

Abstracts

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Criticality Calculations of Non-Ordinary Systems

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Problems in Monte-Carlo criticality calculations of weakly-coupled and non-asymptotic systems are discussed in this paper. Specific examples are presented, and also the recommendations for detecting and properly performing criticality Monte-Carlo calculations are given for systems that are common when performing nuclear safety calculations for VVER reactor fuel management problems. In particular, there are discussed the problem of properly choosing the parameters of a Monte-Carlo criticality calculation and the problem of solving and interpreting the eigenvalue problem for the coupling coefficients matrix of a system.

Key Words: the Monte Carlo Method, Weakly-Coupled Systems, Coupling Coefficients Matrix, the Effective Multiplication Factor, Neutron Batch, Source Normalization

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The Impact of Changes in the Form of VVER-1000 Fuel Assemblies in the Process of Operation on Power Density Distribution

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We propose a new approach to calculation of fuel pin power coefficients of sensitivity to deviation of gaps between fuel assemblies (FA) of VVER-1000 in the process of its operation. We proved that the MCU calculations shall be performed for a full-size core model in order to take into account the interference of gap influence. In order to reduce the conservatism of calculations, coolant density and coolant temperature feedbacks shall be taken into account, as well as fuel burnup.

Key Words: Gaps between FAs in VVER-1000, Coefficients of Sensitivity of Pin Power to Gap Sizes, Interference of Gap Influence.

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Analysis of the Uncertainties in the Physical Calculations of VVER by the Parameters of the Small-Group Constant Preparation Models

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The article covers the uncertainty analysis of the physical calculations of VVER reactor core for different meshes of the reference values of the feedback parameters (FBP). Various numbers of the nodes of the parametric axes of FBPs are investigated and different ranges between them. The uncertainties of the dynamic calculations are analyzed using RTS RCCA ejection as an example within the framework of the model with the boundary conditions at the core inlet and outlet.

Key Words: Uncertainty Analysis, VVER, FBP, Nodes of the Parametric Axes, RTS RCCA Ejection, Model with the Boundary Conditions.

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Approach to the Development and Justification of Effective 3D Models for Neutron-Physical Calculations of ASTRA Critical Facility with the Use of Experimental Information

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The paper presents a technique of the development of 3D effective computational models for calculations of neutron-physical parameters of the ASTRA critical facility (intended for studies of physics of hightemperature reactors) with the use of available experimental information. The effective (extrapolated) height of the critical assembly model with significant difference between the heights of inner and lateral reflectors is determined based on experimental data on axial distributions of ^{235}U fission rates. Due to the presence of the bottom reflector and the absence of the top reflector in some assembly configurations the traditional approach based on 2D models with an effective buckling value is not applicable. Instead, we developed an approach based on the 3D effective model with the extrapolated height. Several examples of implementation of these models confirmed their successful applicability to computational analysis of experimental data on control rods mockup effectiveness obtained at the ASTRA critical facility.

Key Words: HTGR, ASTRA Critical Facility, Axial Fission Rates Reaction Distribution, Buckling, 3D Model.

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Setting the Active Neutron Analysis Content Fissile Material in Nuclear Reactor Fuel Assemblies

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It is described the active neutron method for measuring residual mass of ^{235}U in spent fuel assemblies (FA) of the research reactor IRT MEPhI. High accuracy of determining residual content of ^{235}U is achieved by the special construction of the measuring facility and uniform neutron irradiation of the fuel along the entire length of the active part of the FA. The use of the AmLi neutron sources provides the best value of the effect/background ratio in comparison with other types of isotope neutron sources and eliminates the fission of ^{238}U . The proposed method of the isotope source movement in accordance with a given algorithm can be applied in experiments where it is required to irradiate the object by uniform fluence.

Key Words: Nuclear Reactor, Fuel Burnup, Active Neutron Method, Isotopic Neutron Source, Fluence, Detection Efficiency, Irradiated FA, the Residual Mass of Uranium.

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Measurements of Efficiency of the Control Rods in RBMK Critical Assembly with Using Model of the Reactimeter RKI-1

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The efficiency of the control rods of the RBMK critical assembly in a series of experiments was measured. Aim of measurements was determination of character of the reactimeter RKI-1 model. The basic purpose of reactimeter RKI-1 is measurement of control rods efficiency, if is necessary metrological certificate of results of

experiment. The complications of metrological certificate are arising maybe because of necessity of calculations for corrections of results of measurements. With the using of reactimeter RKI-1 does not be need of the introduction of calculated corrections, the result of measurements is given with the indication of the substantiated errors. The metrological certification of the results of measurements by reactimeter RKI-1 in connection with this would be simplified.

Key Words: RBMK, critical assembly, control rods efficiency, reactimeter, neutron field, error.

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Numerical Simulation of Measurement Performed during the Reactor Physical Startup Tests of Rostov Unit 3

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The article represents the results of measurement and numerical simulation of measurement of certain reactor parameters evaluated during physical startup tests of unit 3 of Rostov NPP. The following parameters are considered: critical boron acid concentration and ionization chamber (IC) current during scram-system efficiency evaluation. Scram-system efficiency was calculated using point kinetics inverse equation with measured IC current and with IC current obtained by numerical simulation of measurement. The results of steady-state calculations of relative power distribution, scram-system efficiency, single control rod efficiency and groups of control rods efficiency are also represented. Different codes including precision ones were used for the calculations.

Key Words: VVER, Rostov NPP, Reactivity, Current, IC, Experiment, Measurement, Simulation, Comparison, Raduga-7.5, MCNP, TDMCC.

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Justification of the Possibility of Using the Ampoule Channel with Natural Circulation for in-Pile Tests

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The possibility of using the ampoule channel for experiments to study the properties of materials under irradiation is considered. The results of the calculated and experimental studies of temperature conditions during irradiation of samples of heat-resistant alloy in ampoule channel with natural circulation of the coolant in the reflector of reactor SM-3 are given.

Key Words: Ampoule Channel Type, Natural Circulation, Reactor SM-3, Thermohydraulic Code RELAP5/MOD3.2.

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On the Mechanism of Formation of Precipitates in the Steel of Water-Cooled Reactors Vessels under Neutron Irradiation

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Experimental results of a research of copper-enriched precipitates (Cu-precipitates) and nickel-manganese-silicon clusters (Ni-Mn-Si clusters) which are formed in steels of VVER-type reactor pressure vessels under neutron irradiation have been analyzed. On the basis of this analysis, a hypothetical model of cluster formation in the course of cascade region evolution is suggested. The model envisages cluster formation in two stages. At the first stage, in the course of the cascade region crystallization, a stable cluster is formed in the center of the cascade region consisting of vacancies and copper atoms following the mechanism of the inverse Kirkendall effect. At the second stage, diffusion of Ni, Mn and P atoms with a flow of vacancies occurs from the matrix to form a cluster. The size of a cluster is limited by a balance of flows of vacancies entering into the cluster and exiting from it. A possibility of stabilization of atomic-vacancies cluster due to nonuniform distribution of Ni, Mn and P atoms which gives a reason for cluster density dependence on the content of these elements was discussed. Kinetics of cluster formation and evolution on the basis of the offered model is analyzed. It is shown that the cluster density drop and their size increase under high irradiation doses may be caused by a decrease of matrix supersaturation with vacancies resulting from high density of dislocation loops.

Key Words: Copper-Enriched Precipitates, Nickel-Manganese-Silicon Clusters, Cascade Region, Vacancies, Inverse Kirkendall Effect.

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What Safety Should Achieve from Nuclear Power Plants?

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Competitive strength of nuclear power plants (NPPs) in comparison with power plants (PPs) at an coal and gas depends also on an estimation of possibility of severe accident on NPP. Share NPPs in a power generation an electric power system is influenced by size of payment of a damage from severe accidents of type Chernobyl. Application NPPs is possible at probabilities of one severe accident 10^{-5} reactor-year $^{-1}$ and more low.

Key Words: Competitive Strength, NPP, PP, Probability of One Severe Accident, Electric Power System Optimization, an Optimality, Non-Optimality.

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Development of the Structured Relational Database for Civil Plutonium in Russia

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By now, a large amount of plutonium has been accumulated within the weapons complex as well as in spent nuclear fuel of various reactors (power, research and propulsion) during the period of the Soviet/Russian nuclear program existence. Plutonium accumulated in the civilian nuclear program of the USSR/Russia is rather scattered in terms of its isotopic composition as well as storage time which affects isotope ratios of plutonium itself and minor actinides accumulated while storing. We should know exactly where, how much and how plu-

Plutonium is stored at the required time in order to determine the future of plutonium accumulated (or being in the process of accumulation): long-term storing, disposal or use as fuel in a closed fuel cycle. Unfortunately, the existent control and accounting system of nuclear materials (including plutonium) lacks such data. The present work deals with the creation of a special-purpose database for civil plutonium in Russia which would make it possible to prepare the source data for system analytical research in justification of decisions on the future use of civil plutonium in Russia.

Key Words: Civil Plutonium, Database, Relational Databases, Fissile Materials, Mathematical Modeling.

Seminar "Physics of Nuclear Reactors"

The seminar "Physics of Nuclear Reactors" is working in the NRC "Kurchatov Institute" since 1999 under the direction of the head of the Nuclear Reactors Physics Department S. M. Zaritskiy.

By the time of this journal issue there were 151 seminar meetings, the theme of which is not limited by the fact stated in seminar title.

The speakers and participants of the seminar are the scientists from NRC KI and other Institutions.

The information about the seminar is located on the site of NRC "Kurchatov Institute" (www.nrcki.ru), and is sending to the participants.

This issue contains the information about 149 – 151 seminar meetings and abstracts of reports provided by speakers.