To Reprocess or Not to Reprocess: The PUREX Question

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To Reprocess or Not to Reprocess: The PUREX Question (*Assessment for alternatives for management of N-Reactor fuel at Hanford*) by Scott Saleska and Arjun Makhijani (1990)

Executive Summary

Introduction

From December 1963 until 1988 the primary mission of the N-reactor at the U.S. Government's Hanford Reservation was the production of plutonium for federal nuclear weapons and research programs. Plutonium was produced as the reactor's fuel rods were irradiated; later, after the rods were withdrawn from the reactor and allowed to cool, plutonium was separated along with uranium in a chemical separation process known as PUREX (*P*lutonium- *UR*anium *EX*traction) .

Until recently, the existing stock of highly radioactive used fuel (generally referred to as irradiated or spent fuel) from the N-reactor was intended to provide plutonium for the U.S. nuclear weapons program. A variety of factors, however, (including reduced international tensions, impending arms control cuts, and the cancellation of a proposed plutonium isotopic refining plant in Idaho known as SIS) have combined to reduce the need for this plutonium for weapons purposes. Since the U.S. Department of Energy (DOE) has acknowledged that it will not produce more plutonium for weapons for many years, the primary concern today for the disposition of this fuel is for environmental, safety, and health factors. Another consideration is the cost of the various options.

The N-reactor is now in a state of cold shutdown as a result of a DOE decision in early 1988 to permanently close the reactor because of safety problems raised in the aftermath of the explosion of the Soviet Union's Chernobyl nuclear station in April 1986. At the time of the 1988 decision to close the reactor, approximately 2,800 metric tons of irradiated fuel was stored in water basins awaiting reprocessing at Hanford's PUREX plant.

The safe and environmentally responsible reprocessing of irradiated nuclear fuel has always been a complex, difficult process because of the combination of radiological and chemical hazards involved, and PUREX has been plagued by many environmental and safety problems. The accumulating problems eventually caused its emergency shut-down in the middle of a reprocessing run in late 1988. Since then, PUREX has not operated except to finish up and clear out the remains of the aborted 1988 reprocessing run.

Currently there are approximately 2,100 metric tons of highly radioactive irradiated fuel from the N-reactor in storage. This fuel is currently stored in two water pools known as the K-basins. The fuel in basin K-West is encapsulated in sealed water-filled containers, while the fuel in the K-East basin is in open containers which leave it in direct contact with the basin water, which has become highly contaminated and has in the past leaked into the environment.

The PUREX Question

This study focuses on the question of what to do with this remaining irradiated fuel. This in turn involves both interim management and long-term management questions. There are three main options available for interim management of N-fuel:

- reprocess N-fuel at PUREX or a similar reprocessing plant, extracting the plutonium and uranium in the process, and converting most of the rest of the spent fuel material into high-level and low-level radioactive wastes. Much of the low-level wastes would be discharged to the ground, while the high-level wastes would be stored and subject to ongoing management in Hanford's high-level waste tanks and waste processing activities;
- continue to store N-fuel underwater in storage basins with encapsulation of exposed fuel elements to protect against continued radioactive contamination of the basin water; or,
- transfer N-fuel to new dry storage facilities where fuel elements would be stored in enclosed casks under a suitable cover gas such as argon or helium.

The latter two of these options would leave the plutonium in the fuel unrecovered. All three interim options would require eventual permanent disposition of high-level radioactive waste, either in the form of containerized spent fuel rods, or in some other form such as vitrified glass (planned by DOE for high-level liquid reprocessing waste) or possibly containerized N-fuel material in an oxidized form. According to current U.S. policy, such disposition will eventually involve permanent emplacement of the waste in a deep underground repository. This is currently scheduled to begin in the year 2010, assuming the one site currently under investigation at Yucca Mountain, Nevada, proves to be suitable and can be licensed by the U.S. Nuclear Regulatory Commission.

In late 1989, Westinghouse Hanford Company, the principal federal contractor at the Hanford site, released a study — "the Westinghouse Study" (WHC 1989c) — outlining several options for N-fuel management and purporting to address the question of which one to adopt. This study was based in part on a 1982 DOE Environmental Impact Statement on PUREX operation (DOE 1982), and has also been supplemented by an April 1990 study examining the non-PUREX options in somewhat greater detail (WHC 1990).

The Westinghouse documents concluded that the most desirable option for the safe, environmentally sound, and cost-effective management of the remaining N-reactor fuel is the re-start of PUREX to reprocess it. Westinghouse further concluded that continued underwater storage of N-fuel in the basins "is not considered environmentally responsible," [1] and that the PUREX option will resolve the problem of N-fuel management the quickest by clearing all N-fuel out of basin storage by 1995.

With regard to the non-PUREX options, Westinghouse found that all "are technically possible," but that all were also "subject to regulatory and legislative guidelines/controIs and more detailed engineering studies that can not be fully evaluated until the decision process begins." "In the interim," Westinghouse concludes, "we are continuing to plan on processing all of the N Reactor spent fuel through the PUREX plant. [2]

Westinghouse also noted that all non-PUREX N-fuel storage options would probably be subject to federal law [3] requiring that an Environmental Impact Statement (EIS) be conducted prior to implementation, and

that “[t]he single exception to the EIS requirement would be processing through PUREX as is currently planned.” (WHC 1990c, p. 2)

Notes:

1. Cover letter from J.C. Fulton, Manager, Chemical Processing Programs of Westinghouse Hanford Company to J.R. Hunter Director of Operations at U.S. DOE – Richland, transmitting WHC 1989c (Dec. 13,1989) ? Return
2. Cover letter from W.G. Ruff, Deputy Manager, Defense Operations Division of Westinghouse Hanford Company to J.R. Hunter, Director of Operations at US. DOE – Richland, transmitting WHC 1990d (April 13, 1990), p. 1. ? Return
3. The National Environmental Policy Act (NEPA), 42 U.S. Code, Sections 4321 et seq. ? Return

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