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Strategies toward the Realization of the Helical Fusion Reactor FFHR-c1

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Design studies on the helical fusion reactor FFHR-c1 has been progressed. The main goal of the FFHR-c1 is to demonstrate one-year steady-state sustainment of the fusion plasma with self-produced electricity and tritium. The major radius of the plasma, R , is ~ 10 m and the magnetic field strength at the plasma center, B , is ~ 8 T. High-temperature superconductor (HTS) magnet coils are adopted in the design. During the one-year operation, ~ 370 MW of fusion power is sustained with ~ 25 MW of auxiliary heating power supplied by the electron cyclotron heating (ECH) of ~ 220 GHz. Then, the fusion gain, Q , is ~ 15 . A liquid metal divertor system named the REVOLVER-D is adopted for the reasons of easy maintenance and a high permissible heat load. In this system, ten sets of molten tin showers are discretely inserted to the inboard side of the ergodic layer surrounding the main plasma. A cartridge-type molten salt (or liquid metal) blanket named the CARDISTRY-B is also adopted for easy maintenance. For the realization of the FFHR-c1, it is necessary to accumulate experiences on the new technologies of the HTS magnet coils, the REVOLVER-D, and the CARDISTRY-B. Including these three, we have defined 22 important issues that should be resolved before building the FFHR-c1. The strategy to efficiently address the 22 issues has been also discussed. As a result, we propose a step-by-step approach by developing FFHR-01 ($R \sim 0.4$ m and $B \sim 3$ T) for basic studies on HTS coils and the REVOLVER-D, FFHR-a1 ($R \sim 2.5$ m and $B \sim 4$ T) for demonstration of one-year operation under a non-nuclear condition, and FFHR-b1 (same R and B as FFHR-a1) for DT operation, before FFHR-c1. The FFHR-b1 plays a role of volumetric neutron source (VNS) and the FFHR-a1 corresponds to the cold test of the VNS.

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