

Application of nuclear data covariance matrices to representativity calculations for fast reactors

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Abstract:

In the framework of the Multipurpose HYbrid Research Reactor for High-tech Applications (MYRRHA), the Belgian Nuclear Research Centre has carried out several experimental programmes since 2011 at the VENUS-F zero power reactor [1]. Those experiments are meant for nuclear data and code validation, while also aiming at the representation of the neutronic phenomena happening in a fast spectrum facility. Throughout the years, the VENUS-F core has been loaded with a number of configurations (critical and subcritical) in a process of progressive adaptation to the evolving MYRRHA core designs.

MYRRHA is a 30%-enriched MOX fuelled reactor design, foreseen to be cooled by Pb-Bi eutectic (LBE). Thanks to the versatility of VENUS-F, a wide range of materials has been loaded in the VENUS-F core, mainly: Pb and Bi to simulate LBE and U fuel (metallic, 30% w.t. enrichment). In order to improve what was done so far in terms of similarity to MYRRHA, possible MOX core loadings at VENUS-F are now under investigation. This analysis started with a representativity study performed at the level of the 2D assembly, assessing a number of possible MOX assemblies to be loaded in the VENUS-F core and how they compare to an analogous model of MYRRHA. The representativity r of one model to another is computed as the model correlation coming from the nuclear data, which is a measure of how coherently the two designs react to the same change in the nuclear data themselves. This measure was used for model comparison of thermal reactors in the past [2]. Despite the effect of the nuclear data evaluation being limited on the sensitivity profiles, the impact of different covariance evaluations on r is strong. This work aims at the investigation of the impact of the nuclear data library choice on r as well as at a definition of which steps should be taken to allow for complete representativity analyses.

[1] J. Wagemans, «Integral experiments in the VENUS-F reactor», Annals of Nuclear Energy, 2021

[2] S. Cathalau, «An application of sensitivity and representativity approach for the design of a 100%MOX BWR experimental program in ZPR», Annals of Nuclear Energy, 2021