Abstract

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Nondestructive Assay of 237Np

The purpose of nondestructive assay in the context of nuclear safeguards is to precisely verify the declared mass of a sample of nuclear material in a noninhibitive amount of time. 237Np is a proliferation concern, and the capacity to efficiently assay samples of it is a missing piece in the verification and safeguards toolbox. The material is subject to the same safeguards as 235U, is reportable in gram quantities, and is classified as “other nuclear material” according to the United States (US) Department of Energy. Given that 3000 kg of 237Np is annually produced in the US and the bare sphere critical mass is 40-60 kg, it is desirable to augment the safeguards toolbox with a system capable of distinguishing 10 g of 237Np in a 20-minute measurement. One measurement modality is neutron multiplicity counting, which relates the detected multiplicity count rates to the amount of fissionable material. Prior simulation work shows that an organic scintillator-based multiplicity counter can achieve the design criteria, whereas the flagship 3He-based system, the Epithermal Neutron Multiplicity Counter, requires much longer measurement times to achieve the same precision. In this work, simultaneous measurements of a 6-kg sphere of 237Np by organic scintillator- and 3He-based systems are used to confirm the trends in the simulation study; the organic scintillator-based system achieves 1% uncertainty in the neutron double multiplicity rate on the order of minutes, while the 3He-based system requires days to reach the same precision. In conclusion, the International Atomic Energy Agency should consider the development and deployment of an organic scintillator-based multiplicity counter.