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Conclusions of a Benchmark Study on the EBR-II SHRT-45R Experiment

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This paper presents the conclusions of a 4 year benchmark study on the simulation of the EBR-II SHRT-45R experiment. The SHRT-45R experiment was an unprotected loss of flow transient where pump dynamics, natural convection, core and mechanical behavior played a large role in passively and safely limiting the power and temperature rise of the fuel assemblies. Participants from China, Germany, Japan, Korea, Netherlands, Russia and the U.S. presented transient reactor system modeling results for a variety of instrumented parameters, including core outlet temperatures, pump flow rates, and fission power. Detailed pin-level experimental data of the instrumented XX10 (non-fueled) and XX09 (fueled) subassemblies were also assessed. Code-to-code comparisons were made for other non-measured parameters, such as decay heat and peak cladding and fuel temperatures. A small subset of participants presented code predictions of the negative expansion feedbacks (coolant, axial, radial) and Doppler feedback inherent to the EBR-II core.
The final meeting held April 2016 in Vienna summarized key findings and sensitivity studies completed after the experimental data was released and the benchmark study converted from blind to open. The fidelity and methodology of core and system models varied greatly between participants. It was found that accurate simulation of the pump coastdown, system pressure drop, and coolant and radial expansion feedbacks strongly influenced the fission power and temperatures in the core during the transient. Relatively simple models for radial expansion were sufficient to capture the behavior during the transient, in part due to the simpler mechanical dynamics of EBR-II's core and the applicability of the point-kinetics model. Reactor core outlet (Z-pipe and IHX) temperatures were somewhat difficult to match due to the high fidelity required to capture the temperature at the specific thermocouple location. Faulty subassembly flow meter data from XX09 and XX10 prevented a more accurate study of the core flow redistribution occurring during the pump coastdown. Uncertainties and variations in heat transfer and subassembly pressure drop correlations, and fuel expansion assumptions were found to have little effect on the prediction of fission power and temperature. Overall, the benchmark of the SHRT-45R was a valuable exercise that facilitated the development of state-of-the-art models for sodium fast reactor system and neutronic reactivity feedbacks.

"Note: EBR-II Benchmarks Invited Session".

Country/Int. Organization

USA (TerraPower LLC) and China (Xin Jiang Technical University)

Authors: Ms ZHANG, Dalin (Xi'an Jiaotong University); Dr BATES, Ethan (TerraPower)

Co-authors: Dr TRUONG, Bao (TerraPower LLC); Dr VEZZONI, Barbara (Karlsruhe Institute of Technology (KIT)); Dr CHOI, Chiwoong (Korea Atomic Energy Research Institute (KAERI)); Ms SUI, Danting (North China Electric Power University (NCEPU)); Mr CARON, Dominic (politecnico di torino); Mr SU, Guanghui (Xi'an Jiaotong University (XJTU)); Prof. MOCHIZUKI, Hiroyasu (Research Institute of Nuclear Engineering, University of Fukui); Prof. MORITA, Koji (Kyushu University); Dr MIKITYUK, Konstantin (Paul Scherrer Institut (PSI)); Mr LUDOVIC, Maas (Institut de radioprotection et de sûreté nucléaire (IRSN)); Mr MARCHETTI, Marco (Karlsruhe

Institute of Technology (KIT); Mr STEMPNIEWICZ, Marek (Nuclear Research & Consultancy Group (NRG)); Dr RTISCHEV, Nikita (Nuclear Safety Institute of the Russia Academy of Sciences (IBRAE)); Mr ZANINO, Roberto (dipartimento energia, politecnico di torino); Dr SUMNER, Tyler (Argonne National Laboratory); Mr HU, Wenjun (China Institute of Atomic Energy (CIAE)); Dr VAN ROOIJEN, Willem Frederik Geert (Research Institute of Nuclear Engineering, University of Fukui); Dr ZHANG, Youpeng (Paul Scherrer Institute (PSI))

Presenters: Ms ZHANG, Dalin (Xi'an Jiaotong University); Dr BATES, Ethan (TerraPower)

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