

Abstracts

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Antineutrino Flux and Spectrum in BN-800 Fast Neutron Reactor with Mixed Fuel

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Antineutrino flux and energy spectrum have been calculated for BN-800 fast neutron reactor with mixed core fueling (16% MOX fuel) based on fuel cycle simulation using the KIR software package. Calculated results demonstrate similarities to antineutrino fluxes and spectra in thermal neutron reactors. The most significant differences are observed at the spectrum edge, where the difference between BN-800 and VVER-1000 fluxes reaches 20%. The decrease in antineutrino flux caused by fuel burnup over the cycle is less noticeable in BN-800 than in VVER-1000 thermal neutron reactor.

Key Words: antineutrino, antineutrino spectrum, fast neutron reactor, BN-800, thermal neutron reactor, VVER-1000.

EDN: WVAUHZ

UDC 539.125.523.43

CHARM Program Modification to Simulate γ -Radiation Transport with Anisotropic Scattering Source

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This article describes CHARM program modification to simulate γ -radiation transport with anisotropic scattering source. It also provides a brief description of photon-matter interaction processes embedded in the mathematical model presented herein, along with the model task calculation results and analysis thereof.

Key Words: photon transport, radiation safety, computer program.

EDN: VVHDOZ

UDC 621.039.586

Method for Combining Correlations of Critical Heat Flux from OKB Gidropress and NIKIET to Calculate the Minimum DNBR in Reactivity Accidents (RIA) of Reactor Plants with VVER

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A comparison of the critical heat flux (CHF) correlations of OKB Gidropress (correlation by Bezrukov Yu.A.) and NIKIET (correlation by Smolin V.N.) was performed. Possible methods for combining two CHF correlations in the analysis of transient modes are considered. A series of variant calculations of typical emergency modes of reactivity accidents (RIA) for WWER-1000 and WWER-1200 reactors were performed with the determination of the departure from nucleate boiling ratio (DNBR) using the “minimum method” of combining correlations. Based on the calculation results, conclusions were made on the applicability of the “minimum method” of combining the critical heat flux correlations of OKB Gidropress and NIKIET for calculating the minimum DNBR in RIA at WWER reactors.

Key Words: critical heat flux, OKB Gidropress correlation (Yu.A. Bezrukov correlation), NIKIET correlation (V.N. Smolin correlation), reactivity accidents, WWER, departure from nucleate boiling ratio, combination of correlations, “minimum method”.

EDN: NVZIVX

UDC 621.039.50

Analysis of Neutronic Parameters of VVER-1200 Fuel Cycles during Multi-recycling of Uranium

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This article considers multi-recycling of reprocessed uranium in VVER-1200 reactors, suggests a computing model to assess fuel cycle integral parameters (such as consumption of natural and reprocessed uranium, etc.) in case of multirecycling, and describes comprehensive neutronic calculations performed for the design-basis 18-month fuel cycle of the cores yielded by successive uranium recycles.

Key Words: reprocessed uranium fuel, VVER-1200, uranium isotopes, fuel assemblies, multi-recycling, neutronic parameters.

EDN: JKQHUK

UDC 621.039.56

Application of MSHIM Maneuvering Algorithm to High-Power VVER Reactor Plants

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The article studies the problem of automation of load following modes of VVER reactor plants operation in flexible energy systems, and analyzes possible ways to adjust the MSHIM maneuvering algorithm used in the AP1000 project for use in the AES-2006 one. This method offers certain advantages including automated load following and cancelled water exchange operations. Based on calculated results, this paper makes a conclusion about MSHIM applicability for the AES-2006 project and specifies restrictions and conditions of its successful use.

Key Words: load following operation, AES-2006 project, maneuvering algorithms, axial offset, spatial kinetics, KORSAR/GP code.

EDN: TOHCZY

UDC 621.039.51

Simulation of Beyond-Design-Basis Accidents Involving RBMK Spent Fuel Pool Dryout

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This paper analyzes temperature modes that may occur in RBMK-1000 onsite spent fuel pools in case of beyond design-basis accidents involving long-term loss of cooldown and complete core dryout coupled with NPP blackout under extreme external or internal impacts. This paper also determines the time to achieve acceptability criteria based on temperatures of both fuel cladding and concrete walls of the spent fuel pool, and considers the application of mobile emergency equipment in such conditions.

Key Words: spent fuel pool, dryout, temperature mode, blackout accident, acceptability criteria, mobile emergency equipment.

EDN: EIVANF

UDC 629.039.58

Chemical Forms of Iodine in VVER Primary Coolant and in Containment Sump during LOCA

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Numerical model describing radiation-chemical transformations of iodine compounds in solutions, whose composition corresponds to either VVER primary coolant or accident sump liquid, is presented. The results of numerical simulations show that iodide ion is the only chemical form of iodine in VVER coolant when the reactor is operated at power level. This is the reason for iodine to come into the containment as aerosol during a loss of coolant accident. In aerosol particles iodide undergoes rapid oxidation to volatile chemical forms under the influence of radiation. The rate of volatile iodine formation is proportional to the dose rate and does not depend on either the iodide concentration or the size of aerosol particles up to 100 μm . Mainly atomic iodine passes into the gas from aerosol particles. Recombining with other radicals, iodine atoms form I_2 , CH_3I and other molecules. According to the obtained results, emergency release of iodine at a power unit with VVER will be determined by the efficiency of removing aerosol particles and molecular iodine from the containment as a result of the sprinkler system operation. Changes of the sump solution pH during an accident period are unable to influence the release of radioactive iodine.

Key Words: VVER, containment, sump, primary coolant, LOCA, fission products, iodine partition coefficient, radiolysis, methyl iodide, aerosol.

EDN: QPGJJM

UDC 621.039.4

Tritium Behavior in a Reactor Plant with Molten Salt Actinide Recycler & Transmuter

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Tritium spreading outside the reactor plant is an important issue for justification of safe operation of nuclear power plants with molten salt reactor (MSR). The analysis of tritium generation and spreading in a reactor plant with a high temperature Molten Salt nuclear reactor Recycler & Transmuter (MOSART) of 2.4 GW thermal power with fuel salt of ^7Li , Be, An/F composition and a cyclone-type core has been performed. The normalised per MW(t) average tritium production rate for the MOSART campaign, calculated using SERPENT-2 and ENDF/B-VII nuclear data library, was $1.7 \cdot 10^{11}$ Bq/MW(t)/day. It was shown that in the presence of helium purging in the reactor and intermediate circuits with a flow rate higher than 1 l/min (~ 0.02 vol.% He in purging cavity of pump), as well as ventilation in the boxes with multiplicity of at least 1 (full change of gas atmosphere during 1 hr), tritium does not pose a hazard during the operation of the MOSART reactor plant.

Key Words: helium sparging, molten salt actinide recycling transmuter, MOSART, primary circuit, fuel salt, tritium.

EDN: NYZMTC

UDC 621.039.536.2

Effect of Structure and Phase Composition on Fracture Toughness of VVER-1000/1200 Reactor Pressure Vessel Welds

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The paper presents a comparative analysis of the macro- and microstructure of weld metals with different structures formed as a result of various welding technologies. The influence of grain structure and phase composition of VVER-1000/1200 reactor pressure vessel welds on their operational characteristics in initial state is analyzed. Structural features causing differences in the yield strength, critical brittleness temperature and fracture toughness of VVER-1000/1200 reactor pressure vessel welds in the initial state are established.

Key Words: reactor pressure vessel, weld metal, ductile-brittle transition temperature, fracture toughness, yield strength, grain structure, phase composition.

EDN: DPFTIZ

UDC 621.039.58

Assessment of Radiation Impact of Tritium, Contained in Ammonia Fertilizers Produced using Nuclear-Hydrogen Technology, onto the Population.

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The radiation safety of population consuming foodstuffs containing tritium in them due to the use of ammonium nitrate made from hydrogen produced at NPP with MHR-100 SMC as fertilizers during their cultivation is assessed. The article gives a comprehensive review of possible ways of tritium radionuclides entering the human body and shows the necessity to take into account its influence when assessing radiation loads. The calculation results showed that with the existing estimates of tritium content in the produced hydrogen and ammonium nitrate the dose loads on the population due to consumption of agricultural products grown with such fertilizers are less than the established criteria of radiation safety for the population established in the federal law on radiation safety of the population and in the regulatory documentation.

Key Words: radiation safety, HTGR, hydrogen production, tritium, food chains.

EDN: YOAZJI