

§6. Construction of a Cryogenic System for the Large Helical Device

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The cryogenic system for the LHD consists of the helium refrigerator/liquefier, the LHD cryostat in which the superconducting helical coils, the poloidal coils and the coil supporting structures are installed, and the peripheral equipment, such as the control-valve-boxes by which the flows of the cryogen from the He refrigerator to the helical and poloidal coils are controlled, the superconducting bus-lines and the cryogenic transfer-lines, etc.

Safety and stable operations of the SC coil system should be required because the total magnetic stored energy of the LHD becomes 0.9 GJ in phase I operations and 1.6 GJ in phase II operations. Reliable long-term operations are necessary for cryogenic system because a warm-up of the total system including the SC coils will be done only once or twice a year. Three different cooling schemes are utilized for each cooling object; a pool boiling for the helical coils (the cold mass of 240 tons), a forced flow of supercritical helium for the poloidal coils (182 tons), a forced

flow of two phase helium for the coil supporting structure (390 tons) and the superconducting bus-lines (the total length of 463 m). Fig. 1 shows the flow diagram for the cooling objects of the LHD cryogenic system.

The helium refrigerator/liquefier has cooling capacities of 5.65 kW at 4.4 K, 20.6 kW from 40 K to 80 K and 650 L/h liquefaction. Shown in Fig. 3 are the main components in the He refrigerator room; the cold-box, the helium gas purifier, the 20,000 liter liquid helium reservoir, the 50,000 liter liquid nitrogen reservoir which is used only for the initial cool down and for the helium purifier.

The development of a new control system, which is highly flexible and expandable concerning both hardware and software, is crucial for the cryogenic system of the LHD because of fairly complicated cooling schemes. Primarily, the overall control system can be expandable, using standard hardware and operating software. Furthermore the software tool packages are being developed based upon them, which provide us more flexible and easy construction of a control program. These software tool packages have the function of system configuration, easy making of graphic control panels, programming sequence and loop control.

The construction of the LHD cryogenic system was started in 1992 and is now at the final stage of assembling toward the completion at the end of 1997.

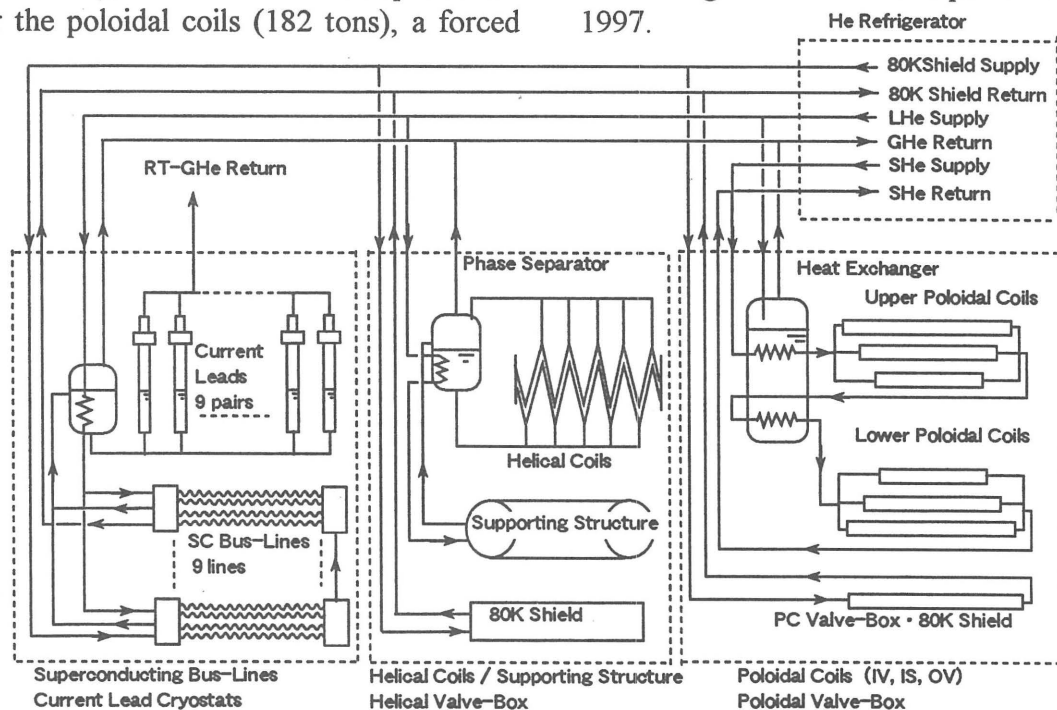


Fig. 1. Flow diagram for the cooling objects of the LHD cryogenic system..