

Abstracts

**Journal “Problems of Nuclear Science and Engineering. Series: Physics of Nuclear Reactors”,
issue No. 4, 2025**

UDC 621.039.518.4, 621.039.573; 621.384.6

Nuclear and accelerator-driven facilities of RFNC-VNIIEF: status and prospects

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This paper reviews the activities performed by RFNC-VNIIEF to reconstruct its existing nuclear and accelerator-driven facilities and to develop new such facilities intended to serve as powerful ionizing radiation sources.

Key words: criticality machine, nuclear pulse reactor, charged-particle accelerator, ionizing radiation.

EDN: BGWHGN

UDC 621.039.518.4; 621.039.573

Nuclear Research Facilities of URAL Nuclear Center: status and prospects

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This paper: describes compact nuclear research facilities (NRFs) that RFNC-VNIITF currently uses to solve radiation resistance problems and to conduct precision nuclear physics experiments; briefly covers the 70-year history of creation and development of these facilities; describes the physical principles of operation and provides the basic parameters of radiation fields for pulsed reactors; provides brief information on the procedures and accuracy indicators involved with integral critical experiments on FKBN critical facilities; compares the capabilities of RFNC-VNIITF facilities with those of other research centers; describes some unique experiments including those related to nuclear-pumped lasers, charge symmetry of nuclear forces, etc.; and provides an idea of further development and use of such facilities to address long-term tasks such as the development of ejected beam research reactors and nuclear fuel cycles, as well as the use of robotics, digital twins and artificial intelligence technologies at NRFs.

Key words: nuclear research facilities, nuclear physics experiments, radiation, pulsed reactors, critical facilities.

EDN: YLIKDG

UDC 621.039.5

VIR-2M NRI modernization: basic results

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This paper presents the basic results of VIR-2M nuclear research facility (NRF) modernization intended to significantly increase the irradiation capacities thereof as follows: energy yield per pulse – from 60 to 120 MJ, highest operating power in continuous static mode – from 12 to 20 kW, largest diameter of irradiation channel – from 30 to 40 cm, and n, γ -levels in irradiation channels – about twice.

NRF modernization includes: core vessel replacement with a larger one; installation of a catalytic recombination system and an automated fuel draining/filling system; replacement of reactivity control elements and drives thereof; and modernization of the control and protection system, gas loop and biological shield.

Key words: core, research nuclear reactor, core vessel, modernization, irradiation capacities, energy yield.

EDN: DLOOBE

UDC 621.039.5

Core vessel development and manufacture for the modernized VIR-2M

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This paper presents the basic results of core vessel development and manufacture performed in the framework of VIR-2M pulsed nuclear reactor (PNR) modernization. The main features of the new vessel are a through irradiation channel and special grids that serve to reduce dynamic loads on the vessel and fix the rod channels, when the reactor operates in the pulse mode.

The development stage involved a cycle of neutronic, hydrodynamic, thermomechanical and strength calculations to optimize new vessel parameters for the modernized PNR to run in both pulsed and static modes. The manufacture stage involved weld sample testes, weld quality analysis, and internal-overpressure hydrostatic tests accompanied by strain gauge measurements of deformations in the most stressed vessel elements.

Key words: core, pulsed nuclear reactor, core vessel, modernization, irradiation capacities, energy yield.

EDN: GCWVYD

UDC 621.039.55

Experimental determination of modernized VIR-2M core vessel strains during hydraulic tests

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This paper presents the basic results of strain gauge measurements of relative strains in the modernized VIR-2M core vessel yielded by hydraulic tests thereof at the manufacturing plant.

Key words: nuclear research reactor, hydraulic tests, numerical simulation, relative strain, strain gauge measurement, resistance strain gauge.

EDN: QJVNWW

UDC 621.038.05

Developing IKAR-M static nuclear research facility based on IKAR-S critical facility: basic results

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This paper presents performance parameters and technical configuration of IKAR-M, and shows its capability to provide irradiation parameters (neutron fluence and exposure dose) that are 7.5 times higher than those achievable by IKAR-S.

IKAR-M design reactivity margin is $\sim 6.8 \beta_{\text{eff}}$. As part of IKAR-S technical improvement, a composite converter was developed, manufactured and deployed. For use of this composite converter, an object loader was also produced based on the facility's trolley.

Experimental studies of radiation fields in the IKAR-S empty irradiation module were carried out, showing the highest nonuniformity across the irradiation cavity volume to be below 40 %.

Automatic power controller performance algorithms were also improved and verified.

Key words: nuclear research reactor, facility for critical assemblies, core, converter, radiation fields, automatic power controller.

EDN: BLYBSU

UDC 621.039.5

Computer model of basic physical processes occurring in operating BR-K1M pulsed nuclear reactor

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Pulsed nuclear reactors (PNRs) serve as powerful neutron and gamma sources in various fields of science and technology. Preparing to start up a PNR in variable core environment configuration (individual experimental conditions) requires reliable prediction of reactor behavior.

This paper presents the integral computer model developed for the BR-K1M PNR to describe the basic physical processes occurring therein. This integral model includes:

- a model describing reactor operation as both a multiplying system and an ionizing radiation source;
- a self-consistent model describing fission pulse formation with account of the “fuel element temperature – fuel element stress-strain state – reactivity” negative feedback.

Key words: core, pulsed nuclear reactor, reactor kinetics, reactor dynamics, fuel rings, thermal mechanics, thermal shock, stress-strain state, computer model, ionizing radiation source, fission pulse.

EDN: PPYMZH

UDC 621.039.55

BIGR reactor: history of operation and prospects for future use

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Dedicated to the BGR reactor launched at VNIIEF in 1977, this paper: describes BGR development goals; highlights the main directions of research carried out at BGR; briefly describes its neutronic parameters including characteristic fission pulse forms; describes possible positioning of the objects to be irradiated; lists the devices applied to improve radiation parameters; provides common reactor performance data at the time of writing; and considers BGR operation prospects.

Key words: nuclear research reactor, radiation resistance, ceramic core, reactivity control elements, experimental devices, characteristic pulse forms, operation statistics, operation prospects, BGR modernization, BGR core integrity.

EDN: GBGXTS

UDC 621.039

Heading toward the first critical mass experiment on FKBN-type facility

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This paper provides a historical overview of critical mass research development in KB-11 including the description of critical mass measuring methods, measuring instruments, experimental setup, and types of neutron sources used at the initial stage.

Key words: critical mass, all-wave detector, multiplication factor, fissile material, nuclear chain reaction, physical fast neutron pile.

EDN: FSPWXH

UDC 621.039.51

IBR-2 reactor dynamics model based on two-component power feedback

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Studies of IBR-2 reactor dynamics indicate two main effects of reactivity feedbacks: elongation of fuel pellet columns and transverse bending of fuel assemblies. This paper describes the IBR-2 reactor dynamics model that accounts for these effects. It assumes the dynamics to become unstable following a single effect's amplitude variation depending on fuel burnup. The reactor dynamics is shown to become unstable at a certain burnup value.

Key words: nuclear reactors, core, reactivity, neutrons, feedback, instability, calculation model, dynamic system.

EDN: QSBGFT