§10. Measurement of Static and Variable Magnetic Fields in a Large Plasma Experimental Facility

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As safety and health problems in a large plasma experimental facility like LHD, static and variable electric and magnetic fields in working places were considered. Although the magnetic field of the LHD is possible to confine the plasma with high efficiency, complete confinement is difficult. Recently acute health effects of magnetic fields become gradually clarified but chronic exposure effects for occupational have not been well defined. The major issues are not only static magnetic field but also variable magnetic fields, of which frequencies are from extremely low frequency (ELF) of 50-60 Hz to high frequency of 184 GHz. In a magnetic plasma confinement experimental facility, many type of electric and magnetic fields generating devices are equipped. Except the super conducting coils system, a motor-generator for electric power supply system, microwave generator for cleaning of plasma facing walls, and plasma heating devices like ICRF (Ion cyclotron range frequency) and ECH (Electron cyclotron resonance heating) has been in operation. Acute biological effect to high frequency electromagnetic fields (EMF) is caused by thermal absorbing effect. Almost all the energy of electromagnetic wave is absorbed by structural materials, but more or less EMF is leaked. Considering occupational safety, electric and magnetic field strength were measured around the LHD and related devices.

Static Magnetic Field:

Static magnetic field strength was measured with a gauss meter of THM7025 (METROLABO) or GAUSS METER 9900 (F.W.BELL) in the LHD hall and outside of the 2 m concrete wall for a radiation shield. In the case of 1.5 T plasma operation, the magnetic field strength was 70 mT near the cryostat, and 0.05 mT outside of the radiation shield wall. The measured values of magnetic field strength were almost agreed with calculated ones in less than 50 %. Further more, static magnetic field around a test stand of gyrotron for ECH system was monitored. The maximum was observed 8.2 mT. Then close to the test stand was regulated.

Extremely Low Frequency Magnetic Field:

Magnetic field strength of extremely low frequency ELF was surveyed using some commercially available monitors in the LHD site. At the same time characteristics of some detectors were compared each other. Then large magnetic field strength was found on the upper floor of the motor generator, that was in front of some electric power supplying boards. It was observed as about 0.1 mT. But all measured values were less than the occupational regulation levels, which are proposed by ICNIRP (International Conference for Non-Ionizing Radiation Protection). Surveying test shows that it is necessary to make consideration to the detectors sensitivity dependence on frequency. To perform reasonable management in electromagnetic workplaces, suitable guidelines should be proposed for occupational safety, and monitoring survey should be continued.

High Frequency EMF:

Monitoring is possible with commercially available monitors in frequency range from 100 MHz to 3 GHz. Then it was confirmed that these monitors are efficiently sensitive to detect the registration limit level, but their sensitivities are not enough to quantitatively measure at the usual working places. Although large EMF values are not observed in the present survey, guidelines should be proposed for occupational safety. Measurement for high frequencies EMF above 30 GHz will be required in near future.