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Simulation of ULOF initiation phase in ESFR-SMART with SIMMER-III

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A large 3600 MWth European Sodium Fast Reactor (ESFR) design was proposed in 2000s. It is studied now in the EURATOM ESFR-SMART project. A new core configuration with several new safety measures, including a reduced to a near-zero value coolant void reactivity effect, mainly due to introduction of a sodium plenum above the core and core flattening, has been established recently. We investigate the efficiency of these measures by simulating transients such as unprotected loss of coolant flow (ULOF) with the SIMMER-III code, starting from nominal conditions till molten fuel discharge from the core. In the initiation transient phase, before structure and fuel melting, sodium boiling happens in the described simulations. The reactivity oscillates after the boiling onset due to subsequent boiling and flooding in the upper fissile core part and the sodium plenum above, where the void effect is negative. These oscillations are associated with interaction of different flow channels. In the paper we investigate these phenomena by considering different modelling options. New SIMMER capabilities for taking in account core thermal and control rode driveline expansion reactivity effects are also presented and their influence on the transient behavior is discussed. We also compare to results of ULOF simulations performed with other codes for ESFR-SMART.

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