§15. Measurements of Static and Variable Magnetic Fields in a Large Plasma Experimental Facility

Uda, T., Takami, S., Obayashi, H.,
Kamimura, Y. (Utsunomiya University)

The safety guidelines for electromagnetic fields namely non-ionizing radiation has been proposed by the International Commission on Non-ionizing Radiation Protection (ICNIRP) and the other organizations. Although health affect of non-ionizing radiation is not clear it would be useful to measure electromagnetic fields around a large magnetic plasma experimental facility for development of nuclear fusion. The LHD is the largest super conductive plasma confinement device with strong static magnetic field and not less magnetic field is leak out around the device. Except the static magnetic fields caused by the superconducting magnetic systems, many electromagnetic devices are applied for fusion plasma experiments. Various frequencies of electromagnetic devices are used like NBI and its electric power source of a motor generator (60Hz), heating systems of ICRF (25-100 MHz), and ECH (84-168 GHz). Also for discharge cleaning, resonance frequency (2.45 GHz) system is used. As above mentioned, static magnetic field and wide spectrum of frequencies electromagnetic waves are concerned. Safety issues seem to be not only strong electromagnetic field but also complex of static magnetic field and variable frequencies of magnetic fields, which are from extremely low frequency (ELF) to high frequency. To establish the safety management system for workers in the plasma experimental facility, electromagnetic fields around the LHD and related devices have been measured. Leakage of static magnetic field strength has been measured since the first plasma experiment of the LHD in 1998. The fixed monitoring point is 23 m far from the center of the LHD in south direction. The measurement instrument is Gauss Meter 9900 (F.W. Bell Co) and three axial probe ZOA99-3208

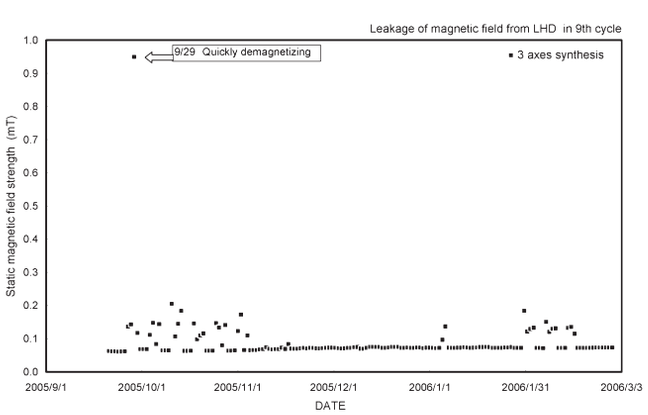

Fig.1 Leakage of static magnetic field measured outside of the LHD hall.

The leakage of magnetic field strength measured in the 9th cycle of the LHD experiment is shown in Fig.1. Background on not-operation period is about 0.06 mT, which is a double of terrestrial magnetic field. It is increased by magnetization of steel materials in the monitoring room. When the LHD plasma magnetic field is 3 T, it increased to 0.1 -0.2 mT. As major issues of the super conducting magnetic coil system, it decreases quickly for protection of the coil systems on quenching or on abnormal event occurrence. According to our experiences magnetic field strength at the fixed point was spontaneously increased to about 0.9 mT on such a coil protection mode. When looking at the measured data in detail, small variation of less than 0.01 mT was observed according to the local island divertor (LID) operation.

Except the coil systems of the LHD, there are some kinds of static magnetic field producing devices. Moreover there are many kinds of ELF related devices in the laboratory. Major devices are electric power source for super conducting magnetic coils system and a motor generator for power supply to the NBI device. The ELF magnetic field strength near the electric equipments in the laboratory was distributed around 0.2-40 μT.

As previously mentioned there are many types of microwave generator for plasma heating such as ICRF and ECH and for discharge cleaning of plasma facing walls. We begin continuous monitoring around the ICRF wave generator using a data logging system. The measurement instrument is EMC-300 and three axes electric field probe Type 18 (Narda Co.). The logging time is 5 Hz, 0.2 sec, and mean value of 1 sec are shown in Fig. 2. The maximum electric field observed is 20 V/m, but the 6 minute mean value is less than that, of which maximum value is 10 V/m that is about 1/6 of the occupational regulation level proposed as guide line by the ICNIRP. Exposure dose measurement and evaluation considering such high frequencies of electromagnetic fields seems to be important safety management issues. To investigate the safety management system, we study in collaboration with Nagoya Institute of Technology and Utsunomiya University.

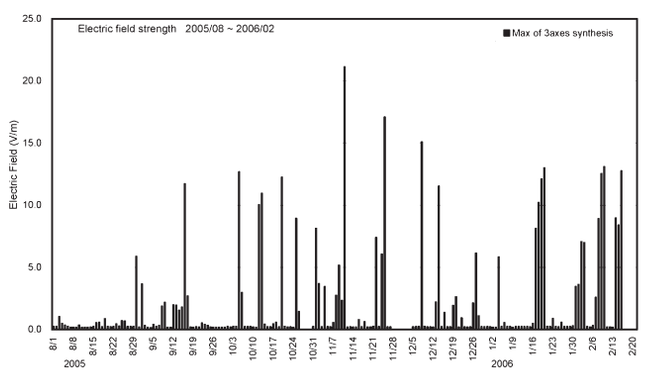

Fig. 2 Electric field strength, mean of 1 sec, monitored around the ICRF electromagnetic wave generator in the period of 9th cycle.