KIT CONTRIBUTION TO THE MULTIPHYISCS R&D ACTIVITIES WITHIN THE H2020 EU *CAMIVVER* PROJECT

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Within the framework of the CAMIVVER (Codes And Methods Improvements for VVER comprehensive safety assessment) project, launched under the European Union research program HORIZON 2020, several R&D activities have been performed with the objective to further investigate and develop a new generation of innovative codes and methods oriented to improve the comprehension of the physical phenomena occurring in the core under steady-state and transient conditions to be applied to Western PWR and VVER reactor types. Within Work Package 5 (WP5) of CAMIVVER, several studies have been conducted in order to assess the performance of advanced tools for multiphysics analyses with the main objective to further develop and verify the prediction capabilities of different coupling schemes based on the APOLLO3® code in view of its industrialization in the long term. According to the strategy adopted within the project, the APOLLO3®-based solutions have been verified against "reference" high-fidelity solutions obtained at KIT using a coupling scheme between the Serpent2 Monte Carlo neutron transport code and the sub-channel thermal-hydraulic code SUBCHANFLOW (SCF). This recently developed state-of-the-art high-fidelity coupling allows performing pin-by-pin transient analysis for both Cartesian and hexagonal configurations and therefore makes possible computing core safety parameters at the local level. Different numerical solutions obtained with such high-fidelity scheme will be presented and discussed, these being reletad to reactivity insertion scenarios occurring on ad-hoc defined PWR and VVER theoretical minicores. The selection of such small size core models for the numerical exercises is motivated not only to allow for both the stochastic solutions to be executed within a reasonable computational time, but also to open the discussion on the codes' capabilities to treat small size reactor cores typical of the Small Modular Reactor (SMR) concepts. The simulated transients are fast (super-prompt critical) control rod ejection accidents followed by the increase of the system reactivity and power with rapid increment of the fuel temperature. When analyzing the power evolutions during the transients, a good agreement between the APOLLO3®-based solutions and the Serpent2/SCF reference solutions has generally been observed. Power peaks timing were also found to be consistent. The results showed that in general the choice of the time bins for Serpent2 (time steps for SCF) has a significant impact in the simulations of fast transients such as the REA analyzed in this study due to the different rate (corresponding to different time bin discretization) in which fields are interchanged between the codes.

109_abstract