Contribution ID: **319** Type: **not specified**

Three-dimensional model of DEMO-FNS reactor for neutronics calculations and radiation shield problems

Monday, 17 September 2018 11:00 (2 hours)

At the present stage of the Demonstration Fusion Neutron Source (DEMO-FNS) design the actual problem is a development and use of the three-dimensional model of this device to the solution of various neutronics problems for the integration of the basic technological systems of tokamak. The radiation safety and the development of the radiation shield are crucial problems which significantly affect the layout and cost of the installation. Besides the basic radiation shield, the FNS blanket obtains shielding properties. The blanket design is currently being developed. The blanket is also a powerful source of neutrons. The recent neutronics studies of the blanket showed a crucial influence of a coolant substance on the rate of transmutations of the transuranium elements and the generation of tritium in the system. This paper presents the three-dimensional DEMO-FNS model developed for the Monte Carlo calculations and the results of its application for the estimation of the characteristics of the DEMO-FNS radiation shield to protect the materials of the superconducting coils of toroidal magnetic field (TMFC) from the neutrons and secondary photons, taking into account the replacement of the water coolant of the blanket to the carbon dioxide one. It was performed the analysis of the neutron balance, the neutron energy spectra and energy release of the neutrons and secondary photons in the shield, case and superconductor on the inner and outer contour of TMFC. It was found that the energy release in the case and superconductor on the outer contour of TMFC located between the injector port and the blanket maintenance port was overestimated in the area facing the injector port by about 10 times in comparison with the monolithic shield option. This indicates that the increase of the local iron-water shield of the injector port is required.

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Session Classification: P1