Project INERI Modeling of Small Modular Reactors with Accident Tolerant Fuels

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Small modular reactors (SMRs) are expected to offer economic, safety and security advantages when compared to current large water reactors. SMRs incorporate advanced safety features, including passive safety systems that rely on natural processes to cool the reactor in accidental situations without the need for active mechanical systems. SMRs can be built in modules, allowing for incremental capacity addition as demand grows, reducing financial risks and construction times. Moreover, the use of ATFs in SMRs can enable increase fuel efficiency through power uprates and/or higher burnups, deriving benefits both from SMRs and ATFs. Therefore, an I-NERI project involving BNL, UPM, INL and NFQ was proposed and approved with the aim of demonstrating and quantifying the safety benefits of ATF for SMRs. To achieve this, different tools such as neutronic or thermohydraulic models, probabilistic risk assessment (PRA) models and fuel behavior models are being applied jointly. The aim of this paper is to show the activities planned and the results obtained in the first phase of the project. Planned activities include: development of a TRACE/PARCS model of NuScale; ATF (FeCrAl, Cr-coated Zry, SiC) material properties and thermo-mechanical models; to select and quantify the risk of the sequences of interest and to analyze the impact of incorporating different ATF materials on risk reduction; to assess the safety and performance of different ATF designs in a broad spectrum of anticipated operational occurrences and design basis accidents; to evaluate the performance of ATF cladding and comparing it with the Zry under different transient and accident conditions of interest.

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