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SIMMER ANALYSES OF THE EBR-II SHUTDOWN HEAT REMOVAL TESTS

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The Karlsruhe Institute of Technology (KIT) and the Kyushu University (KU) have participated to the Coordinated Research Project (CRP) of the International Atomic Energy Agency (IAEA) on the Experimental Breeder Reactor II (EBR-II) Shutdown Heat Removal Test (SHRT). Two SHRT tests (SHRT-17 and SHRT-45R) representative, respectively, of Protected Loss of Flow (PLOF) and Unprotected Loss of Flow (ULOF) transients have been considered.
For the study, the SIMMER-III ver. 3E code has been employed. The SIMMER-III code is a 2D, multi-velocity-field, multiphase, multicomponent, Eulerian fluid-dynamics code tightly coupled with a space- and time-dependent neutron kinetics model and a fuel pin model, jointly developed by JAEA, KIT and CEA.
For SHRT-17, oriented mainly to investigate the effectiveness of natural circulation, only the fluid-dynamics modules of SIMMER were employed resulting in a reduced calculation time that has allowed testing several modeling options (e.g. radial and axial thermal conduction, effect of IHX position, gap conduction, fuel porosity, etc.).
For SHRT-45R, the standard SIMMER-III version already modified by KU for taking into account a set of specific Equations of State (EOS) and the Thermo-Physical Properties (TPP) for the EBR-II metal fuel has been further extended at KIT by introducing a new core thermal expansion reactivity feedback model and a new PARTISN-based spatial kinetics model.
In order to take into account the peculiarities of the core layout of the two tests (several types of sub-assemblies composing the core), two different 2D (RZ) SIMMER core models were established. In both cases, all the reactor components have been taken into account in the assessment of the models. Unavoidable approximations (necessary for 2D geometry) have been introduced for modeling the reactor outlet Z-pipe and the sodium inlet pipes.
The SIMMER results obtained for the two transients are in good agreement with the available experimental data. The study has allowed, through the simulation of the PLOF case, to get a better understanding of the modeling options and via the simulation of the ULOF case to a further validation of the SIMMER-III code neutronics extensions performed at KIT.
An overview of the main results obtained for the two tests is presented in the paper.

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