heavily shielded portion of the reactor building that houses the massive reactor core. A safe storage enclosure is constructed so internal inspection of the remaining reactor building is only required every 5 years, resulting in a facility that is "cold, dark, and dry" and "cheap to keep." To date, the interim safe storage of one reactor has been completed (C Reactor, which is adjacent to the B Reactor facility), and four other reactors are currently undergoing this process (F, DR, D, and H Reactors).

In response to strong stakeholder interest to preserve B Reactor as a museum, DOE and the regulators have delayed cocooning B Reactor, and have taken an interim (10-year) removal action to support escorted public access. This removal action, called an EE/CA, is one of the legal obligations for cleanup under CERCLA. (5)

The result of the EE/CA is an action memorandum, to be issued by the U. S. Environmental Protection Agency, with concurrence of the DOE and the Washington State Department of

Ecology. The action memorandum will authorize DOE to perform hazards mitigation within the reactor and to allow public access to the reactor for up to 10 years along a tour route designated in the EE/CA. Environmental restoration funding provided for cleanup of the Hanford Site can be used for the hazards mitigation; however, museum development and operation are not authorized uses of these funds.

Fig. 5. The legacy of pride and patriotism, which began in World War II, remains alive at B Reactor today.

**B Reactor Today**

During 2000, more than 1,200 people toured B Reactor. The DOE provided eight public bus tours during the spring and summer, and ad hoc tours were conducted as requested throughout the year. Visitors included members of Congress, media (*The New York Times*, *National Geographic*), Russian treaty verifiers, high school students, scientists, and a group from the American Society of Civil Engineers.

The BRMA provided tour guides for most of these tours. Tours of the facility continue to be a priority for DOE.

Providing for public badging and Site access is a challenge. Recent, more stringent Hanford Site security requirements have made it more difficult for members of the public to receive the DOE clearance necessary to gain access to the Site and B Reactor. However, progress is being made to tailor DOE requirements to meet the public's continuing desire for access to the historic B Reactor.

**Will B Reactor Become a Museum?**

The 2001 EE/CA and resulting action memorandum, while allowing public access to B Reactor for up to 10 years, are only interim measures; they will not determine the final use of B Reactor. Therefore, in 2002, the DOE will begin a regulatory decision-making process and public dialogue to help determine the long-term future of B Reactor.

The decision-making process will incorporate the legal requirements of NHPA and other regulatory requirements. A productive dialogue with interested parties will be an essential part of the compliance approach. This decision-making process will result in the following:

- Provide consistency, in spirit and intent, with existing DOE documents, including the recent EE/CA for B Reactor (2001), and the messages and commitments made to the Hanford Advisory Board, stakeholders, and regulators during the public involvement process in 2001.

- Define a regulatory path forward that is requirement-based and streamlined, and yield decisions that can be implemented and that are based on sound technical data.

- Position DOE to complete its cleanup responsibilities at B Reactor in a well-coordinated and timely manner.

- Provide an inclusive forum for interested parties and stakeholders regarding the long-term use of B Reactor.

- Clearly establish DOE's responsibilities and support for a meaningful evaluation of a possible DOE partnership with a non-DOE museum operator. The operator would be responsible for financial/managerial requirements for future museum-related use.

While DOE recognizes that it is not in the "museum business," the opportunity for others to step forward and operate B Reactor as a museum will be given full consideration. The decision-making process will focus on the DOE requirements and support for such an operator, whether the operator would be a non-profit organization or another government entity (e.g., the National Park Service.)

## SUMMARY AND CONCLUSION

As Hanford's B Reactor approaches 60 years of age, its future is uncertain. The DOE provides tours upon request, and the BRMA continues to host these tours as historic guides. Bechtel Hanford, Inc. works to maintain B Reactor in a safe, historic, and regulatory-compliant condition as DOE takes the final steps in determining the future use of B Reactor. It is possible that this historic treasure will be recognized as such and preserved for future generations. Transitioning B Reactor to a state of preservation and curation will require a strong partnership between DOE and a yet-to-be-found "museum operator." The enduring DOE's responsibilities for cleanup and stewardship, working in concert with historic and cultural preservationists, is (and will continue to be) a unique challenge for all parties involved.

## REFERENCES

1. U.S. Department of Energy, *Historic American Engineering Record, B Reactor (105-B Building)*, HAER No. WA-164, DOE/RL-2001-16, Revision 0, Richland, Washington (2001).

2. Bechtel Hanford, Inc., *Surplus Reactor Auditable Safety Analysis*, BHI-01172, Revision 1, Richland, Washington (2000).

3. U.S. Department of Energy, *Final Environmental Impact Statement, Decommissioning of Eight Surplus Production Reactors at the Hanford Site*, DOE/EIS-0119F, Richland, Washington (1992).

4. U.S. Department of Energy, *Final Hanford Comprehensive Land-Use Plan Environmental Impact Statement*, DOE/EIS-0222-F, Richland, Washington (1999).

5. U.S. Department of Energy, *Engineering Evaluation/Cost Analysis for the 105-B Reactor Facility*, DOE/RL-2001-09, Revision 0, Richland, Washington (2001).