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Neutronic analysis for accident tolerant cladding candidates in PWR

Content

The nuclear fuel performance during accidents became a critical issue after the Fukushima Daiichi nuclear accident in 2011. Currently, various research and development programs are being carried out to enhance the fuel's reliability and durability under such conditions. These programs are collectively known as the Accident Tolerant Fuel (ATF) R&D program, which involves multiple countries, research institutes, and fuel vendors. ATF is an enhanced fuel that can tolerate longer periods of active cooling system failure, without significant fuel/cladding system degradation. Moreover, it can improve fuel performance in normal operations, transients, as well as design-basis accident (DBA) and beyond design-basis (BDBA) scenarios. This paper presents a preliminary neutronics analysis for Accident Tolerant Fuel (ATF) cladding materials for a standard PWR fuel rods. The candidate cladding materials were compared with the original Zircaloy-4 cladding material. To confirm the necessary geometry requirements for achieving end-of-cycle fuel reactivity, a parametric evaluation was conducted on fuel and cladding materials. The findings were then compared with the standard PWR reference fuel-cladding system. Several reactor safety parameters such as reactivity, radial power distribution of fuel pellet, reactivity coefficients, and spectral hardening are assessed for the candidate cladding materials. The neutronic and depletion calculations of ATF cladding materials was performed in this study by using the OpenMC code.

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