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Crucial importance of correlation between cross sections and angular distributions in nuclear data of 28Si on estimation of uncertainty of neutron dose penetrating a thick concrete/厚いコンクリートを透過する中性子線量の不確かさの評価における **28Si** 核データの断面積と角度分布の相関の重要性

Accurate estimation of uncertainties, induced by those of nuclear data through error propagation, of quantities calculated by neutron transport calculation is crucially important for Verification and Validation (V&V) of design and safety analysis of nuclear systems. In this paper, uncertainty in neutron dose after penetrating a 3-m-thick concrete with ^{235}U thermal fission neutron source was estimated based on three different kinds of Total Monte Carlo methods under random sampling methodology. A thousand random nuclear data files were generated for ^{28}Si by T6 by perturbing underlying model parameters. In the first method, these files were used directly to yield processed library preserving all the correlations among different physical quantities. In the second method, a covariance file in the ENDF-6 format was generated and 1000 random files were produced based on the covariance file. In the third method, the random files populated by T6 were used but the angular distribution data were kept fixed to non-perturbed nominal ones. It was found that the second and third methods gave equivalent variance of the neutron dose after deep penetration of a concrete, and this uncertainty was larger than the uncertainty given by the first method. It shows that the positive correlation between total cross section and angular distribution of elastic scattering, which stems from Wick's inequality derived from the optical theorem affects uncertainty of the calculated neutron dose. The correlation of uncertainties of such different quantities is not represented properly in the ENDF-6 format, hence this correlation is normally ignored. It could be concluded that the uncertainty obtained by using the covariance files given in the ENDF-6 format may not give correct results for the uncertainty of deep neutron penetration calculation [1].

References
[1] N. Yamano, T. Inakura, C. Ishizuka, S. Chiba, Crucial importance of correlation between cross sections and angular distributions in nuclear data of ^{28}Si on estimation of uncertainty of neutron dose penetrating a thick concrete, J. Nucl. Sci. Technol., 59(5), 641-646 (2022).

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