Westinghouse's Fuel Cycle Strategy towards a "300-year" Nuclear Waste

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Abstract

Currently in the US alone, about 70,000 metric tons of Used Nuclear Fuel (UNF) are stored in fuel pools at the reactor sites or dry stored in casks, waiting for final disposal or alternative solutions. In addition to this "legacy" waste, "new" waste is continuously generated by the operating fleet. Although counting for only about 1% of the total UNF mass, the transuranic (TRU) component of UNF dominates radiotoxicity and heat load in the mid- to long-term after fuel discharge. The permanent disposal of UNF in a geological repository is perceived with scepticism by the public and part of the scientific community, primarily due to the lack of confidence in the claimed repository performance over extended periods of time. This has created a political and societal stalemate which is hampering new builds and threatens nuclear energy growth in current and potential new markets.

To resolve the stalemate and increase public confidence, Westinghouse is proposing an approach to reduce considerably the high level waste (HLW) radiotoxicity by recovering and recycling the actinides contained in the discharged fuel, while burning the TRU waste accumulated in the LWR UNF. The challenge is to develop a nuclear system that is capable of such undertaking while generating electricity in a safe and economically sound fashion. Another major technological element to obtain this goal is to develop a manufacturing and reprocessing technology for the transmutation fuel which can be scaled to an industrial level.

This paper will discuss the fuel cycle strategy and underlying technological elements which are currently under investigation at Westinghouse. The current emphasis is on a combination of LWR and Fast Reactor technology to be deployed on a properly timed schedule. LWRs are the mainstay of the commercial nuclear industry of the current century and their potential role in carrying out the transmutation mission has attractive benefits. The cost and technological risks associated to an accelerated fast reactor deployment would be avoided while allowing for the development of manufacturing and reprocessing technologies compatible with the production of transmutation fuel at an industrial scale.

In particular, Westinghouse is exploring the use of LWRs retrofitted to a reduced moderation lattice to carry out the initial phase of the transmutation. The reduced moderation lattice has harder spectrum than a regular LWR lattice thereby mitigating some of the concerns associated to multi-recycled TRU-bearing fuel. Fast reactors (FR) are also being considered and can certainly be incorporated within the fuel cycle strategy proposed. They offer the perspective of ultimate fuel cycle flexibility and fuel utilization, which together with other potential advantages would make them an unquestionable strategic asset. On the other hand FRs should be developed and introduced at the proper pace and time to allow for its technology to mature and become economically competitive.

A gradual transition to the thorium fuel cycle is also being considered as part of the Westinghouse long-term fuel cycle strategy. Thorium has some key potential advantages,

including reduced endogenous generation of higher actinides (Am, Cm atc.), better feedback coefficients, especially void reactivity coefficient, higher thermal conductivity and melting point, which can be translated into design simplification and/or improved operational and safety behaviour. However, the use of thorium presents also significant challenges and technological gaps. If these gaps can be filled, thorium could certainly play an important role in the future of the nuclear fuel cycle.