In-pile Kinetic Measurement and MCNP5 Calculation of Delayed Neutron Fraction in Training Reactor VR-1

Svetozár Micháleki - Stanislav Števo2 – Ján Hašcíki – Gabriel Farkasi

Dept. of Nuclear Physics and Technology
Institute of Control and Industrial Informatics
Faculty of Electrical Engineering and Information Technology, Slovak
University of Technology Bratislava, Ilkovicova 3, 81219 Bratislava,
Slovakia

Abstract The aim of this work is to provide a theoretical background for the first measurement of delayed neutron fraction (*_eff*) of VR-1 training reactor using in-pile kinetic technique. *_eff* is determined from the transfer function obtained from simulations of reactor response to periodical reactivity insertion, using genetic algorithms for fitting the reactor response function. The final value of *_eff* was determined to be 0.006664. MCNP5 calculations of *_eff* for the model of VR-1 reactor using several libraries are also presented here. All these *_eff* values have to be verified by measurements yet to be performed, to assess the theoretically estimated and currently used *_eff* value of 0.00714, currently used by VR-1 reactor operators.

Keywords: **delayed neutron fraction** (*_eff*), **reactor transfer function**, **frequency response**, **genetic algorithms**

| | Table 1 The influence of noraries selection in MCNP chucanty calculations for p _{eff} determination | | | | | | | | | | | | |
|---------------|--|---|---------|-----------|---|---------|-------------------------|---|---------|--------|------|------|--|
| | JENDL3.3 | | | ENDF/B.VI | | | ENDF/B.VII [*] | | | npc | gen | sgen | |
| kp | 1.00003 | ± | 0.00005 | 0.99792 | ± | 0.00005 | 0.99276 | ± | 0.00007 | | | | |
| k t | 1.00791 | ± | 0.00005 | 1.00636 | ± | 0.00005 | 1.00039 | ± | 0.00007 | 150000 | 2000 | 100 | |
| β_{eff} | 0.007818 | ± | 0.00010 | 0.008387 | ± | 0.00010 | 0.007627 | ± | 0.00014 | | | | |

Table 1 The influence of libraries selection in MCNP criticality calculations for β_{eff} determination

npc – number of neutrons per cycle, gen – number of generations, sgen – number of skipped generations * Calculation using ENDF/B.VII library was done for parameters: npc=100000, gen=1500, sgen=100

CONCLUSION

Genetic algorithms seem to be a suitable tool for delayed neutron fraction determination using in-pile kinetic method based on periodical reactivity insertion to a critical reactor of zero-power. Simulations of such experiment by numerical computing program Bokin2000 with subsequent analysis in MATLAB provided a final delayed neutron fraction = 0.006664 *eff* β . The precision of this value depends not only on the fitting technique, but also, in the case of simulations on the selection of the delayed neutron group parameters and it usually represents an idealized state. The MCNP5 calculations confirmed the fact that the ENDF/B.VII library is more precise in *_eff* calculations than the older B.VI version. The JENDL3.3 *_eff* value for the VR-1 training reactor was calculated to be 0.007818±0.00010, which considerably exceeds the value 0.006664 simmulated by Bokin2000 program. Therefore, a series of *_eff* in-pile kinetic measurements is planned to verify these *_eff* values and to assess, weather the estimation of the currently used *_eff* value of 0.00714 was true.