§11. Design Study of the Electrical Power System for FFHR

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In this report, the design study of the electrical power system for the FFHR is described.

In addition to the reactor and generator, some components are necessary to operate the FFHR as an energy plant. The diagram of the outline of the plant is shown in Figure 1.

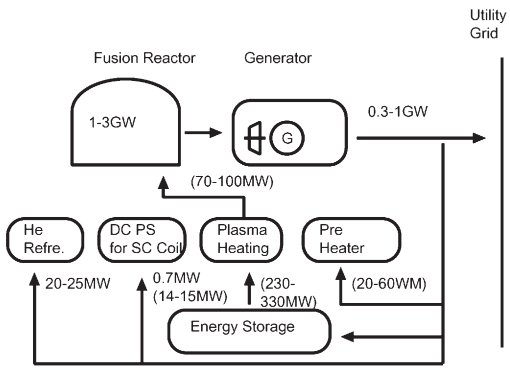

Figure 1: Diagram of the FFHR plant

In the figure, thermal power and electrical power is described. The number shown in the blanket is the necessary power to start up the reactor.

In this figure, we assumed that the efficiency of NBI is 30%, conduction loss of the power supply is 5% respectively. The circulation power in the plant, that is necessary to maintain the plant operation, is used in the He refrigerator and power supplies for coils. These powers are 7-3 % of electrical output of the FFHR plant and it is kept small compared with the plant output. In this point, the merit of FFHR operation that does not require the external plasma heating in the steady state becomes clear.

The outline of the electrical power used in the FFHR2 plant is shown in Figure. 2.

When the FFHR is in the steady stat operation, only the He refrigerator and power supplies for superconducting coils consume the electric power. When start up the FFHR, a pre-heater and dc power supplies for coils require the 8-10% of the plant electrical output. This power is required for several hours and an energy storage device is not suitable for this purpose. Therefore some local generator or power supplies from utility network is necessary.

Plasma heating using the NBI requires 230-330MW in short time. This power is about 30% of the plant output, and the energy storage device such as a flywheel motor-generator should support this energy.

When we consider the maximum voltage while quench protection, the turn numbers of coils are limited.

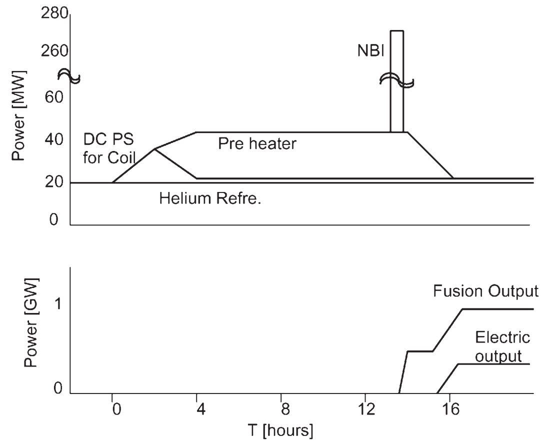

Figure 2: Electrical power used at the start up of the FFHR

Table 1: superconducting coils

	coil cur. [kA]	turn num.	vol. [V]	number of Coils
H	100.1	54	16	8
OV1	100.1	110	18	1
OV2	100.1	115	18	1
IV	100.1	116	0.1	1

In the current design, we assume that the superconducting coil currents of FFHR are ramped up within 5 hours. With this scenario, the required excitation voltages become about 18 V as shown in Table 1. In this coil system, the operating currents of coils are same and they can be connected in series to be excited by a single power supply. With this architecture, the power loss generated by dc power supply in the steady state can be suppresses.

The effect to the plasma operation caused by the series connection of superconducting coils should be studied to realize this architecture.

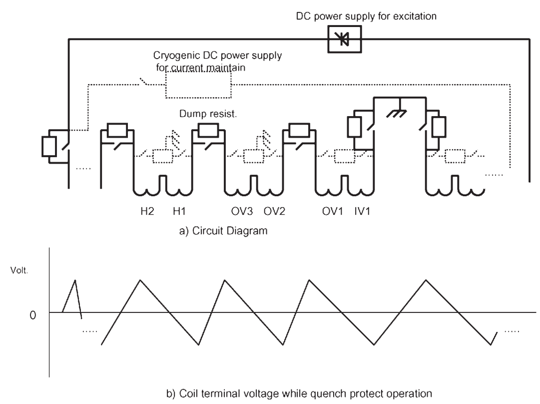

Figure 3: An example of circuit diagram for the excitation of superconducting coils using single dc power supply.