

Type of the Paper (Abstract)

Evaluation of water quality influence on water discharge of a nuclear power plant (non-radiation impact factor)[†]

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Abstract: The main function of the nuclear power plant (NPP) cooling circuit system (CCS) is to remove heat from the power plant equipment. In a NPP, a large amount of water is withdrawn and used by the CCS to remove residual heat from the steam turbines [2]. Moreover, poor cooling water quality can reduce the efficiency of heat transfer, resulting in increased energy consumption and operating costs. In addition to reducing heat transfer efficiency, the discharge of return water from CCS affects the ecological status of the water body. The main function of a NPP cooling circuit system (CCS) is to remove heat from the power plant equipment. However, the quality of cooling water can affect the operation of a NPP [2, 3]. Overall, the basis for assessing the suitability of water for cooling is the analysis of the main parameters affecting the functioning of the circuits [4]. The purpose of the study is to analyze the quality of the make-up, cooling, and return water of the NPP CCS and the surface water of the water body into which the plant discharge water. The study was conducted for the Rivne NPP CCS and the Styr River (Ukraine). Physical and chemical parameters of the water such as temperature, total dissolved solids (TDS), total alkalinity (TA), total hardness (TH), Cl⁻, SO₄²⁻, TSS, dissolved oxygen (DO), chemical oxygen demand (COD), biological oxygen demand over 5 days (BOD), NO₃⁻, Na⁺, K⁺, ammonia nitrogen (N-NH₃), NO₂⁻, PO₄³⁻ were measured weekly and evaluated during 2019–2022. Consequently, each component was analyzed separately to determine the possible impact of the concentration on the maintenance of the water chemistry regime and water discharge. Meanwhile, selected water quality parameters were correlated using Pearson's correlation coefficient to relate the impact of the recharge water to the water parameter in the system, and the water parameter was related to the component content in the water body. Assessment of compliance with the operational standards and according to the Maximum Permissible Concentration (MPC). Discharges of pollutants from the Rivne NPP do not cause the MPC to be exceeded in the Styr River. There are exceedances of the ecological standard for TH, N-NH₃, COD, and BOD₅, but this is due to the discharges of the Rivne NPP and is simultaneously observed in the section of the Styr River up to the Rivne NPP intake. The correlations of quality indicators at the level of very strong and strong between temperature, complex indicators (pH, TA, TH, TSD), as well as between indicators of carbon and nitrogen compounds were determined. The discharges of polluting chemicals were investigated according to the Maximum Permissible Discharge (MPD). The estimated discharges of pollutants, their distribution by components and the actual water discharge of pollutant components of the Rivne NPP do not exceed 50% of the MPD. The evaluation of the effect of water quality on the cooling system of a power plant is essential to prevent operational problems, minimize shut down, and maintain the efficiency of the plant. The value of the actual discharge of a single polluting substance, corresponds to the MPD. Regular monitoring, appropriate treatment, and data analysis are key elements of this assessment process. Overall, the study indicates that there is no negative non-radiological impact of water discharge of polluting chemicals with the effluent of the Rivne NPP CCS on the surface waters of the Styr River.

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