In-service monitoring and diagnostics of equipment and pipelines of nuclear installations

In 2017, NIKIET started developing **a draft standard for in-service monitoring** the condition of equipment and pipelines of a designed **nuclear power installation with lead coolant**. The experimental nature of this installation and the lack of accurate knowledge about the features of its operation (which could not be obtained a priori or from available statistics) necessitate monitoring not only the condition, but also the operational loads and the reaction of the structure to them, as well as assessing the integrity of the structure in real time. The standard provided for the creation of a complex system that would combine functions usually performed by several different systems:

- condition monitoring;
- structural load and static/dynamic response monitoring;
- structural health monitoring, including defect diagnostics.

Such differentiated systems have long been used in the operation of power facilities, air and space vehicles and sophisticated infrastructure objects, for example, high buildings or bridges. In Russia, the construction and operation of the systems intended for monitoring or diagnostics are regulated by standards GOST 30848-2003 (which reproduces provisions of ISO 13380: 2002), GOST R 53564-2009, GOST 31937-2011, GOST R 57281-2016 and other similar documents. I took part in the development of new standard at NIKIET, based on my experiences in solving some problems in this area and the results of the analysis of promising concepts that are described in the publications:

NIIPMM (1997) Matematicheskoe modelirovanie dinamicheskikh protsessov i diagnostika oborudovaniya pervogo kontura AES s WWER-1000 (Mathematical modelling of dynamic processes and diagnostics of equipment of the primary circuit of NPPs with WWER-1000). Research Institute of Applied Mathematics and Mechanics (NIIPMM) at N. E. Bauman Moscow State Technical University, Moscow (Contributors: Kinelyov VG, Drong VI, Perov SL, Spirochkin YK)

Spirochkin YK (1997) Sistema vibroshumovoi diagnostiki reaktornykh ustanovok tipa WWER. Programmnoe obespechenie dlya konechnoelementnogo analiza konstruktsii: NewTone. Versiya 1.5. Spetsial'naya konfiguratsiya dlya raschyota dinamicheskikh kharakteristik konstruktsii v zhidkosti. Rukovodstvo pol'zovatelya (System of vibration-noise diagnostics of reactor installations of the WWER type. Software for finite element analysis of structures: NewTone. Version 1.5. Special configuration for calculation of dynamic characteristics of structure in fluid. User's manual). Concern Rosenergoatom. Center for Non-destructive Testing and Diagnostics: DIAPROM, Moscow

Golovlyov YN, Spirochkin YK, Sizaryov VD (2007) Osobennosti ekspluatatsionnogo monitoringa resursa korabel'nykh PPU (Features of operational monitoring of the life of ship steam-producing installations). Godovoi otchyot FGUP NIKIET - 2007: Sb. statei/ Pod red. E. O. Adamova (In Adamov EO (ed) Annual report of NIKIET - 2007: Collection of articles), p 133-134. NIKIET, Moscow

Spirochkin YK, Evropin SV (2008) Podkhody k informatsionnomu soprovozhdeniyu prochnosti YaU v techenie zhiznennogo tsikla (Approaches to information support of the strength of nuclear facilities during the life cycle). Godovoi otchyot FGUP NIKIET - 2008: Sb.

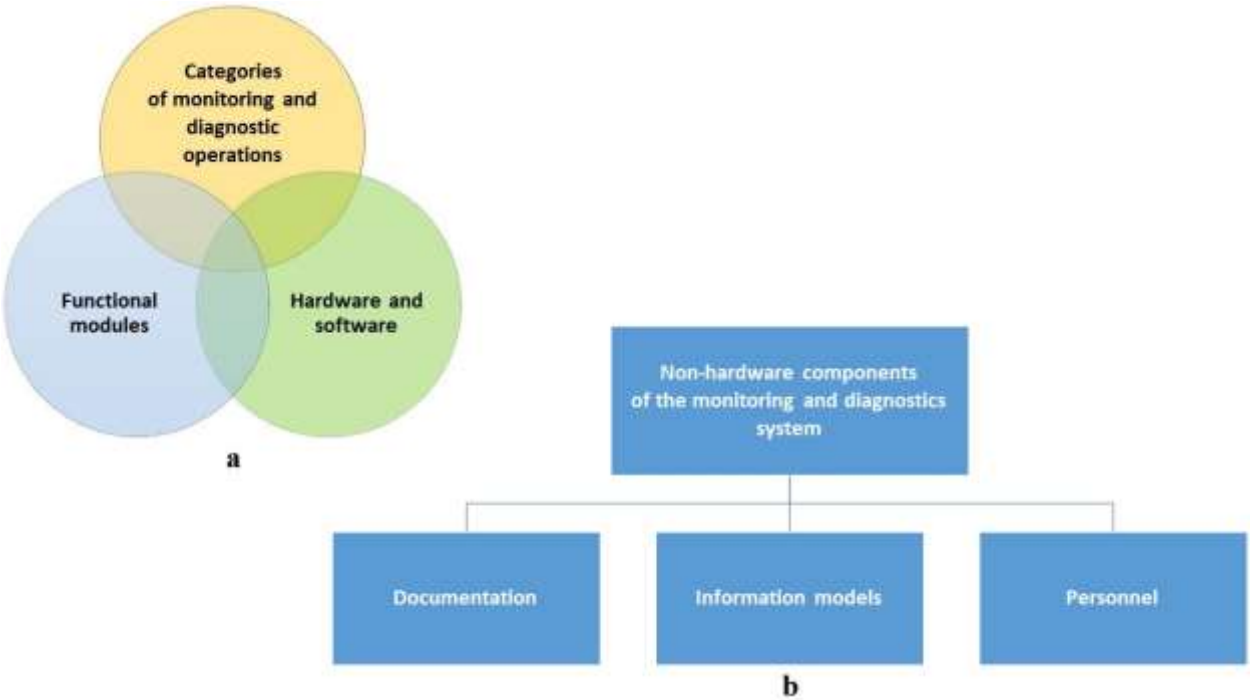
statei/ Pod red. E. O. Adamova (In Adamov EO (ed) Annual report of NIKIET - 2008: Collection of articles), p 120-121. NIKIET, Moscow

Sizaryov VD, Spirochkin YK (2008) Vibrodiagnostirovanie kak odno iz napravlenii v ekspluatatsionnom monitoringe resursnykh kharakteristik oborudovaniya korabel'nykh PPU (Vibration diagnostics as one of the directions in the operational monitoring of the life of equipment of ship steam-producing installations). Godovoi otchyot FGUP NIKIET - 2008: Sb. statei/ Pod red. E. O. Adamova (In Adamov EO (ed) Annual report of NIKIET - 2008: Collection of articles), p 128-129. NIKIET, Moscow

Spirochkin Y, Atroshenkov R and Odintsev I (2010) On active diagnostics method for assessment of technical condition of nuclear facility components. Proceedings of the ASME 2010 10th Biennial Conference on Engineering Systems Design and Analysis. ASME 2010 10th Biennial Conference on Engineering Systems Design and Analysis, Volume 2. Istanbul, Turkey. July 12–14, 2010. p 329-334. ASME. https://doi.org/10.1115/ESDA2010-25089

Spirochkin YK, Atroshenkov RS (2010) Spocob diagnostirovaniya skrytykh defektov konstruktsii oborudovaniya i truboprovodov (Method for diagnosing hidden defects in equipment and pipeline structures). Patent RU 2,437,072, June 09, 2010

The novelty of the standard developed at NIKIET consisted in **the multifunctional nature of the monitoring and diagnostics system, its applicability to the reactor with unconventional structure and operating conditions** (basin-type configuration, high temperatures, interaction of structural parts with liquid lead coolant)**, the possibilities of using new monitoring and diagnostic technologies**.



Concept of the monitoring and diagnostics system: a framework and **b** non-hardware components

The material used in the draft standard includes the following sections and subsections:

1 Application area

2 Terms, definitions and abbreviations

3 Concept of monitoring

Yuri Spirochkin November 16, 2022