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BN600 REACTIVITY DEFINITION

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Since 1980, the fast BN600 reactor with sodium coolant has been operated at Beloyarsk Nuclear Power Plant. The periodic monitoring of the reactivity modifications should be implemented in compliance with the standards and regulations applied in nuclear power engineering. The reactivity measurements are carried out in order to confirm the basic neutronic features of a BN600 reactor. The reactivity measurements are aimed to justify that nuclear safety is provided in course of the in-reactor installation of the experimental core components.

The intrinsic feature of the BN600 reactor neutron kinetics is the very noticeable impact of the spacing effects expressed in terms of the real neutron flux time behavior, a difference from how it is described by the kinetics point-wise model. The spacing effects coming from the in-reactor neutron field modifications during control rod movement results in changing of the efficiency of neutron records by sensors as reactivity changes. The immediate measurements on BN600 have revealed that the application of the traditionally accepted methodology of kinetic equation inverted solution kinetics point-wise model may cause rather serious systematic errors. In case of reactivities inputs within the range of ten fractions β_{eff} the difference in outputs may reach $\sim 10\%$ with further increase as reactivity grows.

If the sensor efficiency is expressed by the justified analytic function with one or two unknowns, there can be simultaneously defined the reactivity, the parameters of sensor efficiency modifications and the effective outer sensor, basing on the requirement of the constancy of reactivity to be measured after the rod movement and the method of least squares.

This method of defining the efficiency of the control rod operating components provides for the error decrease down to 2-3%. However, the unfeasibility of on-line reactivity meter application can be considered as one of the essential shortcomings of the method. Thus two reactivity meters are to be used on BN600 operation:

1. Digital on-line reactivity calculated under stationary reactor operation on power (approximation of the point-wise kinetics is applied).

2. Second reactivity meter used to define the reactor control rod operating components efficiency under reactor startup and take account of the changing efficiency of the sensor, however, this is more time-consuming than the on-line reactivity meter.

The application of two reactivity meters allows for the monitoring of the reactor reactivity under every operating mode.