CONF-791103--24

MASTER

A DISSOLUTION PROCESS FOR ADVANCED-PWR-TYPE FUELS

A process does not presently exist at the Idaho Chemical Processing Plant (ICPP) for reprocessing advanced-PWR-type zirconium fuels. Design is nearing completion and construction has started on a $150 million facility for storage and reprocessing of PWR-type fuels. The new Fluorinel Dissolution Process and Fuel Storage (FAST) Facility, located in the ICPP area at the Idaho National Engineering Laboratory, will provide underwater storage of spent PWR and other special fuels and a new head end process for fuel dissolution.

Fuel will be received by truck and unloaded underwater for storage. The six storage basins will be lined with stainless steel and filled with deionized, chilled water. Fuel will be transported underwater from the storage basins to the adjacent dissolution cell. The dissolution cell will be 20 feet wide by 70 feet long by 60 feet high, and will contain three identical dissolution trains. Fuel will be charged to the dissolver and a two-stage dissolution made using hydrofluoric and nitric acids. An intermittent sulfuric acid dissolution will be made to remove stainless steel components. The process vessels and transfer piping will be constructed of Hastelloy C-4 to withstand the corrosive solutions.

All reagents used in dissolution and solution adjustment will contain cadmium as a neutron poison to maintain criticality safety. The cadmium used in the process solutions will be loaded into a transfer hopper inside a glove box and transported by monorail for addition to the reagent vessels.

Fuel to be dissolved will be moved with a crane to the dissolver, the lid opened, and the fuel lowered into the dissolver. Viewing windows and television cameras will be provided for visual inspection of fuel charging and other operations. Master-slave and PaR manipulators will be used for the necessary in-cell operations. After charging, the dissolver lid will be closed and the dissolver purged with nitrogen to remove oxygen from the system. Reagents will then be added to initiate the reaction with the charged fuel. Pulsed sparge lines will agitate fuel solids during dissolution. A closed-loop system containing cadmium poison will be used to heat or cool the dissolver and other process vessels.

The dissolver off-gas will pass through a condenser and a scrubber to remove residual fluorides before the off-gas is filtered and leaves the cell. The hydrogen concentration in the off-gas will be measured to determine dissolution progress. Following dissolution, the solution will be transferred from the dissolver for complexing with aluminum nitrate. Heel cleanouts will be made in the dissolver as necessary for material accountability. A television camera will be used to inspect the dissolver interior to detect any undissolved fuel.

After complexing, the dissolver solution will be pumped through an etched-disk filter for removal of the undissolved solids. The process filter will be cleared of solids by a high-pressure nitrogen blowback. The collected solids will be dried and packaged for disposal. A neutron interrogator, being developed by Los Alamos Scientific Laboratory, will verify the uranium content of the dissolver fuel charge and measure the uranium content of the waste canisters.

Instrument readouts and process information for the entire process will be transmitted to the control room computer. The computer system will provide data acquisition and monitoring of each operational step.

Instrument probe lines, pumps, jets, valves, and other equipment subject to failure will be remotely replaced. The equipment will be placed in a shielded box and removed from the cell for decontamination or disposal.

The solutions in the process vessels will be sampled for analyses from a remotely operated sample cell. The solutions will be circulated to a sample reservoir by a nitrogen jet. An evacuated sample bottle will be mechanically lowered in the sample station. An attached needle will penetrate a diaphragm in the sample bottle and transfer liquid from the reservoir into the bottle. The bottle will be inserted in a plastic carrier and pneumatically transferred through an underground line to the analytical cell.

The filtered dissolver solution will be collected for final analyses and accountability measurement. It will then be pumped through underground lines to an existing solvent extraction system at the ICPP. Waste solutions will also be jetted or pumped to existing waste handling systems. These lines will be doubly contained and have leak detection and solution recovery systems.

The FAST Facility will provide a dissolution process for advanced zirconium fuels, using an innovative design for remote fuel handling and cell maintenance.