THE ADVANCED FUEL CYCLE INITIATIVE: THE FUTURE PATH FOR ADVANCED SPENT FUEL TREATMENT AND TRANSMUTATION RESEARCH IN THE UNITED STATES

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The U. S. Department of Energy (DOE) has invested over USD 100 million in transmutation research and development over the past three years. The programme has evolved from an accelerator-based transmutation programme to a multi-tier reactor and accelerator based programme. These changes have resulted in a significant re-focus of the research and development programme as well as a name change to reflect the new direction. The Advanced Accelerator Application (AAA) programme is now renamed the Advanced Fuel Cycle Initiative (AFCI).

Research completed by the AAA programme in Fiscal Year 2002 points to a multi-phased AFCI Programme consisting of two elements that would be conducted in parallel as part of an integrated research effort – an intermediate-term technology element (AFCI Series One), which emphasises advanced technical enhancements to the current commercial nuclear power infrastructure; and a long-term technology element (AFCI Series Two), which will require the introduction of next-generation nuclear energy systems to reduce the toxicity of nuclear waste.

AFCI Series One would address the intermediate-term issues associated with spent nuclear fuel disposition primarily by reducing the volume of material requiring geologic disposition through extraction of uranium. A second area of intermediate-term research and development will be development of proliferation-resistant processes and fuels to transmute significant quantities of commercially generated plutonium and other elements of concern (minor actinides) in light water reactors (LWR) or high temperature gas-cooled reactors by approximately 2015. Successful implementation of these technologies would enable the United States to reclaim the significant energy value contained in spent fuel and significantly reduce the need for a second U.S. repository.

AFCI Series Two would address the long-term issues associated with spent nuclear fuel. Specifically, this effort will develop fuel cycle technologies that could sharply reduce the long-term radiotoxicity and heat load of high-level waste sent to a geologic repository. If successful, these technologies could enable the commercial waste stored in a repository to be no more toxic than natural uranium ore after approximately 1 000 years.

In general, we have found that there is reason to believe that the following objectives are attainable:

- **Reduce High-Level Nuclear Waste Volume**: It is possible to develop and implement, by the middle of the next decade, proliferation-resistant technology to significantly reduce the volume of high-level nuclear waste from commercial spent fuel requiring repository disposal.
- **Reduce the Cost of Geologic Disposal:** Based on preliminary analysis thus far, the implementation of AFCI technologies could reduce the cost of spent nuclear fuel disposal in the first U.S. repository by several billion dollars by permitting the use of fewer drip shields and waste packages and reducing the operation and transportation costs associated with those items. AFCI could also avoid the full cost of constructing a second repository under the scenario that anticipates new plant orders during the first third of the century.
- **Reduce Inventories of Civilian Plutonium**: It is possible to develop and deploy, by the middle of the next decade, advanced nuclear fuels that will enable the proliferation-resistant consumption of plutonium in existing LWRs or advanced gas-cooled reactors that may be available in the future.
- **Reduce the Toxicity of High-Level Nuclear Waste:** It is possible to develop and deploy, by approximately 2030, advanced proliferation-resistant treatment and transmutation technologies that will both significantly reduce the volume of spent nuclear fuel and create waste forms sufficiently clean of long-lived, highly toxic species to reduce the time to reach the level of natural uranium from 300 000 years to approximately 1 000 years.

The AFCI will continue to co-ordinated technology efforts of many countries and expand as appropriate. The programme will also continue to seek advice on programme planning, technical and scientific goals, and approaches to research from the Advanced Nuclear Transformation Technology Subcommittee of the Nuclear Energy Research Advisory Committee (NERAC), which is chaired by Nobel Laureate Burton Richter.

This subcommittee has made recommendations, adopted by NERAC, which recognise the successful completion of the first phase of this research (including a significant narrowing of technical options) and urge initiation of a second phase of work to provide decision makers with sufficient information to decide which, among the remaining technology options, is most promising for enhancing the Nation's approaches to nuclear waste, national security, and energy security.

Bringing these technologies into use would require completion of a third phase of work In the case of AFCI Series One, successful completion of the second phase would enable the United States to initiate commercial deployment of these technologies by no later than 2015. The next generation technologies of AFCI Series Two would require significantly more time and research. Deployment could come only after a demonstration phase that could require new facilities in the United States or other countries. If all research and development is completed, deployment would be possible in about 2030. A successful programme would realise the vision anticipated by the *National Energy Policy* to explore advanced technologies to deal with spent nuclear fuel in co-operation with our international partners.