March 22, 2021

REVIEW

for the PhD thesis by **Darkhan Sergazievich Sairanbayev "Study of neutron-physical characteristics of the WWR-K research reactor core with a side beryllium reflector"** submitted for the degree of PhD in the specialty 6D060500 – Nuclear Physics.

The research nuclear reactors around the world are widely used for the development of nuclear science and technology, and fundamental and applied researches are conducted using the research reactors. A nuclear reactor is a facility in which ionizing radiation is generated. Thus, it is necessary to operate in accordance with safety rules so as not affect people or environment. In this connection, it is indicated that the operating organization must ensure the safety of a nuclear reactor at all stages of its life cycle in the specific safety requirements of the IAEA.

The research reactor WWR-K is the only multipurpose and stationary reactor in the Republic of Kazakhstan. In 2016, the core was converted to low enriched uranium fuel with a water reflector. According to the plan of conversion of the WWR-K reactor, it is necessary to gradually replace the annular water neutron reflector with beryllium reflector. Such a replacement entails a change in the configuration of the core and, accordingly, its neutron-physical characteristics.

The dissertation devoted to the research of the neutron-physical characteristics of the WWR-K reactor core with an annular reflector. In his thesis, the logical verification was performed by comparison between the calculations result by MCNP6 transport code and experimental results using WWR-K. MCNP6, the latest and most advanced LANL (Los Alamos National Laboratory) transport code representing a recent merger of MCNP5 and MCNPX, has been validated and verified for neutronic analysis of nuclear reactors. In it, the equation of transport of neutrons and other particles is solved by the Monte Carlo method.

At first, D. S. Sairanbaev developed a computational model of the WWR-K reactor by MCNP6 and determined the main neutronic characteristics of the WWR-K reactor. The created computational model was validated on the experimental data on the production of lutetium-177 and the results of neutronics calculations were full compliance with the requirements of IAEA about operation of research reactors. Next, neutron-physical characteristics of the WWR-K reactor were evaluated in the condition of low-enriched fuel

and a beryllium reflector. The influence of the creation of a gradual lateral beryllium reflector on the neutron flux density, the efficiency of the control rods, kinetic parameters and energy release were demonstrated. The accumulation of lithium-6, tritium and helium in a beryllium reflector was calculated in the medium term. He also recommended on the utilized time of beryllium reflector in the core.

The obtained neutron-physical characteristics of the WWR-K reactor core converted from high enriched uranium fuel to low enriched uraniumone were adopted to justify the operational limits and conditions of the WWR-K reactor in its safety analysis. The energy distribution of neutrons in the irradiation channels of the nuclear reactor for each core configuration was used to plan scientific and applied work at the reactor.

The presented dissertation makes a favourable impression and indicates a significant amount of scientific work done by the author in the process of preparing the dissertation. Of considerable practical interest is the code MCNP6 for mathematical modelling of the WWR-K research reactor and determination of its neutron-physical characteristics, which is important for the development of neutronic physics, physics of nuclear reactors and it can make a significant contribution to the development of the nuclear energy and reactor technology.

Based on the materials of the dissertation, there were published 3 scientific articles in foreign journals indexed by Scopus and/or Web of knowledge databases.

I think that the dissertation work of Darkhan Sergazievich Sairanbayev satisfies all the requirements for the works submitted for the degree of PhD, and the author of the dissertation D.S. Sairanbaev deserves a PhD degree in physical and mathematical sciences.

Sincerely,
Scientific Advisor,

Dr. TSUCHIYA Kunihiko
Deputy Director,
Department of JMTR
Oarai Research and Development Institute
JAPAN ATOMIC ENERGY AGENCY (JAEA)