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CALCULATION OF STABLE EQUILIBRIUM CONFIGURATIONS AND SCENARIO FOR THE FIRST EXPERIMENTS ON THE T-15MD TOKAMAK USING THE TOKSCEN CODE *)

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By the end of 2023, as part of the power start-up at the Tokamak T-15MD thermonuclear installation (Russia, National Research Center "Kurchatov Institute") [1], two experimental campaigns were carried out. To obtain equilibrium magnetic configurations and ensure stable discharge scenarios, a series of calculations were carried out using the TOKSEN code.

The main goal of the autumn campaign was to obtain a discharge with a plasma current in the range of hundreds of kiloamperes. For this purpose, a numerical analysis of the discharges of the spring campaign was previously carried out. Based on the simulation of discharges with unstable vertical plasma equilibrium [2], relations were obtained for the currents in the inductor sections CS1, CS2 and CS3 and the control coils PF2-PF5, which make it possible to ensure vertical plasma stability when using various different combinations of currents in the inductor sections and poloidal coils. Calculations were carried out taking into account current restrictions on currents in control coils. The sensitivity of the results of numerical calculations to the position of the plasma column and the internal plasma inductance, which are input parameters when solving the equilibrium problem, was analyzed. It is shown that changes in the internal plasma inductance for skinned and peaked current distributions have little effect on the currents in the coils.

As a result of the simulation, a methodology was developed for the formation of a vertically stable plasma, a scenario for increasing the plasma current, controlling the gap distance between the plasma and the walls of the vacuum chamber and controlling its movements. It has been shown that to ensure vertical plasma stability throughout the entire pulse duration, it is necessary to ensure that the relation (I(PF3)+I(PF4))/(I(PF2)+I(PF5))>2 is satisfied throughout the entire discharge stage (I (PF2)-I(PF5) – currents in the corresponding control coils). When receiving discharges with a plasma current >100 kA and a duration of 600 ms or more, it was necessary to ensure an optimal horizontal position of the plasma current in order to reduce the interaction of the plasma with the wall on the side of the strong magnetic field. As a result of calculations, current ratios were obtained that made it possible to solve all the problems posed during the experiments.

This paper presents the results of a comparison of experiments with calculations, including those that were made in advance and were in the nature of a forecast. Work was introduced both at the stages of preparation and during the implementation of experiments, which made it possible to quickly adjust discharge scenarios taking into account current experimental information. Extensive experience was gained in testing and implementing discharge scenarios on the T-15MD tokamak.

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References

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