Argonne NATIONAL LABORATORY

Global Threat Reduction Initiative – Conversion Program:

Reduced Enrichment for Research and Test Reactors (RERTR)

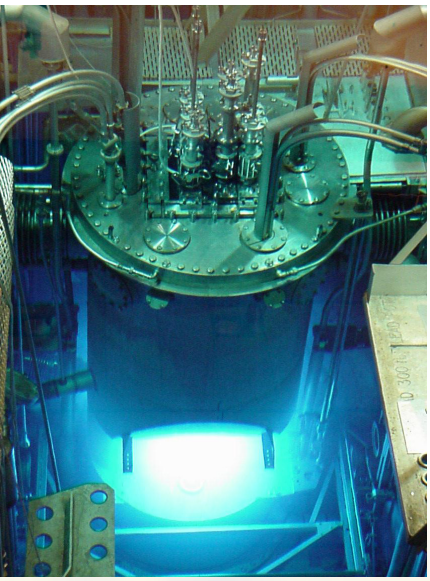
CP-1 ▲

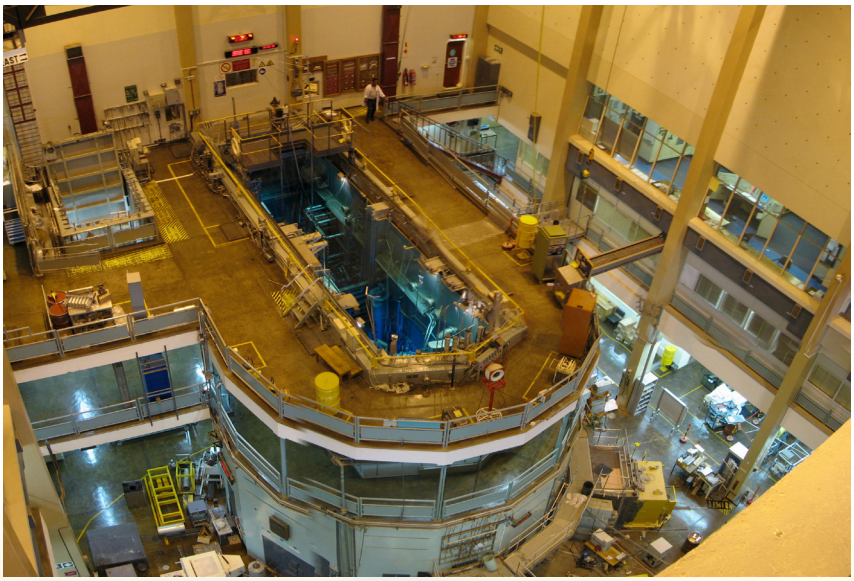
The Nuclear Proliferation Challenge

The nuclear age began on December 2, 1942 when the first self-sustaining nuclear chain reaction took place in Chicago Pile 1 (CP-1) that had been constructed in a basement squash court at the University of Chicago. Information gained in this peaceful precursor to the Manhattan Project set off a second chain of events eventually leading to the Hiroshima and Nagasaki bombings that forced the end of World War II. Counterbalancing its destructive potential, the civilian peaceful application of nuclear energy was later demonstrated when electricity was first generated by the Argonne-designed Experimental Breeder Reactor I (EBR-I) on December 20, 1951, near Arco, Idaho.

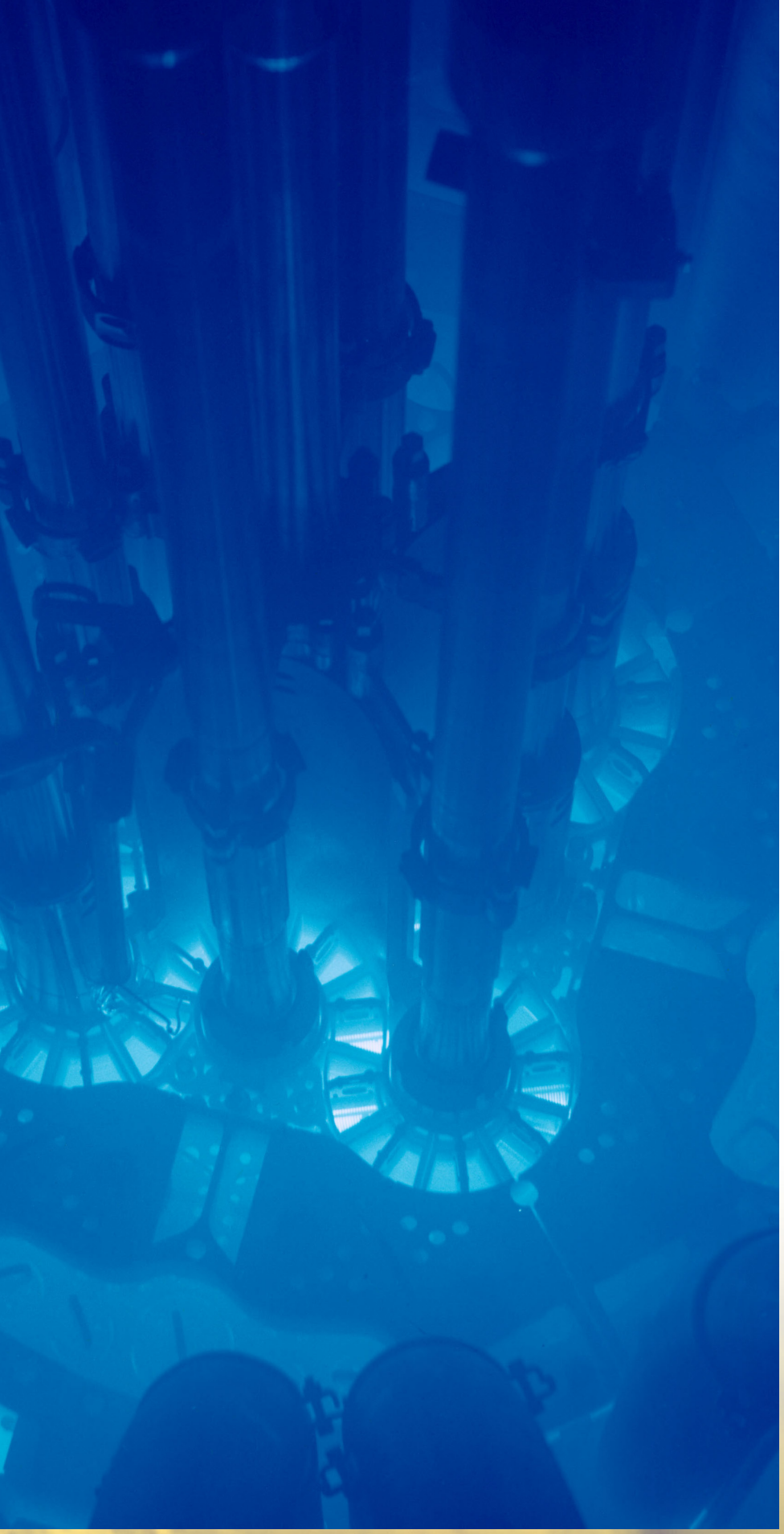
Much like the dual application of splitting the atom, U.S. policy towards civilian use of highly enriched uranium (HEU) has historically exhibited contradictory traits. During these early years, U.S. concern about proliferation risks inhibited the spread of HEU. But as part of President Dwight Eisenhower's 1953 Atoms for Peace plan, the U.S. began to share its nuclear technology with other countries by providing research and test reactors fueled first with low enriched uranium (LEU) and then later with HEU. By the early 1970s, HEU exports from the U.S. averaged about 1,200 kilograms per year for reactors of all types.

During the Gerald Ford and Jimmy Carter administrations, the U.S. began to grapple with the challenge of HEU minimization and called on nuclear scientists to find technical fixes. HEU, especially the very highly enriched form, can be used directly in a nuclear weapon. Safeguarding the production, use and control of HEU against nuclear weapon proliferation or terrorist threats is one of the biggest challenges facing the nuclear industry throughout the world. The imperative for a solution was forever etched into the national consciousness on 9-11.





▲ *The Safari-I reactor is operated by Necsa (South African Nuclear Energy Corporation). With Argonne's assistance, the reactor converted to operating with LEU in 2008 and is currently instrumental in the LEU-based production and supply of the medically important radioisotope Mo-99.*



Responding to the Nuclear Proliferation Challenge

Argonne National Laboratory, the nation's first national laboratory, grew out of the World War II-era Manhattan Project that produced the world's first controlled nuclear fission chain reaction. Argonne long ago recognized and promoted the need for responsible stewardship of the world's HEU.

Argonne provided the inspiration and the driving force for the U.S. Department of Energy's (DOE's) establishment of the Reduced Enrichment for Research and Test Reactors (RERTR) in 1978. Subsequently in 2004 and largely because of RERTR's success, DOE's National Nuclear Security Administration (NNSA) created the Global Threat Reduction Initiative (GTRI), which incorporated the RERTR as well as the nuclear material protection and removal programs.

Since 1978, under RERTR and more recently under GTRI, Argonne has provided technical leadership for the elimination of the use of HEU in research and test reactors as well as in medical isotope production systems. The GTRI-Reactor Conversion program works to minimize and to the extent possible eliminate the use of HEU in civil nuclear applications. GTRI-Reactor Conversion supports conversion of research and test reactors and radioisotope production processes to the use of LEU fuels and targets throughout the world through:

- LEU fuel development,
- Design and safety analysis for research and test reactor conversion, and
- Development of targets and processes for the production of the medical isotope Molybdenum-99 (Mo-99) without using HEU.

In the time since GTRI's predecessor program started in 1978 under Argonne National Laboratory's technical direction, the following has been accomplished:

- Conversion of 80 research reactors (20 in the United States) from operation with HEU fuel to operation with LEU fuel, or to shutdown prior to conversion;
- Shipment of LEU-produced Mo-99 to the United States;
- Conversion activity agreements with the China Institute of Atomic Energy, Kurchatov Institute in Russia and the South African Nuclear Energy Corporation, among others;
- Use of LEU dispersion fuel in numerous research reactors throughout the world; and
- Assisting VNIINM (Bochvar Institute) in Russia in its development and qualification of LEU fuel for Russian-supplied research reactors.

GTRI and Argonne:
Leading the Way to a More Secure Nuclear Future

GTRI and Argonne have made the world more secure through

- Reduced use of HEU in research and test reactors, decreasing the worldwide threat of nuclear proliferation,
- Reduced U.S. dependence on HEU production of the medical isotope Mo-99, and
- Increased cooperation between the United States and other global nuclear powers.

GTRI Goals

- **CONVERT** Convert research reactors from operation with HEU to LEU fuel.
- **REMOVE** Remove and dispose of excess nuclear and radiological materials.
- **PROTECT** Protect high priority nuclear and radiological materials from theft and sabotage.

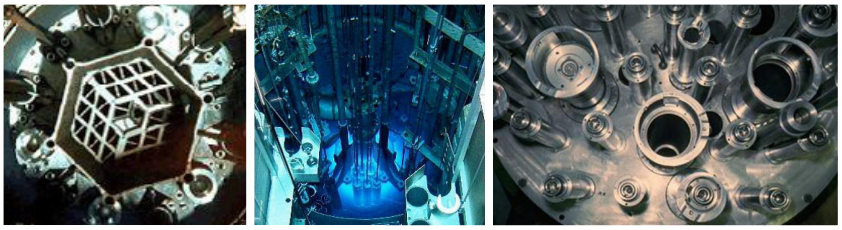
GTRI Sponsor

- National Nuclear Security Administration, U.S. Department of Energy

GTRI International Collaborators

- Bochvar and Kurchatov Institutes, Russia
- China Institute of Atomic Energy
- NNRI-Ghana Atomic Energy Commission, Ghana
- Korean Atomic Energy Research Institute
- NNC-RK, Institute of Nuclear Physics, Kazakhstan
- National Centre for Nuclear Research, Poland
- South African Nuclear Energy Corporation
- Numerous other international collaborators

The Argonne electron linac, which is being used to assist foreign conversion to LEU targets and to produce Mo-99 domestically. For Mo-99 production, the linac is used to develop gamma/neutron reactions on Mo-100 targets and irradiate an electron/neutron converter to produce fissioning in aqueous uranium solutions. Argonne is also irradiating uranium foils using the gamma/fission reaction on uranium-238 to produce tracer quantities of fission and activation products for developing methods to convert foreign producers that currently use HEU targets to LEU targets.



U.S. High-Performance Research Reactors

For More Information

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