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Fuel Cycle Options for the Production and Utilization of Denatured Plutonium

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Abstract—*Denatured reactor plutonium with a ^{238}Pu isotopic content of ~6% or somewhat more can be produced in a suitably adapted fuel cycle. Several such fuel cycle options are proposed. Reenriched reprocessed $^{235}U/^{236}U/^{238}U$, which can be blended with some low-enriched $^{235}U/^{238}U$ fuel, leads, after one burnup cycle of 50 to 60 GWd/tonne in a pressurized water reactor (PWR) core, to denatured reactor plutonium with more than 8% ^{238}Pu isotopic content. Presently existing reactor plutonium with ~2.8% ^{238}Pu from spent fuel with a burnup of 50 GWd/tonne can also be converted in PWRs, during one or two burnup cycles over 50 to 60 GWd/tonne into denatured reactor plutonium. This is also demonstrated by burnup calculations for different fuel cycle scenarios using, e.g., reenriched reprocessed uranium, thorium, and minor actinides. Denatured reactor plutonium with 6% or somewhat more ^{238}Pu isotopic content can be considered as a proliferation-resistant fuel and could be treated like low-enriched (<20% ^{235}U) uranium fuel. It can be incinerated by multiple recycling in PWRs or fast reactors. Advanced aqueous reprocessing or pyroprocessing as well as related refabrication methods, as they are being developed for transmutation scenarios of the minor actinides, would be best suited for such adapted fuel cycle options. Safeguards needs and aspects for the different proposed fuel cycle options are discussed.*