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Conceptual Design Study for Japanese Fusion DEMO Reactor

Hiroyasu Utoh

National Institutes for Quantum Science and Technology (QST), Rokkasho Institute for Fusion Energy, Japan

E-mail: uto.hiroyasu@qst.go.jp

***Abstract*—The conceptual design of the Japanese demonstration (DEMO) reactor is being carried out by the Joint Special Design Team for fusion DEMO to establish the Japanese DEMO concept, named "JA DEMO" [1]. The following values are set for the main design parameters of JADEMO to meet the requirements of the DEMO reactor [2]. The plasma major radius (R_p) is 8.5 m, fusion output (P_{fus}) is 1.5-2 GW, the net electric power (P_{net}) is 0.2-0.3 GW, and the magnetic field on the plasma axis (B_t) is 6 T. On the other hand, from the viewpoint of early power generation demonstration, the larger reactor in the conventional JADEMO concept leads to a more extended construction period and higher development risk. Therefore, based on ITER's experience in manufacturing toroidal field coils and its ability to foresee burning plasma (high energy multiplication), for the early power generation demonstration, a conceptual design study was carried out on a DEMO reactor downsized from JA DEMO (R_p = 8.5 m) to the ITER size (R_p = 6.2 m), with a step-by-step approach to demonstrate early power generation and tritium breeding, and to obtain the net electric power of 100 MW-class.**

By improving the in-vessel components step by step in a single device, the DEMO rector concept was presented that could achieve a net electric power of more than 0 with ITER-like parameters in Phase I, demonstrate comprehensive tritium breeding for self-realization with JA DEMO-like parameters in Phase II, and achieve the net electric power of 100 MW-class with JT-60SA-like parameters in Phase III. As initial parameters, the TF coil was assumed to have the same dimensions and performance as the ITER-TF coil (superconducting wire: Nb_3Sn, conductor current: 68 kA, design stress: 667 MPa (yield stress: 1000 MPa)). On the other hand, assuming the use of high-strength cryogenic steel with a yield stress of 1200 MPa [3] and 83 kA conductors, which have been developed for JA DEMO, the magnetic field on the plasma axis B_t will increase by 0.35 T and P_{net} by about 15 MWe. These are very important to ensure net electrical output in Phases I to III, and since TF coils are difficult to upgrade step by step, it is essential to complete these R&Ds as soon as possible.

***Keywords (Index Terms)*— Fusion DEMO, TF coil, large coil, LTS**

References
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