Advanced Recycling Center - Solving the Used Nuclear Fuel Dilemma

Technology Update

Disposition of used nuclear fuel (UNF) is an important consideration given the anticipated expansion of nuclear energy generation. Accordingly, closing the nuclear fuel cycle with the recycling of UNF is not only necessary, but it also promotes environmental stewardship because it provides better uranium utilization (less mining), increases energy efficiency by making use of unused materials in the used nuclear fuel, results in a shorter half-life waste (requires a shorter time-frame for storage), and reduces the amount of nuclear waste products ultimately destined for disposal.

Government policy is moving toward emission reductions of greenhouse gases. A major source of greenhouse gas emissions is CO_2 which is released when fossil fuels are used to produce electricity. Any attempt to solve these two major issues should focus on avoiding the creation of new concerns. Therefore, the solution should embrace both public and worker safety, have a low impact on the environment, and be economically viable. Safety, in the case of used nuclear fuel, also includes using technology that limits the possibility of diversion of materials that can be used to make nuclear weapons (the system must be proliferation resistant).

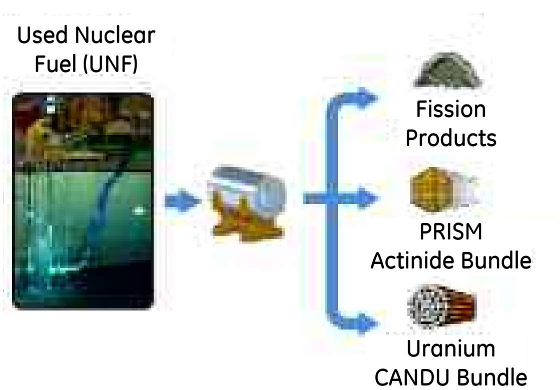

Figure 1: Used nuclear fuel separation is accomplished using the dry electrometallurgical process

The GEH Advanced Recycling Center (ARC) will address the issues of UNF through recycling which, unlike reprocessing, consumes all transuranic elements while reducing greenhouse gases emission from power production. The consumption of transuranics reduces the heat load on the eventual repository.

The ARC combines electrometallurgical processing with one or more sodium-cooled reactors on a single site. This process produces power while alleviating the used nuclear fuel burden from nuclear power generation.

The ARC starts with the separation of used nuclear fuel into three components: 1) uranium that can be used in CANDU reactors or re-enriched for use in light water reactors; 2) fission products (with a shorter half-life) that are stabilized in glass or metallic form for geologic disposal; and 3) transuranics (the long-lived radioactive material in UNF), which are used as fuel in the Advanced Recycling Reactor (ARR).

GEH has selected the electrometallurgical process to perform separations. The electrometallurgical process passes an electric current through a salt bath to separate the components of UNF. A major advantage of this process is that it is a dry process (the processing materials are solids at room temperature), which significantly reduces the risk of inadvertent environmental release. Additionally, unlike traditional aqueous MOX separations technology, electrometallurgical separations do not generate separated pure plutonium, which makes it a more proliferation resistant process. Electrometallurgical separations technology is widely used in the aluminum industry and has been studied and demonstrated in U.S. national laboratories as well as other research institutes around the world.

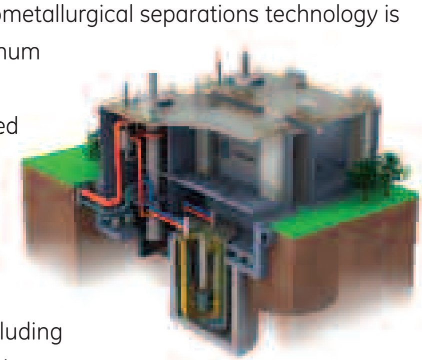

Figure 2: PRISM Reactor power block used to produce electricity from used nuclear fuel

The transuranic fuel (including elements such as plutonium, americium, neptunium, and curium) from the UNF separations step is used in GEH's PRISM (Power Reactor Innovative Small Modular) advanced recycling reactor to produce electricity.

The PRISM is a reactor that uses liquid sodium as a coolant. This coolant allows the neutrons in the reactor to have a higher energy (sometimes called fast-reactors) that drive fission of the transuranics, converting them into short-lived "fission products." This reaction produces heat energy, which is converted into electrical energy in a conventional steam turbine. Sodium-cooled reactors are well-developed and have safely operated at many sites around the world.

The ARC produces carbon-free base load electrical power. An ARC consists of an electrometallurgical separations plant and three power blocks of 622 MWe each for a total of 1,866 MWe. The sale of electricity will provide the revenues (private sector) to operate the ARC while supplemental income will be obtained from the sale of uranium (private sector) and the payment for UNF treatment (currently government controlled).

Today, in the U.S. there are approximately 100 nuclear power reactors in operation. Assuming that they each produce 20 tons of UNF a year for 60 years of operation, the current fleet will produce 120,000 tons of UNF. Twenty-six ARCs are capable of consuming the entire 120,000 tons of UNF. Additionally, they are capable of producing 50,000 MWe and avoiding the emission of 400,000,000 tons of CO_2 every year.

In order to gain the confidence of utilities and financial markets that the regulatory and resource issues (personnel and materials) can be solved, a first-of-a-kind ARC must be built at "full-scale." A full-scale facility is a single reactor and 50 tons per year separations facility. A well-managed U.S. government sponsored program using U.S. technology, national laboratories and universities, and companies can lead this process. The project would take approximately 10 years to complete. The first PRISM reactor could be fueled by excess plutonium from the weapons stockpile, thus further reducing proliferation risk. This program will enable the U.S. to lead the world nuclear community in demonstrating a sound approach to solving the problem of UNF, a solution that our national laboratories pioneered decades ago. Taking action to build the GEH Advanced Recycling Center allows the U.S. to capitalize on existing funded technology and demonstrate leadership in providing a safe, proliferation resistant method to close the nuclear fuel cycle.

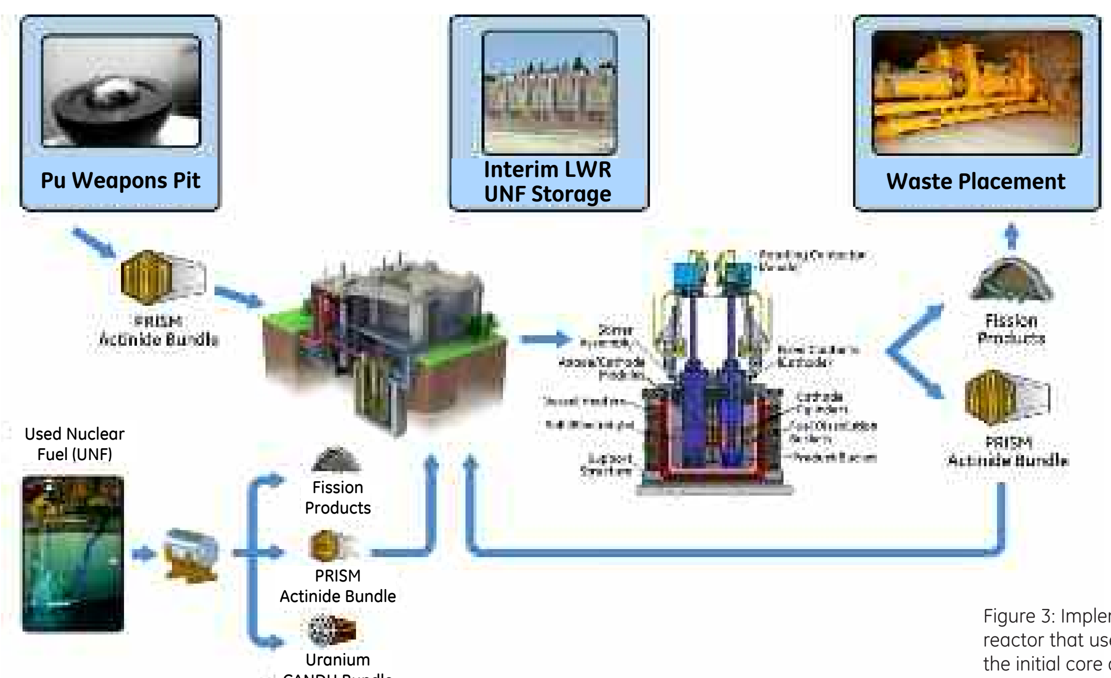

Figure 3: Implementation of a fuel qualification reactor that uses excess weapons material as the initial core and recycled light water reactor used fuel in subsequent operations

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