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Increasing the Acceptance of Spent Nuclear Fuel Disposal by the Transmutation of Minor Actinides Using an Accelerator

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The main challenge in nuclear fuel cycle closure is the reduction of the potential radiotoxicity of spent LWR nuclear fuel, or the length of time in which that potential hazard exists. Partitioning and accelerator-based transmutation in combination with geological disposal can lead to an acceptable societal solution for the nuclear spent fuel management problem. Nuclear fuel seems ideally suited for recycling. Only a small fraction of the available energy in the fuel is extracted in a single pass and the problem isotopes, consisting of the transuranic elements plutonium, neptunium, americium, curium and the long-lived fission products iodine and technetium, could be burned in fast-neutron spectrum reactors or sub-critical accelerator driven transmuters. Most of the remaining wastes have half-lives of a few hundred years and can be safely stored in man-made containment structures (casks or glass). The very small amount of remaining long-lived waste could be safely stored in a small geologic repository. The problem for the next 100 years is that a sufficient number of fast reactors are unlikely to be built by industry to burn its own waste and the waste from existing and new light water reactors (LWRs). So an interim solution is required to transition to a fast reactor economy. The goals of accelerator transmutation are some or all of the following: 1) to significantly reduce the impacts due to the minor actinides on the packing density and long-term radiotoxicity in the repository design, 2) preserve/use the energy-rich component of used nuclear fuel, and 3) reduce proliferation risk. Accelerator-based transmutation could lead to a greater percentage of our power coming from greenhouse-gas emission-free nuclear power and provide a long-term strategy enabling the continuation and growth of nuclear power in the U.S.