Russian Tritium CYCLE TECHNOLOGY readiness level ANALYSIS FOR THE DEMO-FNS HYBRID (fission-fusion) REACTOR [[1]](#footnote-1)\*)

DOI: 10.34854/ICPAF.2021.48.1.019

Ivanov B.V., Ananiev S.S.

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

One of the main systems providing the operation of a fusion or hybrid reactor is the tritium-deuterium fuel cycle (FC). Within the framework of the program for the development of fusion and hybrid technologies in the Russian Federation, a DEMO-FNS project is being underway, aimed at developing hybrid technologies and their integration [1]. The specific features of a tokamak-based reactor are stationary operation, Q ~ 1 and a blanket with fissile materials - these factors largely determine the configuration and basic FC technologies [2].

This paper compares the matureness of the previously selected candidate technologies for tritium-deuterium FC [2] in the Russian Federation and in the world. The DEMO-FNS project provides usage of proven technical solutions [1], [3], including tritium technologies, some of which are included in the dual-use list and cannot be imported from other countries. Technologies for handling tritium and other hydrogen isotopes are used in Russia in various fields, which makes it easier to use them in the DEMO-FNS fuel cycle; however, until now, a systematic approach to assess their readiness level for use in fusion installations has not been carried out.

To assess the technology maturity the authors use the Technology readiness level (TRL) methodology. In a narrow view, the TRL methodology makes it possible to assess the readiness of a particular technology for use in a particular device or technical system, in a broad view - to fulfil the goals of a scientific or technological program. The same approach allows formally assessing technological gaps, planning the necessary research and investments, and identifying possible risks. The TRL methodology has become widespread and has recently been actively used in the scientific field - in particular, it was used to assess the readiness of technologies in the fusion: for a fusion power plant [4]; for the fuel cycle of the DEMO reactor [5]; for plasma diagnostics [6]. These papers demonstrate the effectiveness of the TRL methodology for evaluating various technologies and for planning research programs.

It is shown that the technologies that will be used in the DEMO-TIN fuel cycle have been developed in the Russian Federation and are used in other areas of industry and science. The absence of specialized testing equipment for technologies applied to fusion or hybrid fuel cycle systems only allows us to assess their maturity at the TRL 2-5. This generally corresponds to the readiness of most technologies of the fusion fuel cycle in the world. For further development and increasing the level of readiness, it is necessary to refine technologies in operational conditions.

The work was supported by the NRC “Kurchatov Institute (28.09.2020 № 1934а).

References

1. B.V. Kuteev, E.A. Azizov, et al., *Nucl. Fusion*, vol. 55, no. 7, p. 073035, Jul. 2015.
2. S.S. Ananyev, B.V. Ivanov, and B.V. Kuteev, *Fusion Eng. Des.*, vol. 161, no. December 2019, p. 111940, 2020.
3. B.V. Kuteev and Y.S. Shpanskiy, *Nucl. Fusion*, vol. 57, no. 7, p. 076039, Jul. 2017.
4. M.S. Tillack *et al.*, *Fusion Sci. Technol.*, vol. 56, no. 2, pp. 949–956, 2009.
5. Y.N. Hörstensmeyer, B. Butler, C. Day, and F. Franza, *Fusion Eng. Des.*, vol. 136, no. January, pp. 314–318, 2018.
6. F.P. Orsitto *et al.*, *Nucl. Fusion*, vol. 56, no. 2, 2016.
1. \*) [abstracts of this report in Russian](http://www.fpl.gpi.ru/Zvenigorod/XLVIII/Mu/ru/AE-Ivanov.docx) [↑](#footnote-ref-1)