TRITIUM FUEL CYCLE TECHNOLOGIES DEVELOPMENT FOR FUSION FACILITIES IN THE RUSSIAN FEDERATION [[1]](#footnote-1)\*)

DOI: 10.34854/ICPAF.2023.50.2023.1.1.063

1Ananev S.S., 1Ivanov B.V., 1,2Kuteev B.V., 3Yukhimchuk A.A.

1National Research Center Kurchatov Institute, Moscow, Russia, [Ananyev\_SS@nrcki.ru](mailto:Ananyev_SS@nrcki.ru),  
2NRNU MEPhI, Moscow, Russia  
3Russian Federal Nuclear Center All-Russian Research Institute of Experimental Physics  
 RFNC - VNIIEF, Sarov, Russia

One of the most important systems necessary to ensure the operation of a fusion reactor with tritium is a complex of tritium fuel cycle systems (FC). Since 2007, the National Research Center "Kurchatov Institute" has been carrying out work on the selection and justification of characteristics, as well as the design of FC systems. During this time, approaches have been developed and software products have been developed to determine the parameters of the FC depending on the parameters of the controlled fusion reactor (CFR) for which it is intended. The FC complex is necessary to ensure the operation of any fusion or hybrid plant using tritium in any, even the smallest amount, since it is necessary to organize the circulation of the fuel mixture with the tritium extraction and purification from fusion reaction products.

Tritium handling technologies are historically well developed in Russia, but they are primarily focused on dual use. Therefore, the creation of FC systems in Russia is possible, but it requires cooperation and coordination of the work of a dozen different institutions - leading organizations in their fields.

To create an operating FC system as part of a tokamak, it is necessary to go through several stages:

1. Creation of a complex of laboratory stands for research and improvement of individual fuel cycle systems (systems based on new physical principles with improved characteristics). The creation of such stands is optional, but highly desirable for the training of scientific personnel and improving the performance of the system as a whole.

2. Creation of a tritium-free protium-deuterium fuel cycle CFR, testing and life tests of all fuel cycle systems in the course of joint work. This system can be created at any site, proximity to the tokamak is not needed.

3. Creation of a tritium fuel cycle. This system can be set up at any site where there is permission and experience with large amounts of tritium.

4. Creation of a tritium fuel cycle system at the tokamak (on the tokamak that will be built first).

The implementation of 4 stages at once without the implementation of 2 and 3 stages carries significant risks associated with the fact that the fuel cycle complex, created immediately as part of a fusion plant without preliminary testing of systems and carrying out life tests, may be inoperable or its launch will require an unacceptably long time.

It should be noted that NRC "Kurchatov Institute" can be a scientific supervisor and coordinator of the creation of a closed fusion FC system, since it has a large backlog in designing fuel cycle schemes for fusion facilities.

This report is devoted to the description of the stages of the roadmap for the development of FC technologies for tokamaks, as well as the ways of implementation.

This work was partly supported by NRC Kurchatov Institute.

1. \*) [abstracts of this report in Russian](http://www.fpl.gpi.ru/Zvenigorod/L/Mu/ru/AT-Anan'ev.docx) [↑](#footnote-ref-1)