§11. Power System for Fusion Reactor including Auxiliary Devices with Various Requirements for Supplied Power Quality

Ise, T., Miura, Y., Segi, H. (Osaka Univ.),
Chikaraishi, H.

It is supposed that nuclear fusion generation plant will include various auxiliary devices. For example, in the case of magnetic confinement nuclear fusion reactor, superconducting coils and its power supplies, plasma heating devices, vacuum pumps, helium refrigerators, control and measurement instruments will be included in the system. These devices require various power qualities, that is, some devices require high quality power without voltage sags and interruptions, some devices require high quality power without voltage sags, other devices do not require such high quality power. From this point of view, the concept of multi-quality power supply system proposed in FRIENDS (Flexible Reliable Intelligent Energy Delivery System)[1] is adopted for the power system of helical type nuclear fusion reactor. The purpose is to supply required quality of power to auxiliary devices and not to affect power disturbances to bulk power system caused by the operation of fusion reactor plant.

Table I shows auxiliary devices in helical type reactor and their characteristics. Considering these characteristics, the power system shown in Fig.1 is proposed in this study. The Quality A power does not cause voltage sags and interruptions with the same quality as UPS (Uninterruptible Power Supply). This power is supplied to control and measurement instruments. The Quality B1 power does not cause voltage sags and interruptions except interruptions less than 15ms. This power is supplied to important loads such as helium refrigerators, power supplies for superconducting coils and vacuum pumps. In the case of Quality B2 power, voltage sags are compensated and distributed generator is used for backup power. Plasma heating devices are powered by Quality B2 with energy storage devices, because the peak power of heating devices is large. In the case of Quality B3 power, voltage sags are compensated but interruptions are not compensated. The pellet injector and coolant pump is used only after the generator is stated, so B3 power is used for these loads.

Reference

1) Nara,K., Hasegawa,J., Oyama,T., Tsuji,K., and Ise, T. “FRIENDS – Forwarding to Future Power Delivery System”, Proc. of the Ninth International Conference on Harmonics and Quality of Power (ICHQP 2000), pp.8-17, Florida, USA , (October 2000)

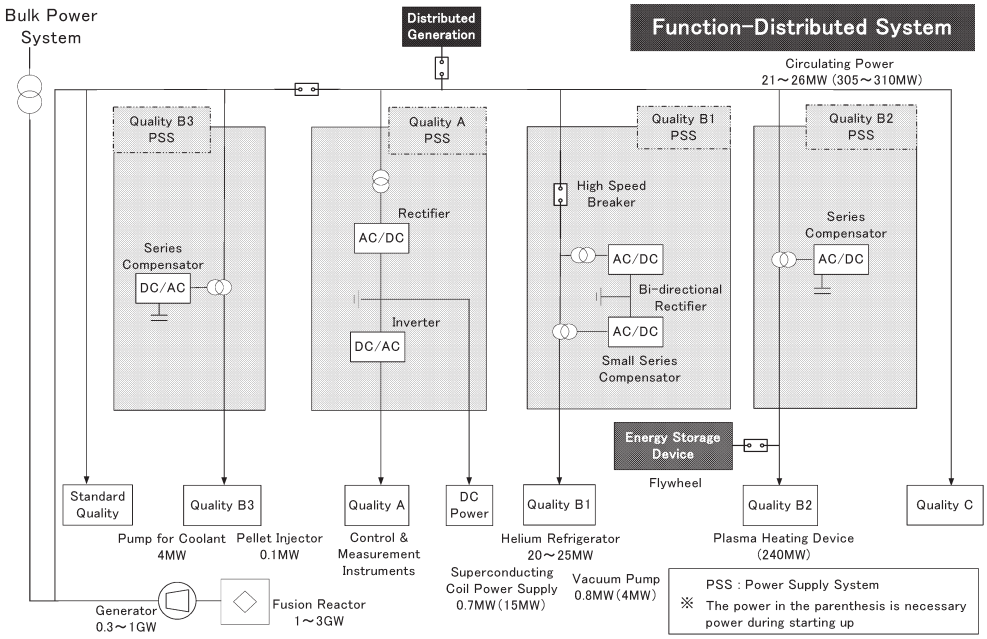

Fig.1. Proposed Power System for Helical Type Fusion Reactor

Table I. Auxiliary Devices in Helical Type Reactor and Their Characteristics

Devices	Load Type	Operating Pattern	Active Power [MW]	Power Factor [%]	Role of the Device
Helium Refrigerator	Induction Motor	Continuous operation	20-25	95	Keep the superconducting coil in superconducting state
Power Supply for Superconducting Coil	Thyristor Rectifier (More than 24-phase)	Depending on the operation scheme	0.7(steady state), 15(starting up)		Excite superconducting coils to make magnetic field
Plasma Heating Device (NBI)	Thyristor Rectifier	Require large power during starting up	200	65	Heating plasma
Plasma Heating Device (RF)	Thyristor Rectifier	Require large power during starting up	40		Heating plasma
Plasma Heating Device (Total)	Thyristor Rectifier	Require large power during starting up	240 (Starting up)		Heating plasma
Auxiliary Heat Source	Resistor	Not known			Pre-heating of plasma
Pellet Injector	Induction Motor	Continuous operation	0.1?	70?	Keeping plasma
Vacuum Pump	Induction Motor or Inverter Driven Motor	Continuous operation	0.8(steady state), 4(starting up)		Keeping vacuum
Coolant Pump	Induction Motor	Not known	4		Cooling generator