Application of a Realistic Approach to Heat Transfer in the ALLEGRO Reactor Core

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Abstract. Gas-cooled high-temperature fast reactor GFR represents one of GenIV. technologies. Although the European GFR-2400 can be characterized by its low thermal inertia and high helium coolant leakage ratio, it is aimed to produce high core outlet temperature and to enable the closure of the fuel cycle. This paper represents a part of the work done within the evolution of the conceptual design of a small high-temperature gas-cooled reactor, ALLEGRO – a demonstrator of the big GFR reactors. Development of this type of fast reactor was started at CEA, and it was continued at several European projects. The ALLEGRO reactor has two consecutive cores: the so-called driver core and the refractory core. The inlet and outlet coolant temperature of the driver core is 260 and 520 °C respectively. It has UOX or MOX fuel with stainless steel cladding. The refractory core inlet coolant temperature is 400 °C while its outlet temperature is 800 °C and it has carbide fuel and silicon carbide (SiC) cladding. Both the driver and the refractory ALLEGRO cores were optimized. The core optimization work aims at obtaining favorable values for parameters that are of major importance for the core behavior in abnormal situations. Safety analyses for both fuel types were performed in two steps – best estimate and conservative calculations. At the best estimate analyses, maximum cladding temperatures stay below the criteria in many cases. But still, acceptance criteria (maximum cladding temperature mainly) were not fulfilled in many conservative safety analyses. The main reason is that inappropriate conservativism was used in a few cases. The strong conservativism was applied mainly because the uncertainty of relevant input parameters is unknown in this phase of the development or has a large uncertainty range. It is proposed to address all the relevant input uncertainties, reduce the uncertainty range (e.g. by experimental support) and define the best estimate values and their corresponding uncertainty ranges.