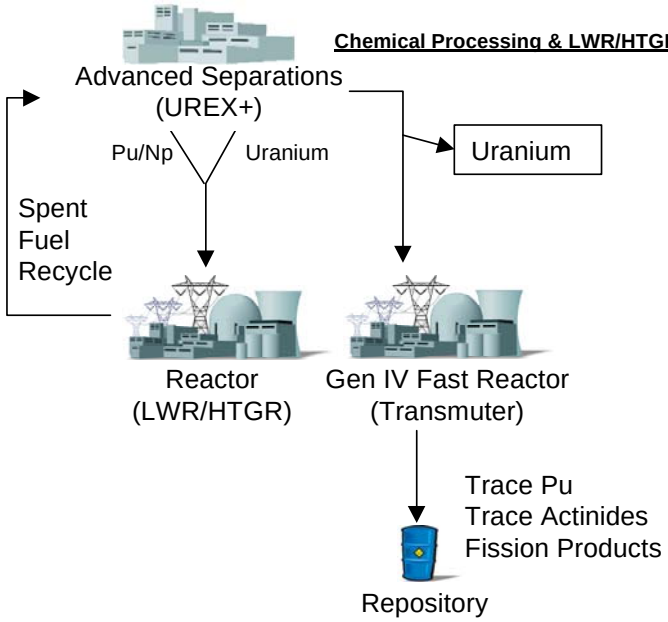
2.4.3 ADVANCED FUEL CYCLE INITIATIVE

Technology Description



- Pu consumption and toxicity reduction
- Significant reduction in number of waste packages
- Permits significant expansion to existing repository

The Advanced Fuel Cycle Initiative (AFCI)**,** under the leadership of DOE, is focused on developing advanced fuel cycle technologies, which include spent fuel treatment, advanced fuels, and transmutation technologies, for application to current operating commercial reactors and next-generation reactors and to inform a recommendation by the Secretary of Energy in the 2007-2010 time frame on the need for a second geologic repository. The AFCI program will develop technologies to address intermediate and long-term issues associated with spent nuclear fuel. The intermediate-term issues are the reduction of the volume and heat generation of material requiring geologic disposal. The program will develop proliferation-resistant processes and fuels for application to current light water reactor systems and Generation IV reactor systems to enable the energy value of these materials to be recovered, while destroying significant quantities of plutonium. This work provides the opportunity to optimize use of the nation's first repository and reduce the technical need for an additional repository. The longer-term issues to be addressed by the AFCI program are the development of fuel cycle technologies to destroy minor actinides, greatly reducing the long-term radiotoxicity and heat load of high-level waste sent to a geologic repository. This will be accomplished through the development of Gen IV fast reactor fuel cycle technologies and possibly accelerator-driven systems

System Concepts

- Advanced nuclear systems (fission reactors and accelerator-driven systems) that aim to reduce the lifetime of the waste from current-generation fission reactors to short times.
- Advanced nuclear systems that aim to extract the full energy potential of the spent nuclear fuel from current fission reactors, while reducing or eliminating the potential for proliferation of nuclear materials and technologies, and reducing the amount of waste produced.

Representative Technologies

- Spent-fuel treatment technologies that are proliferation resistant.
- Advanced fuel types for waste transmutation.
- Advanced fuel types for sustained nuclear energy.
- Accelerator-driven systems for rapid waste transmutation.
- Advanced reactors for sustained nuclear energy.

Technology Status/Applications

- Advanced fuel-cycle development has reached the laboratory scale-demonstration stage in some cases.
- Transmutation fuels are in early R&D stages.
- Development of accelerator-driven systems is at the early R&D stage.

Current Research, Development, and Demonstration

RD&D Goals

- Proving design principles of spent-fuel treatment and transmutation technologies.
- Demonstrating the fuel and separation technologies for waste transmutation.
- Deploying Generation IV advanced fast spectrum reactors that can transmute nuclear waste.

RD&D Challenges

- Demonstrate performance of advanced fuel cycles.
- Demonstrate performance of advanced transmutation fuels.
- Demonstrate technology for advanced fission reactor concepts.
- Demonstrate feasibility and technology for accelerator-driven systems.

RD&D Activities

- Continued development and demonstration of aqueous and electrometallurgical spent-fuel treatment technologies.
- Development of transmutation fuels for Generation IV reactor systems.
- Development of technologies for accelerator-driven systems.

Recent Progress

- Hot demonstration of several parts of the UREX+ (Uranium Extraction Plus) aqueous spent fuel-treatment process, including separation of high-purity uranium, cesium/strontium, plutonium/neptunium, and americium/curium products.
- Irradiation tests of several transmutation fuels containing transuranic elements

Commercialization and Deployment Activities

- Disposal of spent nuclear fuel is a government activity in the United States. Similar spent-fuel treatment and transmutation technology development programs exist in France, Japan, and the United States. Development of treatment and transmutation technologies for use with advanced Generation IV fuel cycles will increase the acceptability of nuclear energy.
- Advanced Fuel Cycle Initiative has the potential to decrease the quantity and toxicity of nuclear waste, possibly eliminating the need for a second geologic repository.

Market Context

- Technologies to improve spent-fuel disposition increase the value of keeping existing nuclear power plants online as well as increase the likelihood for expanded new nuclear power capacity.