

# The Problem of Verification and Attestation of Computer Programs Used for Research Reactor Calculations

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The design of a new pulsed fast neutron reactor "NEPTUN" is being developed in JINR. A large number of calculations are required for the correct operation of the reactor and validation of its safety. In accordance with the requirements for the content of the report on safety justification of research nuclear facilities (NP-049-17 par. 16) [1], the programs used must be verified and attested. Since May 23, 2018, amendments to Article 26 of Federal Law No. 170-FZ of November 21, 1995, "On the Use of Atomic Energy" [2], have stipulated that the development of calculation models must exclusively rely on software programs (SPs) that have undergone thorough expertise.

Creating calculation models using computer programs has its own limitations in applicability. The validity of such models in the Russian Federation is carried out by the Scientific and Engineering Centre for Nuclear and Radiation Safety (SEC NRS), which since 2018 is an official scientific and technical support organization of Rostekhnadzor and carries out expert expertise of computer programs [3]. There were over 300 software programs in the Attestation Certificate Database as of 2023, but less than 10% of them have been attested for use at nuclear research reactors (NRRs) [4]. Factors that complicate the attestation of NRRs software programs include the following:

- Specificity of NRRs' characteristics:

NRRs have some unique characteristics and parameters that do not always correspond to the standard models and methods adopted for commercial reactor calculations. It requires the use of specialized software programs, which must be adapted and verified for the specific conditions of a particular NRR.

- Insufficiency of experimental data:

In some cases, the insufficient amount of experimental data on the operation of a NRR may make it difficult to develop and verify software programs. Insufficient experimental data may make it difficult to properly model the processes occurring in the reactor facility and reduce the accuracy of the calculations.

- Increased safety requirements for NRRs:

NRRs are generally subject to more stringent safety requirements, due in part to the experiments conducted at these facilities.

Neutron-physical calculations are central to the safety justification of NRRs, as the results of neutron-physical calculations are the basis for making judgments about the safe operation of NRRs. In this work, SPs for neutron-physics calculations (MCNP, MCU, PRIZMA-2017, OpenMC, Serpent, SCALE, SAPFIR\_95.1, etc.) were analyzed in order to select the most suitable SP for attestation and further calculations.

1. The requirements for the content of the report on safety justification of research nuclear facilities (NP-049-17) - The Federal Service for Environmental, Technological and Nuclear Supervision, Moscow, 2018.
2. Federal Law No. 170-FZ of November 21, 1995, "On the Use of Atomic Energy". [base.garant.ru](https://base.garant.ru), 22 -01-2024, URL: <https://base.garant.ru/510105506/>
3. Bogdan S. N., Zhylmaganbetov N. M., Kozlova N. A., Ponizov A. V., Sharafutdinov R. B., Shevchenko R. A., Shevchenko S. A., Yashnikov D. A. Current issues of review of computer codes used for safety analysis of nuclear facilities. Nuclear and Radiation Safety, 2022, no. 2 (104), pp. 31–49. DOI: 10.26277/SECNRS.2022.104.2.002 [in Russian].
4. SEC NRS. "List of Attestation Certificate of computer programs (as of 09.11.2023)". [www.secns.ru](https://www.secns.ru), 18.01.2024, URL: <https://www.secns.ru/expertise/software-review/>