Hanford's Historic B Reactor
Presentation to PNNL Open World Forum
March 20, 2009

Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management
Project Hanford Management Contractor for the
U.S. Department of Energy under Contract DE-AC06-96RL13200

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B Reactor is America's newest National Historic Landmark (NHL)

- NHL status is the highest possible designation for a historic property in the United States
  - Only 2,200 properties in the entire nation are NHLs
- Equal in stature to the White House, the U.S. Capitol, Fort Ticonderoga, Lexington Green, the U.S. S. Arizona, Mount Vernon, Monticello, others

- B Reactor is significant to those holding all opinions about reactors - not a "triumphalist history"
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Other awards for B Reactor’s unique achievements

- National Historic Mechanical Engineering Landmark (1976)
- National Register of Historic Places (1992) (National Park Service)
- Nuclear Historic Landmark (1993)
- National Civil Engineering Landmark (1994)
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What is B Reactor?

- **World's first full-scale nuclear reactor – of any kind**
  - 2 previous test reactors were small, simple and incapable of sustained production
  - Weapon of war -- Built in WWII – in secret and in a hurry
    - played key role in ending the war (defeating fascism and imperialism) –
  - Key role in the Cold War
  - BRx "super-sized" us as a nation
  - America isolationist before WWII – coming out of WWII as a nuclear power made us a world leader
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What is B Reactor, con't?

- BRx also demonstrates problems of Hanford's age:
  - Trying to cleanup facilities that are extremely old & contaminated
    - dealing with 1940s technology, electronics, instrumentation, lack of double-containment piping, etc.
  - Showing damage to the environment that occurred at Hanford by running these old machines
    - damage to the soil, rivershore and river
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What? con’t.

- B Reactor also offers a glimpse of Tri-Cities future
  - Eco-tourism and Historic tourism as big part of economic future
  - The entire rivershore of the Hanford Site – and river itself as it runs the 50 miles through Hanford Site – is a “National Monument”
- Enormous tourism potential & economic potential in BRx visitation
Management Alternatives:

National Park Service (NPS) Special Resources Study occurring now

-Multi-party management arrangement is possible

- Federal ownership (liability, property management, indemnification)

- Local partner to operate and manage tours

- Educational/interpretive role for NPS

- Additional potential partners such as Washington State University-Tri-Cities, WA State Parks, WA State Historical Society, others
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Beginning the Story....

- 1934 – Dr. Enrico Fermi – Physicist in Italy: Bombarding U targets with neutrons
  - People knew that U fissions when bombarded (atom splits) –
  - Fermi discovered that if you slow down ("moderate") the neutrons by passing them through various materials – slower speed allowed better chance of capture by the target

- Fermi showed that the target lost weight, and gave off heat – meant that matter had been destroyed and energy created!!

- For this work, he won Nobel Prize in Physics in 1938
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Story, con't

• By 1938, Italy was fascist & passing anti-Semitic laws
  – Fermi's wife Jewish
  – Took family to Stockholm to accept Nobel Prize in 1938 and kept going—emigrated to America

• 1938 — Fermi learned that Germany was repeating his experiments
  – Einstein letter to Pres. Roosevelt, Sept 1939
  – Roosevelt formed Scientific Committee to pursue studies
  – Pearl Harbor in 1941 — US entered war — Roosevelt accelerated study program and turned it over to US Army

• Became Manhattan Project in June 1942
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Story, con’t

- Dec 1942 - Fermi proved the principle of “sustained, controlled nuclear chain reaction” at Chicago Pile I

  - Three weeks later: (still Dec 1942) Hanford Site was scouted and chosen
  - Construction of Hanford Site began March 1943
  - B Reactor construction began October 1943

- B Reactor was completed and operating 11 months later (September 1944)!
What did B Reactor do?

- Irradiated uranium fuel elements (called rods or slugs), turning part of the uranium into plutonium-239
  - Essential ingredient in nuclear bombs

• Irradiated material used in the world’s 1st and 3rd atomic explosions
  - Trinity bomb test, New Mexico, July 16, 1945
  - Nagasaki weapon, Japan, August 9, 1945
    • Nagasaki weapon ended WWII within 5 days
What did B Reactor do? Con’t

- Operated for 25 years (except brief shutdown 1946-48)
  - Influenced every major Cold War development and issue until 1968 closure
- Korean War, early “Space Race,” development of nuclear Navy, other events
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What is B Reactor Physically?

- Reactor is a large cube of graphite pierced by 2,004 aluminum tubes
  - Cube surrounded by shields is 38 feet front to back, 46 feet wide, 41 feet tall (about 1,750 square feet, 5 stories tall – moderate house)
  - Cube weighs 2,200 tons (4.4-million pounds)
  - Sits on a 23-foot concrete pad topped with cast iron blocks
What is B Reactor Physically? Con’t

- Entire shielded cube operated in a gas atmosphere
- Cooled by cold Columbia River water pumped through each of the 2,004 process tubes
  - Water carried away inferno of heat generated by irradiation reaction
    - 35,000 gpm at beginning – doubled by mid-1950s
- Controlled by very large 9 horizontal control rods (HCRs)
  - Absorbed neutrons, to stop fission chain reaction
  - HCRs came in from left (near side)
  - 6 test holes on right side (far side)
- 29 vertical safety rods could stop reaction suddenly
  - Later safety ball (3X) system, and liquid vats of boron solution
How did B Reactor Work?

1. Fuel elements were loaded into the process tubes at the front face (250-300 tons) – about 60,000-80,000 fuel elements

2. Fuel remained in reactor block while it was irradiated by nuclear reaction – 6 weeks
   - 1/20th of 1% changed into Pu-239 – explains HUGE waste

3. Irradiated fuel was discharged from the rear face and stored in a water-filled basin – segmented discharge
   - very simple machine – worked by heat transfer
   - make more Pu by loading more fuel rods, or slightly enriched rods

Reactor was modified over time to raise its power level by almost 10-fold! – from 250 MW to 2,400 MW
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From Reactor to Finished Product

- After discharge from B Reactor, nuclear fuel rods were stored for several days/weeks/months
- Then taken to 200 Areas in central Hanford and dissolved in acid mixture to a liquid form
  - Liquid now contained plutonium
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From Reactor to Finished Product, con't

- Liquid was sent through a long chemical process which removed the by-products and separated & purified the plutonium fraction in the mixture.

- The plutonium fraction of the mixture was heated and hardened to form plutonium metal (Pu "button").
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B Reactor is a Regional “Super-Star” in attracting tourists:

*People want to tour B Reactor!*

Tours fill in 2-3 minutes!! (hundreds to thousands of seats!)

- All tour registrations are followed by numerous complaints from those who did not get seats
- Inquiries from all over the world to tour B Reactor!

Does everyone love science?
- Probably not! It gives people a sense of connection
- Makes people wonder about daring, boldness and confidence
- Contains lessons about genius, waste and loss
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B Reactor has major political and community support

- Senators Patty Murray and Maria Cantwell
- All 4 Senators from Manhattan Project “sister” states (Tennessee & New Mexico)
- Many others
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B Reactor support, con’t.

- Congressmen Doc Hastings, Norm Dicks and others, State Senator Jerome Delvin, and State Representatives Larry Haler, Maureen Walsh and others
- TRIDEC, Tri-Cities Visitor & Convention Bureau, Hanford Communities (4 cities), Benton & Franklin Counties, others
- Oregon Hanford Cleanup Board
- Hanford Advisory Board
- Tri-City Herald, Tacoma News-Tribune, others
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B Reactor support, con't.

• National Park Service
• U.S. Environmental Protection Agency
• Atomic Heritage Foundation
• Richard Rhodes (premier U.S. nuclear historian, author)

• People who love the reactor and those who strongly dislike the reactor agree on the goal & value of preservation –
  • To debate & learn lessons
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B Reactor is Tour Ready, Tour Proven

More than $4 million invested since 2002 to remove potential hazards, with more investments planned

- Asbestos removed
- Electrical system upgraded
- Ventilation system enhanced to control radon level
- Fire protection improvements
- Safe radiation levels ensured through continuous monitoring
- Land areas around B Reactor have been excavated and are being cleaned of nuclear debris

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WHY SHOULD PEOPLE CARE?

• BRx is one of most historic sites in the world
  – Changed the course of world history
  – Engineering feat is fascinating
  – Legacy of debates and issues are endless