REVIEW

of the scientific and technical reasoning for the renewal of theme "Development of the IBR-2 facility with a complex of cryogenic moderators" for 2024-2028

The experience of operating the IBR-2 nuclear facility has shown that the IBR-2 is an efficient source of neutrons for research in various fields of physics, chemistry, biology, materials science and other sciences.

The main application of the IBR-2 nuclear facility is mainly focused on fundamental research of condensed matter. In addition, the unique possibilities of the nuclear facility are also used for applied nuclear physics research. In recent years, at the IBR-2 facility, the number of studies related to the investigation of the structure and properties of constructions and construction materials for nuclear physics facilities, biologically active compounds, as well as the amount of research work connected with obtaining nuclear data and data on heavy elements in the environment, which are of great importance for the development of atomic science and technology, have been constantly increasing.

The main objectives of the theme are to increase the efficiency of using the IBR-2 nuclear research facility in the implementation of the experimental research program, to ensure operational reliability and safety of the reactor.

Development and construction of a complex of cryogenic moderators at the IBR-2 facility

Within the framework of the theme, the project "Development of a complex of cryogenic moderators at the IBR-2 facility" is being implemented. It is planned to use three cryogenic moderators of the complex. At present, since 2013, the CM-202 cryogenic neutron moderator has been in operation for physics experiments on neutron beamlines No. 7,8,10,11. The CM-202 is in fact a bispectral source, i.e. it includes both cold and thermal moderators. The CM-202 proved the reliability and efficiency of the used technology proposed at FLNP JINR. The CM-201 cryogenic moderator in the direction of beamlines No. 1, 4, 5, 6, 9 was installed in its regular place in 2021 and is currently in trial operation. The CM-203 cryogenic moderator is at the stage of approval of the technical specification for the development of design documentation with due account for the program of neutron physics research for these beamlines.

The implementation of the project will improve the efficiency of ongoing experiments on the study of long-period and low-dimensional structures and complex novel materials due to a significant increase in the flux of slow neutrons, maintain and strengthen the leading position of the IBR-2 among the world's best operating neutron sources (such as ISIS, SNS, JSNS) for research in the field of condensed matter physics for the next 20-30 years.

The CM-202 and CM-201 moderators are cooled by a Linde AG cryogenic refrigerator with a cooling power of 1200 W at 10 K (KGU 1200/10). In order to ensure the most efficient use of research instruments in working with cold neutrons, in 2023, it is planned to put into operation the second Linde AG cryogenic refrigerator with a cooling power of 1800 W at 10 K (KGU 1800/10). By the end of 2023, it is planned to complete work on optimizing the operation of the cryogenic complex. The technical feasibility of the program for the development of a complex of cryogenic moderators in 2024-2025 is beyond any doubt, since its successful implementation is ensured by the availability of highly-skilled experienced personnel and state-of-the-art technologies and equipment.

Manufacturing of a backup movable reflector MR-3R

At present (as of 01.06.2023), the existing movable reflector MR-3 is at 50% of its estimated service life. The MR-3 operation is reliable; continuous monitoring and diagnostics of its state are provided. However, the movable reflector is potentially the most hazardous unit of the IBR-2 reactor. Therefore, even a slight deviation of MR-3 operating parameters from the operational limits will entail a shutdown of the reactor and the termination of the scientific research program until the replacement of the movable reflector with a new one. In order to reduce the idle time of the reactor

and ensure the possibility of resuming the operation of the IBR-2 nuclear facility for physics experiments, the MR-3R backup movable reflector has been manufactured in the shortest possible time. In 2024-2025, during the period of duration of theme 1105, a large complex of activities is planned on check assembling, adjustment and testing of MR-3R at the FLNP test stand.

Research activities under contracts to ensure safe operation of the reactor. Monitoring, diagnostics and prognostics of the reactor state

The nuclear-physical and operational characteristics of IBR-2 vary significantly in the process of its operation. To maintain a high level of nuclear, radiation and technical safety of the facility, and ensure control over the state of the reactor, regular monitoring of the operating parameters of the movable reflector, basic technological equipment, vessel and other reactor equipment is conducted. The information-measuring system for research and diagnostics of the IBR-2 reactor state requires constant improvement and development using the most advanced hardware, computational and analytical methods of diagnostics and prognostics. In this regard, it is important to note the continuation of work on the development of the hardware and software structure of the information-measuring system for studying and diagnosing the state of the IBR-2M reactor, as well as on the computational and experimental substantiation of the safe and reliable operation of the IBR-2 under conditions of increasing radiation load and intensification of degradation processes in the core. On the basis of the performed analysis, appropriate measures are planned to compensate for undesirable changes in the reactor parameters.

Upgrading of safety-related equipment

In the process of operation of the reactor, appropriate activities are regularly planned and conducted to maintain the design performance efficiency of the equipment of the IBR-2 safety systems. An effective way to improve or ensure high-level performance of the equipment is its gradual replacement and upgrading of the basic safety-related technological and electrical equipment of the IBR-2 nuclear facility.

In order to extend the service life of the reactor for physics experiments until 2040, in cooperation with the Mayak Production Association, the possibility of manufacturing and supplying an additional batch of fresh fuel for the IBR-2M core should be explored and worked out.

The fulfillment of the above tasks within the framework of the theme, including obtaining a license from Rostekhnadzor for the operation of a research nuclear facility, will allow maintaining the leading position of IBR-2 among the best neutron sources in the world.

- I propose the CMP-PAC to approve the support of the present project proposal for 2024–2028.

Sangaa Deleg
Professor,

D.Sc. in Physics and Mathematics