EFFECT OF THE FISSION SPECTRA CHANGES ON PRESSURE-VESSEL FLUX DETERMINATION

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The paper discusses the impact of the differences in fission spectra from SAILOR and BUGLE-96 cross-section libraries on the reactor pressure-vessel (PV) flux determination. The fission spectra from the SAILOR library[1] (ENDF/B-IV) and BUGLE-96 library[2] (ENDF/B-VI) are compared in Fig. 1. The "SAILOR" ^{239}Pu spectrum was collapsed from the VITAMIN-C library[3] which was the basis for SAILOR. The high-energy parts of the spectra (above ~ 3 MeV) are much higher in SAILOR than in BUGLE-96. To assess the effect of these differences, a series of transport calculations of the H. B. Robinson-2 pressurized water reactor[4] were performed with the DORT code.[5] The "combined" fission spectrum was taken as $0.5 \times \chi$(U-235) + $0.5 \times \chi$(Pu-239). The calculations with SAILOR cross sections were done with the combined fission spectrum from SAILOR and from BUGLE-96. The spectra in the surveillance capsule and in the cavity from the two calculations are compared in Fig. 2: the differences in fission spectra are readily transported to the out-of-core locations.While group fluxes at 20 MeV differ by a factor of 2, the fast fluxes (E > 1MeV) from the two calculations agree within 3-4 % in the capsule, inside the PV, and in the cavity. Equivalent calculations with BUGLE-96 produced similar results. The calculated reaction rates are compared with the measurements[6] in Table 1. The calculations with the SAILOR fission spectra give higher average calculated-to-measured (C/M) ratios both in the capsule and in the cavity, and with both SAILOR and BUGLE-96 cross sections. However, the C/M ratios obtained with SAILOR fission spectra show systematic increases from lower to higher threshold dosimeters (left-to-right in Table 1) and larger variations of the C/M ratios. Both effects are more pronounced in the cavity. The higher C/M averages obtained with the SAILOR fission spectrum are mostly due to the higher C/M for Cu dosimeters. The C/M ratios for the calculations with the BUGLE-96 fission spectrum show no systematic trend. The standard deviation of the average C/M ratio for the calculations with the BUGLE-96 fission spectrum is less than half the value obtained with the SAILOR fission spectrum at both locations. While the number of available measurements in this work is not large enough to allow for a definite conclusion, the results clearly indicate that calculations with BUGLE-96 fission spectra provide better agreement with the actual spectrum during irradiation. The changes in fission spectra from the SAILOR to BUGLE-96 library are not significant for the fast fluxes obtained directly from the transport calculations, but are important for the comparison of the calculations with measurements, and consequently for the PV flux determined by any method that combines the calculations and measurements.

References

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3. R. W. Roussin et al., “VITAMIN-C: The CTR Processed Multigroup Cross-Section Library for Neutronics Studies,” ORNL/RSIC-37, RSICC Data Library Collection DLC-41/VITAMIN-C, Oak Ridge National Laboratory, 1980.

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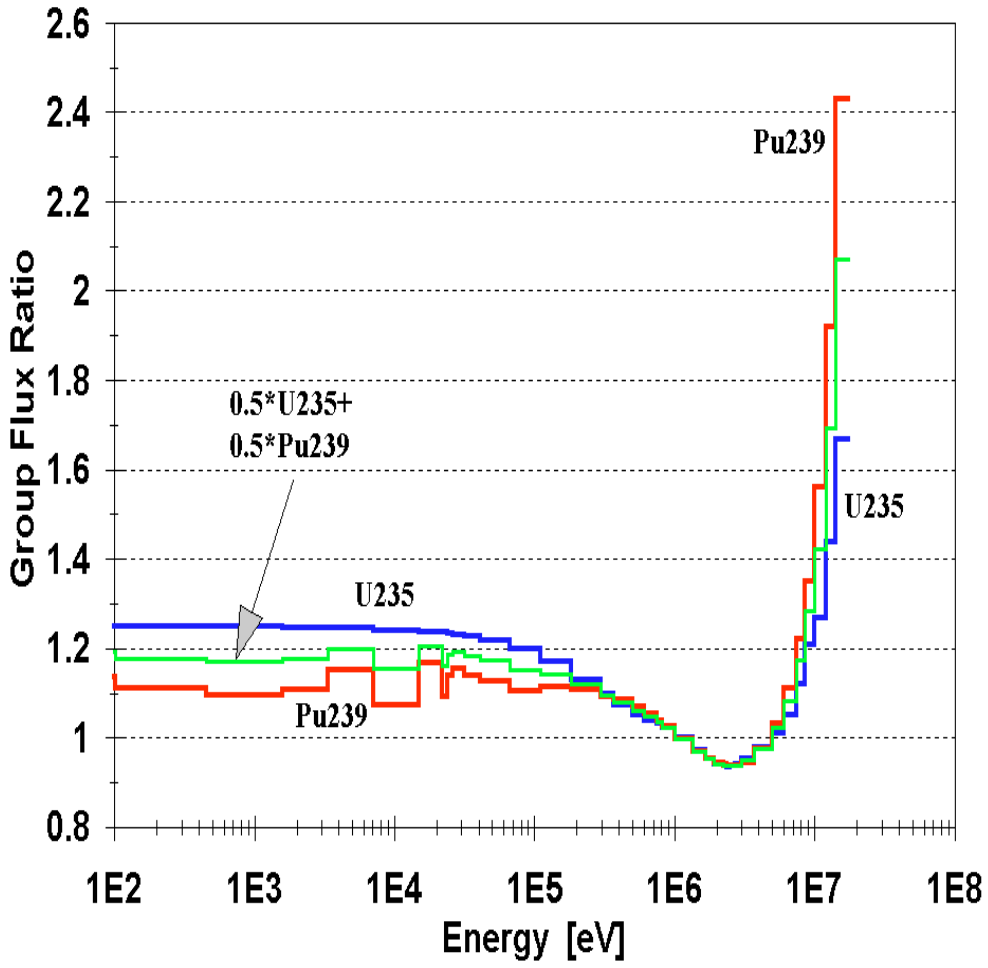

Figure 1 **The ratios of fission spectra (SAILOR/ BUGLE-96) for the ^{235}U, ^{239}Pu, and the average of the ^{235}U and ^{239}Pu spectra, from the BUGLE-96 and SAILOR libraries**.

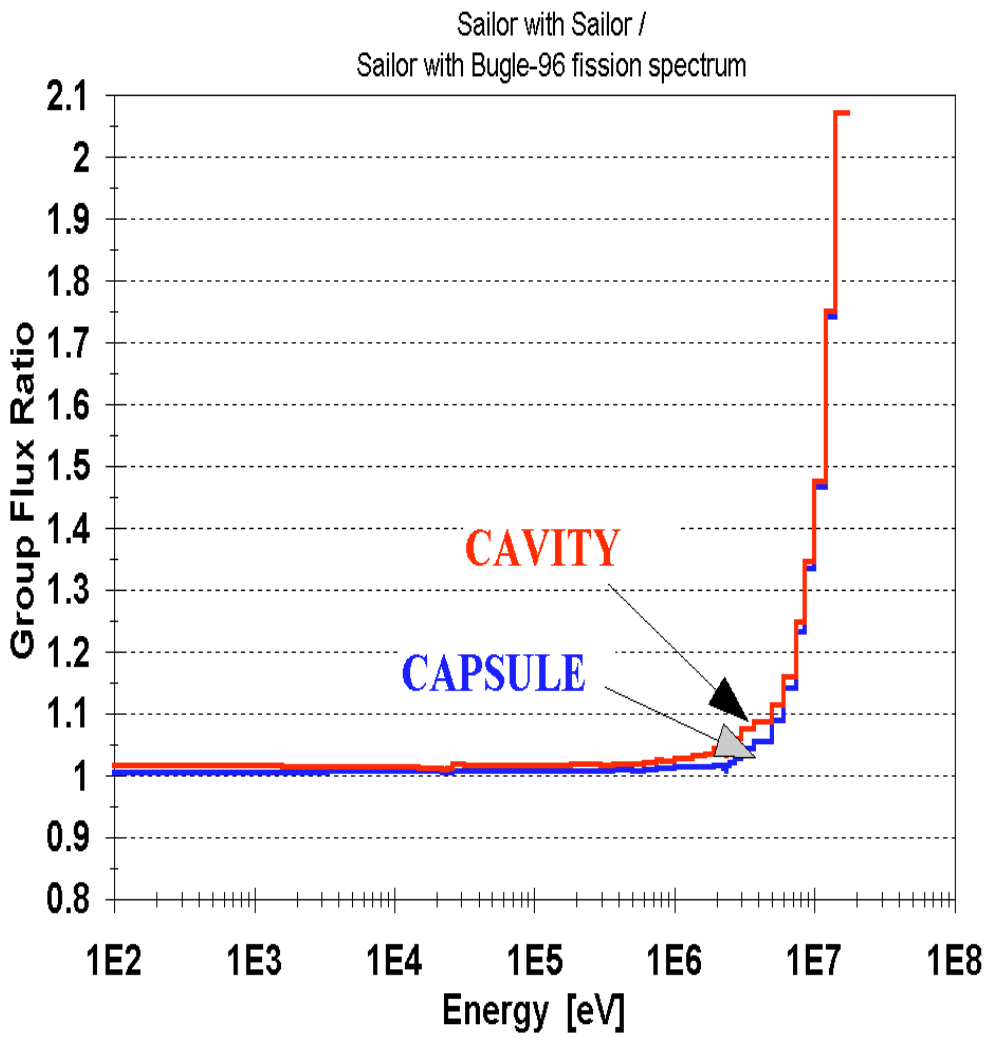

Figure 2 **The ratios of group fluxes, calculated with the SAILOR library and the "ENDF/B-IV" and "ENDF/B-VI" fission spectra, in the surveillance capsule and at the location of dosimeters in the cavity**.

Table 1 The ratios of the calculated and measured reaction rates for the calculations with BUGLE-96 and SAILOR libraries with different fission spectra.

	^{237}Np (*n*,*f*) ^{137}Cs	^{238}U (*n*,*f*) ^{137}Cs	^{58}Ni (*n*,*p*) ^{58}Co	^{54}Fe (*n*,*p*) ^{54}Mn	^{46}Ti (*n*,*p*) ^{46}Sc	^{63}Cu (*n*,*α*) ^{60}Co	Ave. C/M ± σ
Capsule							
BUGLE-96 and "ENDF/B-VI fission spectra"	0.92	0.89	0.96	0.93	0.85	0.93	0.91 ± 0.04
BUGLE-96 and "ENDF/B-IV fission spectra"	0.94	0.93	1.04	1.01	0.99	1.16	1.01 ± 0.08
SAILOR and "ENDF/B-VI fission spectra"	0.85	0.82	0.86	0.84	0.78	0.90	0.84 ± 0.04
SAILOR and "ENDF/B-IV fission spectra"	0.88	0.86	0.94	0.92	0.93	1.13	0.94 ± 0.10
Cavity							
BUGLE-96 and "ENDF/B-VI fission spectra"		0.82	0.97	0.96	0.90	0.96	0.92 ± 0.06
BUGLE-96 and "ENDF/B-IV fission spectra"		0.87	1.07	1.07	1.09	1.24	1.07 ± 0.13
SAILOR and "ENDF/B-VI fission spectra"		0.63	0.73	0.71	0.71	0.80	0.72 ± 0.06
SAILOR and "ENDF/B-IV fission spectra"		0.67	0.81	0.80	0.87	1.06	0.84 ± 0.14