

# Effect of JENDL-5 nuclear data library on criticality and fission rate distributions of full MOX BWR core mockup experiments FUBILA

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Using the MVP3 Monte Carlo code with the JENDL-5 base neutron library, analysis of criticality and fission rate distributions was performed for the full MOX BWR mockup cores in the FUBILA program. The analysis results were compared with those with JENDL-4.0. As a result, the trend in  $k_{eff}$ s with the numbers of the 7.0 wt% Put MOX fuel rods in the driver region was improved while the updated thermal neutron scattering law (TSL) of water in JENDL-5 brought worse C/E-s in comparing the calculated core radial fission rate distributions with the measurements.

**Keywords:** EOLE, FUBILA, Full MOX BWR mockup core, MVP3, JENDL-5, JENDL-4.0, Neutron multiplication factor, Fission rate distribution, Thermal neutron scattering law.

**1. Introduction.** To extend the validation data of JENDL-5 [1], analysis of criticality and fission rate distributions was performed with MVP3 [2] for the nine full MOX BWR mockup cores in the FUBILA program [3,4] and the  $k_{eff}$ s and fission rate distributions were compared with those with JENDL-4.0 [5].

**2. Full MOX BWR mockup cores.** The references [3,4] reported the detailed specifications of the full MOX BWR mockup cores in the FUBILA program implemented in the EOLE critical facility. The test regions of the mockup cores were composed of four 9x9 full MOX assemblies in a hot operating condition with a 0% void simulation (9x9Ref), those with a 40% void (40v), those with a 70% void (70v), those with an axially distributing void (axial v), those partially loaded with UO<sub>2</sub> fuel rods (UO<sub>2</sub>), those loaded with Gd<sub>2</sub>O<sub>3</sub>-UO<sub>2</sub> fuel rods (Gd), those loaded with a B<sub>4</sub>C control blade (B<sub>4</sub>C), four 10x10 full MOX assemblies (10x10), and the 513-day-elapsed 9x9ref core (9x9Ref-te). The driver region was composed of the 7.0 wt% Put MOX rods with a <sup>241</sup>Am content of 6 wt% in Pu+Am.

**3. Analysis models and calculation conditions.** The calculations modeled the inside of the core tank wall. **Fig.1** illustrates a radial plane of the 9x9ref core. The  $k_{eff}$ s and fission rate distributions were calculated with 40-million and 100-million neutron histories, respectively.

**4. Analysis results and discussions.** The calculated  $k_{eff}$ s of the cores with JENDL-5 and JENDL-4.0 are illustrated in **Fig. 2**. The horizontal axis is the numbers of the 7.0 wt% Put MOX rods in the driver region. The effects of the updated cross-sections of main nuclides on the  $k_{eff}$ s of the 9x9ref core were analyzed by replacing the JENDL-5 cross-sections with the JENDL-4.0 cross-sections. They were 497 pcm for H in H<sub>2</sub>O, -208 pcm for <sup>16</sup>O, -25 pcm for <sup>235</sup>U, 12 pcm for <sup>238</sup>U, -158 pcm for <sup>238</sup>Pu, -173 pcm for <sup>239</sup>Pu, 14 pcm for <sup>240</sup>Pu, -42 pcm for <sup>241</sup>Pu, -50 pcm for <sup>242</sup>Pu, and -235 pcm for <sup>241</sup>Am. Their calculation errors were 17 pcm. As seen in Fig. 2, the trend in  $k_{eff}$ s with the numbers of the 7.0 wt% Put MOX fuel rods in the driver region was improved by the updated cross-section of <sup>241</sup>Am in JENDL-5. The C/E-1s of the fission rate distributions with JENDL-5 were compared with those with JENDL-4.0. **Fig. 3** shows the differences in the C/E-1s (%) with JENDL-5 and those with JENDL-4.0 for the left-bottom 9x9 assembly in the 9x9ref core.

The calculated fission rates with JENDL-5 were smaller for the MOX rods adjoining the water gaps and larger for those not adjoining the water gaps than those with JENDL-4.0, which brought worse C/E-s with JENDL-5. This trend was the same for the other cores. An additional calculation by replacing the cross-sections of H<sub>2</sub>O with those in JENDL-4.0 indicated that the main cause was the updated TSL of H<sub>2</sub>O in JENDL-5.

**References.** [1] Iwamoto O, Iwamoto N, Kunieda S, et al. Japanese evaluated nuclear data library version 5: JENDL-5. J Nucl Sci Technol. 2023;60:1-60. [2] Nagaya Y, Okumura K, Mori T, et al. MVP/GMVP II:

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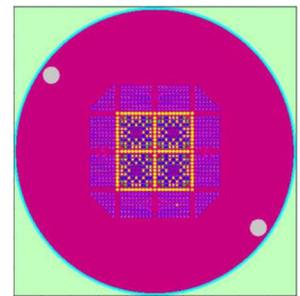


Fig. 1 Radial plane of 9x9ref core

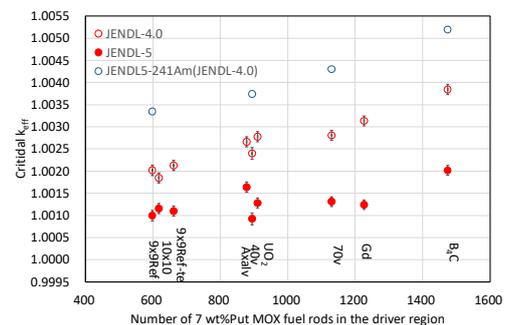


Fig. 2 Comparison of  $k_{eff}$ s with JENDL-5 and JENDL-4.0.

-0.986	0.078	-0.481	-0.887	-0.202	-0.375	0.048	-0.788	-1.684
-0.492	0.215	0.609	1.173	0.249	1.632	1.078	1.177	-0.971
-0.036	1.322	0.674	0.568	-0.201	-0.099	1.178	1.178	-0.208
-0.281	1.073	-0.640				-1.339	0.064	-0.153
-0.174	0.578	-0.549				-0.587	0.385	-0.188
0.315	0.978	-0.133				-0.387	1.631	0.182
-0.353	1.400	0.554	-0.187	0.079	0.106	0.421	0.755	0.220
-0.245	-0.573	0.781	0.473	-0.070	0.548	0.553	0.812	-0.434
-1.407	-0.333	-0.710	-0.345	-0.088	0.850	0.285	-0.616	-0.001

Fig. 3 Comparison of C/E-1s (%) of fission rate distributions for 9x9ref core (JENDL-5-JENDL-4.0).