Proposal for opening a subproject **"A new promising neutron source at JINR"** with a subproject **"Conducting research and development work to substantiate the development of a draft design of a new perspective neutron source at JINR - the pulsating fast reactor NEPTUNE"** within framework of the large infrastructure project **"Pulsed neutron source and spectrometers"**

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In accordance with the work plans within the subprojects in 2024-2028, the following research and development projects are being prepared research of pulsating reactor dynamics, development of nitride-neptunium fuel and fuel rods based on it, optimization of the design of the reactivity modulator and reactor vessel in terms of reducing thermal loads and shape change, development and implementation of a list of R&D in support of the development of a preliminary design, including the main systems of the reactor plant, development of a scientific program and a complex of spectrometers with a complex of cryogenic retarders based on it.

Work continues on the construction of a model of the dynamics of power pulses and vibrational stability of the pulsed fast reactor NEPTUNE. To implement the model and carry out reliable calculations of reactor dynamics, it is necessary to carry out theoretical (computational) and experimental work that solves two problems:

1. Obtaining fuel element and medium parameters that are used in the model.

2. Verification (verification) of the operation of individual blocks of the model, as well as the entire model as a whole. Amendments and modification of the model.

In order to solve the above tasks, a preliminary program of work was developed to create and verify a mathematical model of the dynamics of a pulsating reactor. One of the main blocks of the research program is the preparation for performing precision calculations of non-stationary bending of fuel rods under conditions characteristic of the NEPTUNE reactor, in order to verify the developed dynamics model together with RFNC-VNIITF (Rosatom State Corporation). The possibility of conducting research on experimental reactors available at RFNC-VNIITF is being studied in order to verify calculations to substantiate the neutron-physical and dynamic characteristics of the NEPTUNE reactor. Currently, the contract for the implementation of this research work is "The study of thermomechanical processes in fuel rods of the pulsating reactor NEPTUNE. Stage 1" is being approved.

The technical specification for JSC NIKIET has been developed and is undergoing the approval stage (Rosatom State Corporation) to carry out work on optimizing the design of the reactivity modulator and the NEPTUNE reactor vessel in terms of reducing thermal loads and shape change, to perform the necessary thermohydraulic studies, strength estimates, calculated estimates of radiation characteristics, as well as to develop a list of experimental testing of adopted technical solutions. One of the main tasks of these R&D is the development of two variants (with a casing and without a casing) of the design of a reactivity modulator that is operable under all specified operating conditions and making a decision on the use of one of the options, as well as the development of a design variant of the reactor vessel with the lowest thermal load, including two versions of the reactivity modulator.

The technical specification for the implementation of research and development work "Production of titanium hydride plates for use in the structural elements of the reactivity modulator of the NEPTUNE periodic pulse reactor" has been developed and agreed. The contract for conducting this research and production of an experimental batch of plates is being negotiated with Grankom LLC (PJSC Ruspolimet).

The agreement between JINR and JSC "VNIINM" is currently being negotiated (Rostatom State Corporation) to conduct the first stage of joint research, development and development work on the development of fuel manufacturing technology for experimental fuel rods of the NEPTUNE reactor and conduct pre-reactor studies of fuel compositions. Carrying out this R&D involves the implementation of the following stages: determining the technological ranges of the operation of pressing fuel tablets using simulators; technological testing of the initial neptunium powders; testing the technology of manufacturing fuel from NpN and (U, Np) N, a set of statistical data in determining the characteristics of fuel; development of recommendations for adjusting the characteristics of powders of raw materials and initial technical requirements to fuel according to the results of technological testing and testing of technology; production of experimental samples of fuel compositions and conducting pre-reactor studies of fuel from NpN and (U, Np) N.

The scientific program planned to be implemented on a new neutron source is being discussed, the composition of scientific instruments with sample environment systems and the configuration of the moderator complex is being discussed. Work is underway on the selection of materials and optimization of the configuration of the cryogenic moderator complex of the NEPTUNE reactor. A full-scale test bench of a cryogenic moderator based on mesitylene with a system for fast loading and unloading of working material is being developed.