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A new approach to MSR safeguards

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1. Introduction

The carbon neutral aspect of nuclear power has increased interest in using the technology to mitigate CO_2. Advanced nuclear power plants (NPPs) are being developed to play an important role in the future of nuclear energy. One of the advanced NPPs, the Molten Salt Reactor (MSR), is receiving considerable attention because its safety features are superior to existing light water reactors (LWRs). For this reason there is a push to bring the MSR to commercialization.

The MSR uses liquid fuel dissolved in molten salt rather than solid fuel in coolant. This feature allows the MSR to be operated at low pressure and refueled on-line. More important, since there is no separate coolant, it has an inherent advantage in preventing core melting, unlike existing NPPs, where loss of coolant can result in a severe accident.

However, since the fuel is liquid, it is difficult to apply existing safeguards, which were mainly designed for solid fuels. This is one of the challenges of MSR operation and poses a potential problem for MSR commercialization. Because the MSR is in the development stage, there is still time to take a safeguards by design approach, which is advocated by the IAEA. This study will focus on one Korean MSR design and determine which safeguards by design applied at other facilities could potentially be applied to the MSR. This study will focus on burnup monitoring of the flowing fuel regarding the depletion and movement of fissile materials: Once the fuel is loaded into the reactor, the burnup will increase until the fuel is discharged. Therefore, if the reactor design includes fuel composition and reactor power, normal operation and off-normal removal of fissile materials can be checked by measuring burnup along with process monitoring.