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REACTOR PLANTS.
LIFE CYCLE MANAGEMENT
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The influence of steam generator type, design, and performance characteristics on the development of two-loop VVER nuclear power plant projects

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Abstract

In 1954, Russia commissioned the first nuclear power plant in the world and became the birthplace of nuclear industry that further extended to other world’s major economies. The progress of Russia’s stationary and propulsion nuclear power plants relies upon a comprehensive approach to solution of various research and development problems. A very important problem is that of deciding on the type, configuration, and design of a steam generator (SG). In this paper, the authors criticize a conservative approach to the design of stationary two-loop VVER power plants where only one type of SG is adopted – a large-sized horizontal SG of 50-year-old design. Moreover, there are no plans for development of advanced SG designs in this century.

Key words: reactor, horizontal steam generator, once-through steam generator, loop type design, integral design, self-regulation, maneuverability.

Development of the U.S. Department of Energy's Naval Reactors Program

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Abstract

The paper reviews the development steps of the Naval Reactors program of the U.S. Department of Energy through years 2010–2025. The program structure, contents, and scope of support to the missions are described. It is focused that ensuring the full life cycle of advanced naval nuclear propulsion plants requires preliminary testing of new reactor components in land-based prototypes. The Naval Reactors program provides significant financial support for operation and maintenance of the prototype facilities.

The presented information about the Naval Reactors program missions and tasks, steps and budget allocations can be useful for development and planning of design, technological, and organizational efforts aimed at improvement of Russia's nuclear propulsion and on-shore infrastructure that supports safe operation and testing of naval reactors, as well as management of naval spent nuclear fuel and decommissioned components.

Key words: Naval reactors, nuclear reactor refueling, development of naval reactor systems, ensuring the safety of operation of naval nuclear propulsion plants, management of naval spent nuclear fuel.

Testing of volume control tank (DA 65/20), for the Leningrad NPP-2

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Abstract

The paper presents testing results of a volume control tank (VCT) in the chemical and volume control system (CVCS) that is used at VVER NPPs. The VCT system contains a packed column type deaerator designed for degasification of the primary coolant letdown.

Start-up operations at the Tianwan NPP (China) revealed the problem of hydrodynamic instability in the VCT system when operating at high coolant flows.

Based on results of numerical thermal-hydraulic analysis and simulation of processes in the VCT system, a new VCT design was developed which would remove the mentioned problem. The new VCT was manufactured by JSC Sibenergomash for the Leningrad NPP.

The design of this new VCT containing omega-shaped elements (packing) was improved after preliminary testing. The improved VCT demonstrates high degasification efficiency and hydrodynamic stability and can perform under all CVCS operating conditions at VVER NPPs.

Key words: volume control tank, degasification, deaerator column, packing, packing element, flooding, chemical and volume control system.

Improvement of water chemistry regime of the PIK reactor liquid regulation circuit

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Abstract

According to the project, a heavy-water liquid regulation circuit is provided at the PIK reactor (NRC KI – PNPI). Initially, it was planned to use a neutron absorber solution of gadolinium nitrate as a coolant in the regulation circuit to regulate the reactivity during fuel burnout in the core. Currently, the regulation circuit is used to control the integrity of the reactor vessel and its coolant is pure heavy water. In this regard, it became necessary to revise the chemical control for this circuit.

The list of controlled parameters of regulation circuit heavy water proposes and substantiates in the paper. An assessment of the maximum permissible concentrations for each parameter is carried out.

Key words: chemical control, water chemistry regime, liquid regulation circuit, heavy water coolant, PIK reactor.

Oxidation of molten “hyperstoichiometric corium-stainless steel” system

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Abstract

An experimental study of molten corium oxidation kinetics was carried out. The study was performed in support of the In-Vessel Retention (IVR) strategy for PWR, BWR, VVER in NPP severe accident conditions. The $(\text{UO}_{2+x} - \text{ZrO}_2) + \text{stainless steel}$ melt was oxidized by Ar/O_2 composition under hyperstoichiometric conditions of the oxidic part of the melt. The experiments were conducted without and with partial crust formed on the surface of the metal liquid located at the top of the molten pool. The process characteristics and influence of the system parameters on the oxidation rate are discussed in the paper.

Key words: severe accidents, NPP, corium melt, oxidation, induction melting in the cold crucible.

Research of the prototype of an industrial induction furnace with a cone-shaped cold crucible for vitrification of high-level waste

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Abstract

The article presents the results of research on the operation of the prototype industrial induction furnace with a cold crucible for vitrification of high-level waste.

During the experiments, the furnace life tests were carried out during 100 hours, 440 liters of a model solution of liquid radioactive waste from the processing of VVER-1000 SNF containing noble metals were processed, and 250 kg of borosilicate glass was produced. The average capacity of the furnace was 11.4 kg/h for glass.

The studies identified electro-technological parameters of installation, confirmed the effectiveness of using the cold crucible with a conical bottom for removal of noble metals and issued the initial data for designing industrial furnace for vitrification of high-level waste.

Key words: induction melting, cold crucible, vitrification, conical bottom, electrical and thermal parameters, high-level waste, noble metals.