Deep geological repository performance of low- and intermediate-level wastes from PyroGreen-PEACER system*

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Abstract

The Nuclear Transmutation Energy Research Center of Korea (NUTRECK) has developed the innovative fuel cycle concept, "PyroGreen" that aims at decontaminate spent nuclear fuels to low- and intermediate-level waste. Co-located advanced pyroprocessing and lead-bismuth eutectic-cooled burner, Proliferation-resistant, Environment-friendly, Accident-tolerant, Continuable and Economical Reactor (PEACER) would significantly reduce volume, radiotoxicity and heat of final wastes.

To minimise waste volume, about 90 wt.% of uranium (i.e. about 87 wt.% of spent nuclear fuels) is removed for future uses while over 99.9 wt.% transuranic elements can be recovered as recycled fuels to be loaded into PEACER. Caesium and strontium generating the most of heat from spent fuels could be separated up to 99% and isolated in the interim storage for 200 years or would be utilised as gamma sources for Cs, batteries for Sr or medical isotopes for both. Trapped technetium and iodine, at the recovery rate of over 98%, will be fabricated into targets for transmutation in thermal traps within PEACER. Recovered zirconium could be reutilised as cladding or metal fuels that allow low-level radiation.

The rest of the materials will be stabilised within glass or ceramic prior to the final disposal in a deep geological repository in such a way to satisfy Korean safety criteria for low- and intermediate-level waste (LILW). There are enormous advantage to apply this meticulous process of waste improvements and to dispose of them in deep geological repository in reducing environmental risk through minimising the mobility of actinides and to cut the risk of human intrusion that, otherwise, would be counteracted by severely limiting long-living isotope concentrations. It is also expected that waste volume can be considerably decreased by relaxing intrusion issues, which can compensate the higher construction and waste reconstitution cost incurred by shifting from the conventional near surface or medium-depth disposal to the deep geological repository.

To assess the performance of the deep geological repository for final wastes from this alternative approach, SAFE-ROCK, developed by Korea Radioactive Waste Management Corporation, was used to evaluate the long-term migration of radionuclides to groundwater from the repository located in saturated zone. Preliminary safety assessment with wastes from 20 light water reactors for 40 years resulted in the peak annual dose below 1.0E-6 Sv/yr that was 100 times lower than the land disposal criteria on low level waste of Korea. The dose rate was dominated by a few fission products and activation isotopes such as ^{14}C, ^{36}Cl, ^{79}Se, ^{126}Sn, ^{129}I. The sufficient safety margin may be used to reduce the active institutional control period not more than of 300 years.

* The full paper being unavailable at the time of publication, only the abstract is included.