

## Abstracts

Journal “Problems of Nuclear Science and Engineering. Series: Physics of Nuclear Reactors”  
issue No.3, 2013

Prepared by RFNC-VNIIEF

UDC 621.039

### Critical Experiments on Assemblies with Metallic Plutonium Carried out at RFNC-VNIIEF

*S. V. Vorontsov, M. I. Kuvshinov*  
RFNC-VNIIEF, 37, Mira Av., Sarov, 607188

We present a brief review of RFNC-VNIIEF experiment procedures dedicated to a study of neutron multiplication characteristics and critical masses of assemblies containing metallic fissile materials. Here are described results of measuring critical plutonium masses in  $\alpha$ - and  $\delta$ -phases with various isotopic composition carried out by M. I. Kuvshinov, A. A. Malinkin, B. D. Stsiborski, V. A. Davidenko, V. P. Yegorov in RFNC-VNIIEF in the years of 1956–1965.

*Key Words:* Metallic Fissile Materials, Neutron Multiplication Factor, Reactivity, Critical Mass, Plutonium in  $\alpha$ - and  $\delta$ -Phases, Enriched Uranium, Isotopic Composition, FKBN Critical Bench, Nuclear Safety, Core, Reflector, Protective Container, Nuclear Constant Verification.

UDC 621.039.52

### Breeding of $^{233}\text{U}$ in a Thorium-Uranium Fuel Cycle in WWPR Reactors Employing Heavy Water

*V. E. Marshalkin, V. M. Povyshev*  
RFNC-VNIIEF, 37, Mira Av., Sarov, 607188

We propose a method for securing optimal neutron kinetics and efficient isotope conversion into  $^{233}\text{U}$ ,  $^{232}\text{Th}$  oxide fuel of WWPR with variable water composition ( $\text{D}_2\text{O}$ ;  $\text{H}_2\text{O}$ ) supplying breeding of isotopes  $^{233}\text{U}$ ,  $^{235}\text{U}$  and characterized by comparatively simple implementation.

*Key Words:* Reactors Kinetics, Water- Water Reactors with Light Water, Water-Water Reactors with Heavy Water, Water-Water Reactors with Light-and-Heavy Water Mixture, Oxide Nuclear Fuel, Fuel Breeding.

UDC 621.039.14

### Background of Uncertainties in Reactivity Determined with the Aid of Inverse Solution of Kinetics Equations

*V. F. Kolesov*  
RFNC-VNIIEF, 37, Mira Av., Sarov, 60718

There are analyzed the reasons of uncertainties in reactivity determined with the aid of technique known as «Inverse solution of kinetics equations (ORUK)», and the ways of such uncertainties neutralization are demonstrated. It is shown that within the framework of this technique to different stages of measurement procedures there corresponds its own form of neutron flux density space distribution what leads to variation of the source efficient intensity and efficiency of neutrons registration by a detector and - as a result – to errors in experimentally determined reactivity.

*Key Words:* Reactor, Critical Assembly, Reactivity, Equations of Point Kinetics, Inverse Solution of Kinetics Equations, Technique of Reactivity Measurement, Space Distribution of neutron Flux.

UDC 621.378.33

## **Nuclear-Pumped Lasers – Devices with Direct Conversion of Nuclear Energy into Laser Radiation**

*A. M. Voinov, V. N. Krivososov, S. P. Melnikov, A. A. Pikulev, A. N. Sizov, A. A. Sinyanskiy*  
RFNC-VNIIEF, 37, Mira Av., Sarov, 607188

The basic stages of studies aimed at investigations of nuclear-pumped lasers and designing of nuclear laser facilities with direct conversion of nuclear energy into laser radiation are considered. The main attention is paid to studies which were carried out in VNIIEF with help of pulsed nuclear reactors.

*Key Wwords:* Gas Laser, Active Medium, Plasma Processes, Lasing Mechanism, Nuclear Pumping, Reactor-Laser, Pulsed Reactor.

UDC 621.019.039.571:539.1.084

## **Gamma-Field Spectral Characteristics of VNIIEF Reactor Facilities.**

*A. S. Koshelev, V. Kh. Khoruzhy*  
FNC-VNIIEF, 37, Mira Av., Sarov, 607188

There are presented the calculated versions of spectra of prompt and delayed gamma-quanta in a 23-group energy format on reactors BR-K1, BR-1M, GIR-2 and BGR for 7,14, 10 and 6 radiation fields, respectively. For each spectral distribution there are presented in addition the ratios between prompt and delayed components, average spectra energies, absorbed doses in air, silicon, biological tissue, IS-7 detector material, gas-filler used to fill ionization chambers and in 12X18H10T steel as normalized for the absorbed dose in DTS detector material. For the selected spectral distributions their graphic versions are given.

*Key Words:* Prompt Gamma-Quanta, Delayed Gamma-Quanta, Fluence of Gamma-Quanta, Fluence Spectrum, Average Energy of Spectrum, Relative Absorbed Doses.

UDC 621.039.51

## **Experimental and Calculation Parameters of Spherical Critical Assemblies with a Core of Metal Plutonium ( $^{239}\text{Pu}$ (~98 %)) in $\delta$ -Phase and Reflectors of Duraluminium, Lead and Tungsten**

*V. N. Bogdanov, S. V. Vorontsov, Eh. A. Gumennykh, A. A. Devyatkin, A. A. Kaigorodov,  
M. I. Kuvshinov, A. V. Panin, S. V. Finogeev, V. Kh. Khoruzhy*  
RFNC-VNIIEF, 37, Mira Av., Sarov, 607188

There are presented the results of benchmark critical experiments performed on FKBN-2M facility with spherical assemblies with a core of metal plutonium ( $^{239}\text{Pu}$  (~98 %)) in  $\delta$ -phase and reflectors of duraluminium, lead and tungsten. Critical ( $k_{\text{eff}} = 1$ ) parameters (geometric shape and dimensions) for the given nuclide composition of core materials and reflector are determined. The values of  $k_{\text{eff}}$  for the critical assemblies under investigation were also calculated with the use of Monte-Carlo method and different nuclear data libraries: ENDF/B-7, BAS, JENDL 3.3, JEF-3, CENDL-2. There was performed the comparison of experimental and calculation results of investigations.

*Key Words:* Critical Assembly, Core, Plutonium, Reflector, Duraluminium, Lead, Tungsten, Benchmark Test,  $k_{\text{eff}}$ , Monte-Carlo Method, Nuclear Data, ENDF/B-7, BAS, JENDL 3.3, JEF-3, CENDL-2 Libraries.

UDC 621.039.53

## **Some Issues of Designing Actuating Mechanisms of Pulsed Nuclear Reactors**

*I. A. Nikitin*

RFNC-VNIIEF, 37, Mira Av., Sarov, 607188

There are described the modes of fission pulse generation on aperiodic pulse reactors as well as the purpose of work members. Basic principles of providing nuclear safety applied to actuating mechanisms at a stage of design and general requirements to them under operation are presented. Depending on functional purpose of the work member there are given the approaches to the determination of actuating mechanism engineering parameters and its schematic diagram. It is demonstrated that these approaches can be used at a stage of designing actuating mechanisms of pulsed nuclear reactor.

*Key Words:* Pulsed Nuclear Reactor, Work Member, Reactivity, Drive, Actuating Mechanism, Rate, Positioning Accuracy.

UDC 621.039.514

## **Shaping of Fission Pulses on Prompt Neutrons of BR-1M Reactor under High Initial Power**

*A. S. Koshelev, V. Kh. Khoruzhy*

RFNC-VNIIEF, 37, Mira Av., Sarov, 607188.

There are presented the results of calculated simulation of shaping pulses on prompt neutrons of BR-1M reactor with essentially inertial reactivity quenching in the mode of generation from the initiating (starting) level of power in the core  $\sim 2 \cdot 10^{20}$  core fissions/s. The results of calculations are compared to the experimental data obtained in joint start-ups of BR-1M reactor and LIU-30 accelerator.

*Key Words:* Reactor BR-1M, Fission Pulse on Prompt Neutrons, Initial Power, Fission Pulse Parameters.

UDC 621.039

## **Statistical Modeling in Steady-State Reactor Analysis**

*D. G. Modestov*

RFNC-VNIITF, 13, Vasilieva Str., Snezhinsk, Chelyabinsk Reg., 456770

The paper describes a scheme for the coupled calculation of reactor neutronics and thermal-hydraulics with statistical modeling which is used to estimate released energy distributions. It provides results of test calculations for the VVER reactor core, which are used to construct a converging iteration procedure.

*Key Words:* Statistical Modeling, Monte-Carlo Methods, Numerical Techniques, Simple Iteration Method, VVER-1000, Neutronics, Thermal-Hydraulics.

UDC 621.039

## **An Adaptive Scheme for Solving Nuclear Fuel Depletion Equations with the Estimated Equilibrium Concentrations of Short-Lived Nuclei**

*D. G. Modestov*

RFNC-VNIITF, 13, Vasilieva Str., Snezhinsk, Chelyabinsk Reg., 456770

Nonphysical oscillations in released energy estimates, which are observed when nuclear fuel depletion equations are solved with large time steps in thermal reactor calculations, can be eliminated by using the equilibrium concentrations of short-lived nuclei from neutronics analysis. The paper describes an algorithm which is used to estimate the concentrations, the integration scheme, and results of some test calculations which prove that the algorithm is applicable to practical problems.

*Key Words:* Nuclear Composition, Fuel Depletion, Cauchy Problem, Numerical Techniques, Integration Scheme, Integral Manifold, Singular Perturbation.

UDC 621.039.534

## **Reactor Plant with Horizontal Steam Generators**

*A. V. Beznosov, O. O. Novozhilova, A. A. Molodtsov, M. V. Yarmonov, P. A. Bokov, A. V. Nazarov*  
Nizhniy Novgorod State Technical University by R.E.Alekseev, 24, Minina St., Nizhniy Novgorod, 603950

The analysis of the application of horizontal steam generators in reactor facilities with lead and lead-bismuth coolant are discussed.

*Key Words:* Fast Reactor, Horizontal Steam Generators, Lead Coolant, Intercontour Leak Of A Steam Generator.

UDC 621.039

## **MUZA Code Employed for Calculation Support of Experiments in Research Reactors**

*A. V. Alexeev*

SRC NIAR, Dimitrovgrad-10, Ulyanivsk Reg. 433510.

MUZA code models applied for calculation of fuel element tests in MIR research reactor are described, as well as experimental and calculation results for water-moderated water-cooled power reactor (WWPR) fuel elements are compared.

*Key Words:* Calculation, Experiment, Fuel Element, WWPR, Research Reactor, MUZA Code