Contribution ID: **70**

Type: **ORAL**

IAEA NEUTRONICS BENCHMARK FOR EBR-II SHRT-45R

Monday 26 June 2017 15:45 (20 minutes)

A Coordinated Research Project (CRP) initiated by the International Atomic Energy Agency (IAEA) aimed to benchmark Shutdown Heat Removal Tests (SHRT) conducted at Experimental Breeder Reactor II (EBR-II). Two SHRT tests (SHRT-17 and SHRT-45R) representative, respectively of Protected Loss of Flow (PLOF) and Unprotected Loss of Flow (ULOF) transients were considered. The SHRT-45R benchmark included both safety analyses and an optional neutronics benchmark for SHRT-45R. Only the activities carried out for the neutronics benchmark are described in this paper.
The objective of the neutronics benchmark was to provide reactivity feedback coefficients for the thermal hydraulic analysis of SHRT-45R. Several institutes participated in this benchmark, including: Karlsruhe Institute of Technology (KIT), University of Fukui, Paul Scherrer Institute (PSI), and Argonne National Laboratory. The parameters compared code-to-code were keff, βeff, reactivity feedback coefficients (axial, radial and control rod expansion, sodium density, and Doppler) and the power distribution in each subassembly, including fission and gamma heat. The fission and decay heat power for 15 minutes after a postulated scram at the beginning of SHRT-45R were also calculated.
Several stochastic and deterministic codes were used: MC2-3/TWODANT, DIF3D, VARI3D, and PERSENT by Argonne, SERPENT by PSI, and the ECCO/ERANOS codes by the University of Fukui and by KIT. KIT also used the PARTISN code.
Results obtained for keff and βeff were in good agreement (1.2% maximum difference) among the participants. The reactivity feedback coefficients initially showed a large spread that was reduced by establishing consistency among the definitions used by the participants. However, some spread remains, partially due to the different linear thermal expansion coefficients used in converting the change in reactivity (pcm) to change in reactivity per change in temperature (pcm/K), and will be discussed in the full paper. Differences due to core modeling options (detailed fuel pin modeling vs. homogenized subassembly modeling) and neutron cross-section preparation were also analyzed.
Differences among the calculated power distributions were large (up to 80%) in the non-fueled subassemblies, where photon heating dominates, while differences were less than 5% in the fueled subassemblies. No recorded data are available for the detailed power distribution.

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Session Classification: 6.11 IAEA Benchmark on EBR-II Shutdown Heat Removal Tests

Track Classification: Track 6. Test Reactors, Experiments and Modeling and Simulations