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WATER TREATMENT AND WATER CHEMISTRY

Automated Chemical Monitoring in New Projects of Nuclear Power Plant Units

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Abstract—The development of automated chemical monitoring systems in nuclear power plant units for the past 30 years is briefly described. The modern level of facilities used to support the operation of automated chemical monitoring systems in Russia and abroad is shown. Hardware solutions suggested by the All-Russia Institute for Nuclear Power Plant Operation (which is the General Designer of automated process control systems for power units used in the AES-2006 and VVER-TOI Projects) are presented, including the structure of additional equipment for monitoring water chemistry (taking the Novovoronezh 2 nuclear power plant as an example). It is shown that the solutions proposed with respect to receiving and processing of input measurement signals and subsequent construction of standard control loops are unified in nature. Simultaneous receipt of information from different sources for ensuring that water chemistry is monitored in sufficient scope and with required promptness is one of the problems that have been solved successfully. It is pointed out that improved quality of automated chemical monitoring can be supported by organizing full engineering follow-up of the automated chemical monitoring system's equipment throughout its entire service life.

Keywords: automated chemical monitoring, high-tech analyzer, unit-level control system

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The evolution of tools for automated monitoring of water chemistry conditions at nuclear power plants (NPPs) passed a few stages. The projects of the first NPP units did not incorporate any systems for performing automated chemical monitoring (ACM). But with development of the requirements for water chemistry conditions in the main process loops, a need to develop such systems arose. As regards ACM tools for operating power units, there was nothing to do but develop and put them in use by groups of measurement channels taking into consideration constraints connected with the kinds of support, premises, and conditions of carrying out works on operating equipment.

Technical solutions adopted at the level of individual NPPs served as a basis for the first efforts to introduce elements of ACM systems (the Kola NPP in 1983–1986 and the Novovoronezh NPP in 1984–1989). In the subsequent, full design development of ACM systems with the use of computerized tools was planned (the Titan-2 and Uran computer-based control systems for the Zaporozh'e and South Ukrainian NPPs in 1987–1992 [1]). However, insufficient experience and lack of clear idea about the tasks to be imposed on ACM systems (in the absence of relevant regulatory documents), as well as a limited fleet of automatic analyzers and computerized tools that were available at that time, were the factors due to which the work on introducing ACM at NPPs slowed down.

However, in the late 1990s, which saw a change in the social and economic situation, and in which the construction of power units at the Rostov and Kalinin NPPs was resumed, and new projects of NPP units began to be developed, a need arose to develop ACM systems, and conditions for implementing them became available.

At present, the following standard solutions have become commonly accepted ones [2]:

(i) The tasks imposed on a sample preparation system and on the hydraulic components of analyzers are separated from each other: a sample conditioned to the analyzer's normal mode of operation is delivered to it (the temperature, pressure, and flowrate are reduced and stabilized, and coarsely dispersed admixtures are removed from the sample), whereas the design of an analyzer itself ensures convenience of its operation, maintenance, and calibration.

(ii) Samples of media operating under vacuum conditions are taken by means of plunger pumps.

(iii) Sample preparation devices are cooled by water circulating in their own cooling circuits.

(iv) Pressurized samples are prepared to measure the concentrations of hydrogen and oxygen dissolved in the water of reactor coolant systems.