Abstracts
Journal "Problems of Nuclear Science and Engineering. Series: Physics of Nuclear Reactors", issue No.4, 2022

UDC 539.411.5

Complex Calculation of a Challenging Pulsed Polution-Type Reactor

S.A. Lopukhov, S.A. Kartanov, S.A. Korablev, A.A. Pikulev, K.G. Pluzyan, D.N. Tkachenko,
FSUE «RFNC-VNIIEF», 607188, Sarov, Nizhny Novgorod region, Mira ave., 37

In the paper there are presented the results of complex calculation research of the challenging pulsed nuclear reactor (PNR) that is a continuation of the VIR-series solution- type reactors development (FSUE «RFNC-VNIIEF»). To determine parameters of pulse and reactor vessel loads by calculation there was developed a mathematical model of fuel solution dynamics that makes it possible to take into account radial displacement of solution related to inhomogeneous distribution of energy release by the core volume and to the variation of vessel crosssection by height. There was undertaken the complex of calculations of the reactor vessel stress- deformed state in order to increase its strength properties. The calculations were performed for two operation modes: 1) pulsed mode (dynamic loads) and 2) long-time static operation mode (thermomechanical loads). The maximum possible parameters of reactor operation in these modes are determined.

Key words: complex calculation research, core, challenging nuclear reactor, mathematical model, fuel solution dynamics, energy release, reactor vessel, optimization calculations, strength properties, pulsed mode, long-time static operation mode, fuel solution, stress-deformed state.

UDC 539.411.5

Dynamic Deformation Calculations of Block NB-1p of Reactor BR-K1M

D.N. Tkachenko, N.V. Lopukhov, K.G. Pluzyan,
FSUE «RFNC-VNIIEF», 607188, Sarov, Nizhny Novgorod region, Mira ave., 37

In the paper there are presented the results of numerical investigation of nonstationary thermomechanical state of fast pulsed reactor core under the effect of a 600μs-long fission pulse in terms of physical and geometric nonlinearity of material deformation process, contact interaction and dependence of fuel ring strength properties on temperature. In the paper there was for the first time developed – on the base of three-dimensional simulation of BR-K1M reactor components dynamics and further analysis of stress-deformed state of the block under nonstationary (pulsed) homogeneous heating of fuel elements – the dynamics of the NB-1p block units in the course of fission pulse development. The analysis of results demonstrated the lack of shock contact interaction between submachines of block NB-1p in the pulsed operation mode.

Key words: Fast pulsed reactor, booster-reactor, fuel rings, numerical investigation, core, mathematical model, energy release, reactor vessel, strength properties, pulsed mode, long-time static mode, stressdeformed state.

UDC 621.039.514.4

Non-Applicability of the Moments Method to Kinetics of Weak-Source Reactors

V.F. Kolesov, A.N. Ganichev,
FSUE «RFNC-VNIIEF», 607188, Sarov, Nizhny Novgorod Region, Mira ave., 37

In the article there is made an attempt to solve stochastic problems from the sphere of reactor kinetics with the aid of moments method. The moments of probability distribution for representative values of reactor kinetics can be easily deduced from primary differential equations and this circumstance turned out to be an important stimulus of the contemplated works performance. It seemed that a semi-analytical new algorithm would not require development of a complex computer program and fulfillment of results calibration. However, the above specified optimistic expectations failed. It is shown, that as applied to the considered problem the moments method either does not ensure uniqueness of the solution or does not even make it possible to get a physically acceptable result. Non-applicability of the moments method to the considered in the article problem is validated by a rigorous proof obtained basing on Karleman theorem.

Key words: weak-source reactor, probability distribution, pulsed reactor Godiva-II, moments method, Karleman theorem, existence and uniqueness of problem solution.

UDC 621.039.51

Estimation of the Effective Multiplication Factor and the Prompt-Neutron Multiplication Constant for Fast-Neutron Systems

L.S. Ershova, A.V. Lukin,
FSUE «RFNC-VNIITF», 456770, Snezhinsk, Chelyabinsk region, Vasilyev street, 13

The paper considers simple analytical dependences of the integral parameters, i.e., effective multiplication factor and prompt-neutron multiplication constant, on size, density and gap between the parts of multiplying system. Results of formula evaluation are compared with those of Monte-Carlo calculation for spheres and cylinders made of ^{235}U.

Key words: effective multiplication factor, prompt-neutron multiplication constant, multiplying system.

UDC 621.039.51

Consideration of the Evolution of Limited Chains of Nuclear Fission in the Study of Probabilistic Neutron Processes in a System that Multiplies Neutrons

A.V. Lutsenko,
FSUE «RFNC-VNIITF», 456770, Snezhinsk, Chelyabinsk region, Vasilyev street, 13

To develop a scientific-technical approach and methods of obtaining experimental data under laboratory conditions with the view of verifying models of neutron probabilistic processes in multiplying systems, the evolution of limited fission chains with the help of theory of branching processes is considered.

Key words: systems that multiplies neutrons, limited chains of nuclear fissions under the action of neutrons, branching process, Rossi-alpha method.

UDC 621.038.05

Development of the Automated Complex of Remote Control and Management of the Full-Scale Model of System of the Catalytic Recombination Solution Nuclear Reactor

I.A. Sinitsin[1], D.A.Yunin[2], A.A. Kubasov[2], A.R. Dyagel[2]
[1] SARFTI NIYAU of MEPhI, Sarov, Nizhni Novgorod region;
[2] FSUE «RFNC-VNIIEF», Sarov, Nizhni Novgorod region)

In the report there are presented the results of developng the program to control the breadboard of detonating gas catalytic recombination system (CRS), the detonating gas being formed in above-fuel space during operation of solution-type nuclear research reactor VIR-2M. For the CRS breadboard the general aspect of measurement and control system is defined and the selection of measurement and control equipment is made. The paper presents operability conditions of the full-scale CRS breadboard that are defined on the base of operability parameters at working in a static mode at a power up to 30 kW.

Keywords: solution-type nuclear reactor, water radiolysis, catalytic recombination system, measurement system, emergency and precautionary settings.

UDC 536.911

Investigations of Gamma-Ray Unit of Radiation Safety and Irradiation Potentialities

Ye.I. Valekzhanina, S.A. Demyanov, S.A. Kartanov, A.V. Mashagin, P.V. Openyshev, K.G. Pluzyan, K.A. Popikova,
FSUE «RFNC-VNIIEF», 607188, Sarov, Nizhny Novgorod region, Mira ave., 37

To provide resistance testing of electronic component base (ECB) against the effect of cosmic space ionizing radiation there are carried out in FSUE «RFNC-VNIIEF» the works on creating a synchrotron complex. One of its facilities is gamma-ray unit (GRU) on the base of ^{60}Co sealed radioactive source (SRS). This facility is being developed in two embodiments: of low and average intensities. The paper presents the results of dose rate calculation at a 1-meter distance from the GRU components and behind the walls of the dose irradiation hall. The chart of radiation fields in the dose irradiation hall is calculated. There are presented the calculation results of space distribution of dose rate and radiation field nonuniformity in the assumed place of ECB arrangement.

Key words: gamma-radiation unit, radiation safety, irradiation resource.

UDC 621.039.51

Comparison of the Results of Determining the Lifetime of Instantaneous Neutrons in the Core of the *IGRIK-2* and *YAGUAR* Reactors by Statistical Methods

V.V. Zakharov, O.A. Mingazov, V.I. Cherashev, I.A. Zhikhovsky, S.V. Shugaev, S.G. Porubov, A.A. Manakov, A.A. Kuzinskaya,
FSUE «RFNC-VNIITF», 456770, Snezhinsk, Chelyabinsk region, Vasilyev street, 13

The results of determining the lifetime of instantaneous neutrons in the YAGUAR and IGRIK-2 reactors by three different statistical methods are presented The experimental facility has been briefly described and the experimental scheme is given. A comparison of the results obtained by the methods of Babala, Fejnman and autocorrelation analysis was carried out. Conclusions are drawn about the applicability of these methods.

Key words: pulse nuclear reactor, lifetime of instantaneous neutrons, reactivity, Rossi-alpha constant, Babala method, Feynman method, autocorrelation analysis.

UDC 621.039.56

Pulse Mode on the BARS-5M Reactor with a New Mechanism of Reactivity Control

A.V. Lutsenko, Yu.V. Oseev, V.V. Suknevich, V.I. Cherashev, M.Yu. Evert,
FSUE «RFNC-VNIITF», 456770, Snezhinsk, Chelyabinsk region, Vasilyev street, 13

Results of fission pulses generation are given for a coupled system of the BARS-5M reactor with a new mechanism of reactivity control in the «on power» mode. Shortcomings of the mechanism of reactivity control are noted, in particular: instability of movement synchronization of two independent reactivity regulators in reactor cores and, as a result, unreliability of forecasting pulse parameters. There are considered the ways of this mechanism improvement.

Key words: pulse reactor, active zone, reactivity.

UDC 536.21

Numerical Simulation of Radiation Heating of Gamma-Plant Structural Members

K.A. Shcherbakova, K.V. Sharafetdinova, K.G. Pluzyan, S.A. Kartanov, Ye.I. Valekzhanina, Demyanov S.A.,
FSUE «RFNC-VNIIEF», 607188, Sarov, Nizhny Novgorod region, Mira ave., 37

Gamma-plant (hereinafter – GP) is a component of a irradiating complex intended to provide and perform testing of electronic components (hereinafter – ECs) as to their resistance against the cosmic space ionizing radiation effect. Testing of ECs and instruments in their resistance against the accumulated dose takes into ac-count the effect of electrons and protons in Earth radiation belts and bremsstrahlung generated by them as well as space radiation contributing insignificantly to integral indexes. To test in resistance against accumulated dose, GP based on different radionuclides with the effective energy in spectrum not less than 0.6 MeV is used among others. In a range we will understand average value of energy of quantum as effective energy. Such gamma-quantum energy ensures physical closeness to simulated basic radiation processes:

– structure failure of semiconductors and dielectrics;

– generation of non-equilibrium free charge carriers in ECs and instrument assemblies;

– accumulation of space charge on trap centers.

The given paper presents the results of calculated determination of GP structure assemblies temperature under radiation heating. Basing on calculated data on the value of energy release in component assemblies of GP there was determined the temperature of basic elements in the course of the plant operation.

The results of the undertaken researches made it possible to substantiate structural decisions accepted in the course of GP development.

Key words: source activity, gamma-radiation, closed radioactive source, ionizing radiation, radiation heating, irradiating measurement complex, maximal operating temperature, exposure dose rate, electronic components, energy release.