§ 12. Study about Electromagnetic Field Environment and Biological Effect Evaluation in Fusion Experimental Facilities

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1. EMF monitoring around the LHD facility

The Large Helical Device (LHD) is the largest heliotron type super conducting device for fusion plasma experiment. It has two continuous helical coils with pitch number ten and six poloidal coils. It has a major radius of 3.9 m and a plasma minor radius of 0.5-0.65 m, and its magnetic field strength is 3 T. Although it is possible to confine the plasma with strong static magnetic fields, weak leakage of the magnetic fields is still unavoidable around the device. Except the superconducting magnetic systems, many electric devices are used for the plasma heating experiment. The major heating devices are a neutral hydrogen beam injector and its electric power source (around 50Hz) of a motor generator, an ion cyclotron around 50 MHz, and an electron cyclotron resonating around 84-168 GHz. For discharge cleaning, a 2.45 GHz resonance system is used. As mentioned above, there are both static magnetic fields and time-varying electromagnetic (EM) fields ranged in a wide frequency band in the experimental facility. Safety issues seem to be complex for the static magnetic fields and the time-varying EM fields, which are ranged from extremely low frequencies (ELF) of 50-60 Hz to extremely high frequencies of 168 GHz. In view of the complex electromagnetic environment, measurement of electric and magnetic fields around the LHD and its related devices has been conducted. In this report, monitoring results of the static magnetic field and the ELF magnetic field are shown.

(1) Continuous monitoring of the magnetic field leakage around the LHD in the 6th experimental campaign.

The monitoring point was 23 m far from the center of LHD. Due to the leakage of magnetic fields from the LHD, weak magnetization was observed from some steel cabinets. The background level of magnetic fields at the monitoring point was about 0.7 Gauss, which is about twice of the natural magnetic field of 0.3 Gauss. When the LHD super conducting device operated at 2.5T, it increased to about 0.75 Gauss. The maximum magnetic field leakage was about 11 Gauss because the attenuation of the super conducting magnetic force was very quick.

(2) Measurement of ELF magnetic field exposure to workers in and outside of the laboratory.

The exposure level of ELF magnetic fields was measured for many volunteer workers of the institute. The dose was evaluated with a unit of mGauss.hr, which means that a person is exposed to 1 mGauss of ELF in 1 hour. Although strong ELF magnetic fields were observed around many electric devices, the exposure dose in the laboratory tends to be less than the exposure dose outside the laboratory. However, considering the health effects on workers in the research institute, the magnetic field strength is less than the guidelines proposed by the International Commission on Non-Ionizing Radiation Protection (ICNIRP). Another consideration is that strong exposure of some electric devices tends to disturb the other devices property and their displayed values.

2. Meeting on Electromagnetic Field Environment and Biological Effect Evaluation in Fusion Experimental Facilities

In addition to a static magnetic field for confining the plasma, many devices such as plasma heating and discharge cleaning may also produce an electromagnetic (EM) field leakage ranged from several MHz to several hundred GHz. For protecting the workers from possible health hazards in such a special EM environment, it is essential to quantify the exposure level. In this meeting, various EMF protecting topics were presented and discussed with respect to the safety guidelines in order to ensure the workers' safety.

The meeting was held on 5th July 2002. Topics are as follows.

a. electromagnetic field protection guidebook for operators in hyperthermia therapy.; Kamimura Y. (Utsunomiya Univ.)
b. Measurement of the electromagnetic environment in the fusion experimental facilities.; Wang J. (Nagoya Institute of Technology)
c. Compliance test method with radio protection guidelines. Yamanaka I. (CRL; Communication Research Laboratory)
d. Studies on radiofrequency dosimetry at CRL.; Watanabe S. (CRL)
e. Special lecture; "Inductive consideration on results of epidemiological papers related to cancer and power-line magnetic fields",; Amemiya K. (Kanazawa Inst. Tech.)
f. The effect of 2.45GHz radiofrequency on mutation induction.; Ono T. (Tohoku Univ.)
g. Study on biological effects by electromagnetic field in LF, MF, and UHF.; Suzuki, T. (Tokyo Metropolitan Univ.)

Proceedings of the meeting were reported (in Japanese).