

§10. A Study on Dosimetry and Health Protection of Human in Electromagnetic Environment of Fusion Experimental Facilities

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1. Introduction

In a fusion experimental facility, 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 study, the high frequency (HF) and microwave EM fields in fusion experimental facilities were measured, and the exposure levels were compared with the safety guidelines to ensure the workers' safety.

2. Measurement

The measurement was conducted for three devices: an HF generator of heating device at ion cyclotron range of frequency (ICRF, 38.5 MHz), a microwave power source of linear high-density plasma generator (HYPER-I, 2.45GHz) and an electron cyclotron resonance (ECR) cleaning device in a compact helical system (CHS). By using a spectrum analyzer and an APD (Amplitude Probability Distribution) measuring instrument, both the electric fields versus the frequency and the cumulative APDs of electric fields at the center frequency were obtained. The measuring antennas were a biconical antenna at 38.5 MHz and a double ridged guide antenna at 2.45 GHz. For comparing the measurement results with the safety guidelines in our country, the period in each measurement was set to 6 minutes. To be concrete, the measured data were sent to a personal computer in a time interval of 10 seconds via the GP-IB interface, and then the averaging was made within a period of 6 minutes.

3. Results and Discussion

[1] ICRF Heating Device

The measurement was conducted in the vicinity with a height of 2.8 m. In general, the HF field at 38.5 MHz has a period of 100 ms at an interval of 5 seconds. However, in this measurement the HF field was set to be continuous for simulating a worst case. Fig. 1 shows the measured APD result within a period of 2 seconds. As can be seen, the leaked electric fields with a level between 50 – 100 dB μ V/m (0.32mV/m – 0.1 V/m) had a percentage of 90%, and the maximum electric field level did not exceed 105 dB μ V/m (01.8 V/m). This result implies that the electric field level is only 1/615 compared to the safety guidelines (61.5 V/m) in a controlled environment even if the HF field generates in

the whole period of 6 minutes.

[2] Microwave Power Source of HYPER-I

This power source generates microwaves at an interval of 120 seconds. The continued period at each time is 30 seconds. From the worst value at a vertical plane in the 20 cm front of the power source, the maximum transient electric field was 3.2 V/m and the average within 6 minutes was 0.8 V/m. This level was only 1/172 compared to the safety guidelines in a controlled environment. Fig. 2 shows the measured APD result within a period of 2 seconds. As can be seen, the leaked electric fields kept at a level larger than 85 dB μ V/m (0.018 V/m) and almost did not exceed 120 dB μ V/m (1 V/m). It should be noted that the measurement was made for an output power of 10 kW. Scaling the result to the maximum output, i.e., 15 kW, the leaked fields were still low enough to the safety guidelines.

[3] ECR Cleaning Device in CHS

Although this device also leaks EM fields at 2.45 GHz, its level is smaller than the microwave power source of HYPER-I. It was found that the electric field level averaged within 6 minutes was 0.08 V/m, which was only 1/10 of leakage from the microwave power source. In addition, the maximum transient value of electric fields was lower than 1 V/m.

4. Conclusion

The measurement of leaked HF and microwave EM fields was conducted in a fusion experimental facility. As a result, the EM field levels were found to be much lower compared to the safety guidelines in controlled environments in all cases. The future subject is to quantify the EM absorption inside human bodies.

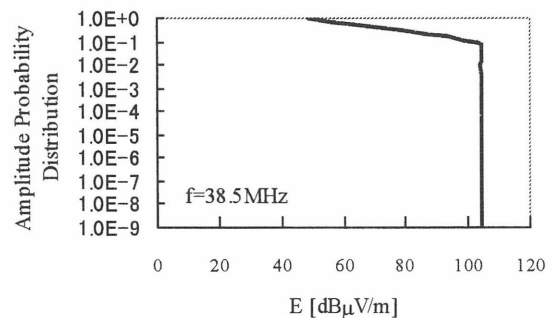


Fig. 1 Electric field levels versus APD for ICRF heating device.

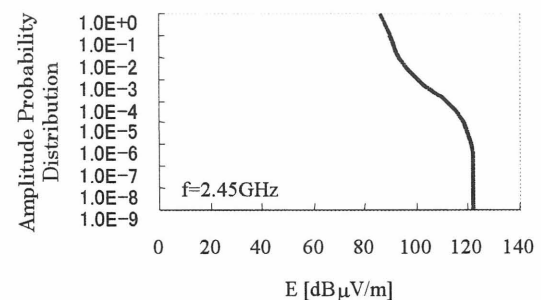


Fig.2 Electric field levels versus APD for micro wave power source of HYPER-I.