ASSESSMENT OF THE TECHNOLOGy READINESS LEVEL FOR TRITIUM PRODUCTION AND Tritium safety IN RUSSIA ON THE EXAMPLE OF THE DEMO-FNS PROJECT [[1]](#footnote-1)\*)

DOI: 10.34854/ICPAF.2022.49.1.069

Ivanov B.V., Ananyev S.S.

National Research Center Kurchatov Institute, Moscow, Russia, kapjicohh@gmail.com

In the report, the authors continue the analysis of the technologies of the tritium fuel cycle (FC) in Russia and the world, begun earlier [1], [2]. The analysis is supplemented with an overview of technologies: tritium production in the blanket of a fusion reactor; preparation of breeder materials; extracting tritium from the blanket; storing tritium in the fuel cycle; ensuring tritium safety and analyzing tritium-containing substances, as well as technologies for fuel injection into the plasma and pumping out the tokamak chamber. Considering the previously obtained results, a complete assessment of tritium technologies for all fuel cycle systems of the projected hybrid (fusion-fission) DEMO-FNS reactor [3], [4] was carried out.

The analysis was carried out using the Technology readiness level (TRL) methodology developed by the United States National Aeronautics and Space Administration (NASA). The methodology allows, based on objective and systemic criteria, to quantify the maturity of a particular technology in the target area of application. The rating scale includes 9 levels that correspond to: demonstration of the basic principles of technology (TRL 1), verification of technology components/mock-ups in the laboratory (TRL 4), verification of the technology in the target state during successful operation (TRL 9), etc. The levels are grouped into stages: Research (TRL 1-3), Development (TRL 4-6) and Demonstration (TRL 7-9).

The authors show that at present in Russia work is underway to develop and master the technologies of the tritium fuel cycle. Tritium technologies are actively used in various fields; additional research and development of technologies are needed to adapt and refine it to the specific parameters and modes of the FC. Most of the technologies are sufficiently developed for use in the FC of DEMO-FNS. Some technologies, for example, hydrogen isotopes chromatographic separation and cryoadsorption purification of tritium-containing mixtures are at the stage of Research and should be developed and tested for use in the FC of DEMO-FNS. To increase the level of technology readiness in Russia, it is advisable to create specialized research facilities.

Comparison of the development of technologies with the world level shows the lag of some key technologies, for example, the purification of hydrogen-containing mixtures in reactors based on palladium membranes and the extraction of tritium from the blanket. It is advisable to work on international cooperation in the field of tritium technologies application in fusion research.

This work was partly supported by NRC Kurchatov Institute.

References

1. S.S. Ananyev et al., *Nucl. Fusion*, https://doi.org/10.1088/1361-6463/aad7de, Sep. 2021.
2. B.V. Ivanov, S.S. Ananyev, “ Analysis of the readiness level of tritium cycle technologies in russia for the DEMO-TIN hybrid reactor”, *XLVIII International (Zvenigorod) Conference on Plasma Physics and Controlled Thermonuclear Fusion*, 2021, http://www.fpl.gpi.ru/Zvenigorod/XLVIII/Mu/ru/AE-I (in Russian).
3. B.V. Kuteev et al., “Development of DEMO-FNS tokamak for fusion and hybrid technologies” *Nucl. Fusion*, vol. 55, no. 7, p. 073035, Jul. 2015.
4. E.A. Azizov *et al.*, “Tokamak DEMO-FNS: Concept of magnet system and vacuum chamber,” *Phys. At. Nucl.*, vol. 79, no. 7, pp. 1125–1136, 2016.
1. \*) [abstracts of this report in Russian](http://www.fpl.gpi.ru/Zvenigorod/XLIX/Mu/ru/BS-Ananiev.docx) [↑](#footnote-ref-1)