

Abstracts

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The concept of closed thorium-uranium-plutonium fuel cycle in nuclear-power industry

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The use of ^{232}Th as a raw isotope instead of ^{238}U and the main fissile isotope ^{233}U instead of ^{239}Pu , as well as the use of heavy water instead of light water as a coolant and its dilution with light water in the VVER-type reactor campaign make it possible the fuel self-enrichment with active isotopes, including the time upon the achieved balance in the isotope ratio of actinides) and provide conditions for closing the thorium-uranium-plutonium fuel cycle. This allows increasing the fuel life time by ~ 2 orders of magnitude, making easier the management of radioactive wastes, decreasing the nuclear risk of the VVER-type reactor; and providing a technological barrier to prevent the distribution of fissile materials and nuclear technologies.

Key words: VVER-type reactors, ^{232}Th and ^{233}U isotopes of the second generation, heavy-water coolant and its dilution with light water, fuel self-enrichment with active isotopes, closed thorium-uranium-plutonium fuel cycle, utilization of highly enriched uranium; transmutation of actinides by fission reaction.

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Creation of Irradiating Installation with the Certified Neutron Field on the Base of the Critical Stand IKAR-S

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In 2017 the park of modeling installations IARF was filled up by the new static nuclear installation - critical stand (CS) IKAR-S. The stand is intended for neutron and gamma radiation resistance testing of large-sized objects. For their placing on IKAR-S the irradiation module with record for Russia research nuclear reactors dimensions $200 \times 50 \times 50$ cm is used. Modeling reference neutron fields complex (MRF-K3) has been certificated at SC IKAR-S together with FGUP «VNIIFTRI».

Key words: critical stand, section of active zone, critical parameters, reactivity, temperature reactivity coefficient.

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Multiplication Factor for Subcritical Multiplying System and the Efficiency of Source Neutrons

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On the basis of equation of neutron transport, analysis was performed of a ratio between multiplication factor of neutrons of multiplying system measured in critical experiments and its reactivity. A simple ratio was obtained for calculation and experimental determination for the efficiency of source neutrons. In order to

verify obtained ratios, numerical calculations were performed for spherical-symmetrical systems, which contain highly enriched uranium, plutonium, iron, beryllium and polyethylene.

Key words: multiplication factor, critical experiments, efficiency of source neutrons.

UDC 621.039.564.2+681.5.08

Specialized Systems Aimed at Controlling Parameters of Research Nuclear Facilities Ionizing Radiation

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Design approaches, structure concepts and functional features for the specialized systems developed in RFNC-VNIIEF are presented in the article. There are multipurpose systems to register wide range of ionizing radiation parameters and special-purpose systems to register particular characteristics or systems referred to the specific experiment configuration.

Key words: research nuclear facilities, neutron-physical parameters of ionizing radiation, gamma radiation, measuring channel, control software.

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Results of the Unit Physical Launch of a Research Nuclear Installation «IGRIK-2» in Stationary Mode

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The systems of the research nuclear installation are described. The results of the unit physical launch of the reactor in steady state mode is given.

Key words: the research nuclear installation, the unit physical launch, delayed critical state.

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Application of the Pulsed-Neutron Method for Measuring the Reactivity of the Fissile Systems with Reflector

M. A. Voinov, V. V. Voronin, V. V. Kulik, O. A. Golubeva

There were performed the experiments in registration – within the range from 0 to 40 μs – of a signal of GIR-2 reactor core radiation fall under the effects of external intense neutron pulse $\sim 1 \mu\text{s}$ long. The reactivity internal from sub-critical (-7.5β) to critical ($+0.28 \beta$) reactor states was studied. It was revealed that the signal of the applied detector with plastic scintillator depended on reactivity and was proportional to density variation of thermalized neutrons in the reactor converted. As a result it was demonstrated that the solution of the task of GIR-2 reactor reactivity determination basing on the measurement scintillation detector signal fall and the well-known expression $\alpha_{\infty} = \frac{\beta}{\Lambda}(\rho - 1)$ for reactivity values calculation is possible only for the states with reactivity no lower than $\sim -3 \beta$.

Key words: fissile systems with reflector, reactivity, scintillation detector.

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Results of Research of Reactor «YAGUAR» Characteristics after Modernization

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The paper presents the results of experimental studies of the characteristics of a nuclear homogeneous aperiodic uranium reactor obtained after modernization.

Key words: reactor «YAGUAR», the reactor core, the unit physical launch.

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Determination of an Efficient Independent Neutron Source Intensity in the Core of Reactor «YAGUAR»

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In the course of carrying out the works there was produced and tested a new pulse channel of neutron flux monitoring. There were performed measurements with the use of this channel and found the intensity of the internal neutron source in the reactor core.

Key words: pulse channel of neutron flux monitoring, reactor «YAGUAR», internal neutron source, the reactor core.

UDC 539.1.07

Verification of Design Model of Semiconductor Detector Involved in Radiometric Facility

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There is presented a brief description of the detector design model and its structural components. Three versions of measurement geometry «source-detector» are considered. There are given on the base of the model the results of calculation and detector sensitivity measurements for different versions of geometry and their comparison is made. The design model was verified using a collimated beam of gamma quanta. The «goodness of fit» values for calculated and experimental data are given, and the sampled values of corrections for the applied standard models as to the difference between calibration geometry «OSGI – detector» and typical measurement geometry «disc – detector» are cited.

Key words: semiconductor detector, design model, design model verification, measurement geometry «source – detector», detector sensitivity, point source, corrections for applied standard models.

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Precise Integral Experiments with Assembly out of Plutonium and Depleted Uranium and Numerical Modeling of Experiments

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The work presents the comparison of results for critical and correlation experiments with assembly out of metallic plutonium in all-round reflector out of depleted uranium with the results of their numerical modeling by Monte-Carlo method according to codes PRIZMA-D and PRIZMA using the libraries of neutron constants ENDF-B6.8 and ENDF-B7.1.

Key words: critical and correlation experiments, critical gap of assembly, asymptotical constant of decay, lifetime of prompt neutrons, library of neutron constants.

UDC 621.397.4

Integrated with CPS Video System Aimed at Controlling Human Absence in the Hall of Research Nuclear Installation

V. V. Peshkov, I. V. Zhukov, A. A. Devyatkin, M. V. Mochkaev

There is considered the approach to creation of a video system providing independent on human factor monitoring of reactor hall environment. At revealing danger factor the system forms an alarm signal guided to the system of reactor protection and control. The signal provides operator attention focusing and blocking of the possibility of reactor reactivity growth.

Key words: computerized testing, core, alarm condition, algorithm comparison, supporting stage, camera coverage.

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Comparative Possibilities of Multi-Core Reactors «BARS-5», «TIRAN» with One-Core Reactor Type «BARS»

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Below are presented new performance capabilities of multi-core reactors «BARS-5», «TIRAN» as compared to one-core aperiodic pulsed reactors of «BARS» type.

Key words: pulsed reactor, core, reactivity.

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Quick Pulsed Block of the Reactor BR-K1M

A. S. Koshelev, I. A. Nikitin, V. Kh. Khoruzhy

There is presented the analysis of results of calculation and experiment related to the possibility of applying on BR-K1M reactor a block with the mass of ~1.0 kg and the reactivity insertion rate being ~100 β_{eff}/s . Block is aimed to generate fission pulses on prompt neutrons with the halfwidth equal to ~600 μs at the energy release in the core of $\approx 3 \cdot 10^{18}$ fissions. The parameters of the actuator pneumatic drive and its design features providing the block travel at a velocity of ~9 m/s are given.

Key words: booster-reactor, modernization, steel case, titanium alloy, stress, deformation, reflector, fast pulse unit.

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Development of Critical Mass Measurement Techniques in RFNC-VNIITF

Yu. A. Sokolov

The RFNC-VNIITF experience in the field of critical mass measurements since 1970 was summarized and systematized. The features of critical mass benchmark experiments which were assembled on the critical mass facility RFNC-VNIITF FKBN (FKBN-M, FKBN-2) are discussed. A brief description of the number of critical mass experiments which were done at different times is given. These experiments were hold on the FKBN facility with spherical and cylindrical assemblies from metallic uranium and plutonium. The questions of necessity and the ways of primary experimental critical mass assemblies information conservation are discussed.

Key words: critical assembly, metallic uranium, metallic plutonium, reflector, Monte-Carlo method, efficient multiplication factor, nuclear data libraries.

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Calculated Substantiation of a Construction Diagram of the BR-K1 Reactor Core Air Cooling When it Functions in a Static Mode

L. S. Shalaeva, I. A. Nikitin

A brief description of reactor core and its design features are presented. There are given the results of BR-K1 first criticality in a static mode of operation the rated capacity being 30 kW (energy release $3 \cdot 10^{18}$ fis.). The reasons restricting reactor operation parameters are demonstrated. The construction diagram of the core air cooling is developed. There are performed calculations of the body thermomechanical deformation in the blocks of the core and its cooling efficiency with air flow. The ultimate power levels of BR-K1 safe operation in the static mode at natural and forced convection are determined.

Key words: booster-reactor, reactor core, static mode, natural convection, forced convection, sealing case, thermomechanical deformation, turbulent flow, cooling system, cooling medium.

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Methods of Generating Fission Pulses in Reactors «BARS-5», «TIRAN» in Presence of «Strong» Internal Neutron Source

S. A. Andreev, A. A. Snopkov, N. V. Gorin, V. I. Cherashev, V. V. Suknevich

There are considered five methods of generating fission pulses in the reactors of «BARS» type in the mode when a «strong» internal neutron source is available where either the space between the cores or experimental channel (channels) is free of reactivity regulator.

Key words: pulsed reactor, core, reactivity.

UDC 539.17+002.63+681.3

Activities on Development of the International Library of Experimental Nuclear Data Exfor in RFNC-VNIIEF Center of Nuclear Physics Data

G. N. Pikulina, S. M. Taova

The Centre of Nuclear Physics Data (CNPD) has been working in RFNC-VNIIEF since 1997. CNPD is a member of the Nuclear Reaction Data Centre Network – NRDC that functions under IAEA [1]. The main goal of NRDC is dissemination of information on nuclear reactions over the world community. The article describes the CNPD activities on the development of the international library of experimental nuclear data EXFOR as a member of NRDC.

Key words: experimental data on nuclear reactions; interactions of neutrons, charged particles and gamma quanta with nuclei; compilation; software; editor; numerical data validity; digitizer.