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STATUS OF THE ELECTRON CYCLOTRON SYSTEM OF THE ITER PROJECT *)

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The electron cyclotron system, along with ion cyclotron and neutral beams, is one of the additional heating systems of the ITER project. The project planned to use 24 gyrotrons with an output power of about 1 MW each, two 20 MW ion-cyclotron heating units and two 16 MW neutral beam sources with atomic energies up to 1 MeV. All systems were considered promising not only for heating plasma components, but also for generating or maintaining a toroidal current. For the electron cyclotron system (EC), additional functions were provided for the breakdown and initial formation of plasma, as well as the suppression of MHD instabilities, which involved the use of gyrotrons in a frequency mode of up to 5 kHz. It should be noted that the mentioned prospects were associated with expectations of the successful development of technology samples for all three methods and the possibility of their use for thermonuclear plasma purposes. However, to date, of all the methods, only gyrotrons have achieved the planned parameters. Therefore, and also in connection with the change in the material of the first wall of the reactor to tungsten, it is planned to increase the power of the gyrotron complex by 2 times by the first stage of ITER operation (Augmented First Plasma) and then by the next phase (DT1) to increase the total number of gyrotrons to 72. Electron-cyclotron the system functionally consists of high-voltage sources (HVPS), gyrotrons located at a distance of more than 100 m in the region of weak scattered fields of the tokamak, transmission lines (TL) and radiation shapers (Launcher Equatorial, Upper), located in the equatorial and upper nozzles of the tokamak. High-voltage sources and gyrotron complexes with a control system are located in building B15, transmission lines pass through building 13, adjacent to the tokamak building B11. High-voltage sources, each with 2 gyrotrons (with an output power of up to 6 MW), are the responsibility of Europe and India in equal shares. The supply of gyrotrons, which includes installation and configuration of equipment, is distributed between Japan - 8 pcs., Russia - 8 pcs., Europe - 6 pcs. and India - 2 pcs. The transmission line in the assembly elements is being prepared by the USA. Formers of radiation into plasma are the responsibility of Europe. The entire infrastructure of the complex is the responsibility of Europe. In 2024, it is planned to begin installation of the main equipment of the EC system. Here are the main technical characteristics of gyrotrons produced by NPP GYCOM: power at the output of the diamond window is at least 1 MW, frequency 170 GHz, efficiency. not less than 50% (actually up to 57%), the HE11 mode content at the input to the transmission line is not less than 95%, the pulse duration is not less than 1000 s with a reliability of more than 95%, etc.

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