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Mechanical and Temperature Calculations of the Reactivity Modulator Construction of the Research Pulsed Reactor NEPTUN

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The NEPTUN reactor is a pulsed periodic research reactor under development with a sodium coolant and a core based on neptunium nitride fuel. The reactor is designed for experiments using extracted beams. Average thermal power is 10-15 MW, pulse half-width is 200 μs, pulse frequency is 10 Hz, time-average thermal neutron flux density is ˜1014 cm−2 · s−1. The reactor vessel and its core are divided into two parts. A reactivity modulator (RM) is located in the space between parts of the core.
The power pulse (therefore the stability and safety of the reactor) is sensitive to such parameters as the reactivity and the rate of reactivity change. The above parameters depend on the stability of the reactivity modulator. RM is a non-standard design, not used on serial types of reactors. Therefore, there is a need for research of the reactivity modulator construction.
The report presents the results of numerical calculations of a reactivity modulator construction:
• Natural frequencies and oscillation shapes of the reactivity modulator disk. Obtained during modal analysis in the Modal Analysis of the ANSYS software;
• Distribution of stresses, strains and displacements in the RM construction during its rotation. Also, the safety factor of the RM during its rotation is estimated. The results were obtained during mechanical calculations in the Explicit Dynamics module of the ANSYS software;
• Temperature distribution in the RM "window" area at nominal capacity mode of the reactor with forced helium cooling. The results were obtained during thermal calculations in the CFX module of the ANSYS software.

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