

Empirical studies on the effect of electromagnetic radiation from multiple sources in Dhaka

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ABSTRACT

Just after the invention of electricity by Michael Faraday, there has been a revolution in the communication technology, which lead to the invention of radio, television, radar, satellite, and mobile. While these machines transformed our life high quality, safer and simpler, they have been associated with alarming probable health hazards owing to their electromagnetic radiation (EMR) emission. Couple of cases it has been reported by personals regarding various health related issues relating to exposure on electromagnetic field (EMF) and EMR. Although couple of persons showed light symptoms and respond by avoiding the electrical field (EF) and EMR fields as much as possible, some others are so much affected that they have changed their entire lifestyle. In this paper, empirical survey study has been carried out in the laboratories of Daffodil International University (DIU) main and permanent campus. It was found that some of the instrument had higher EMFs. The findings from this survey may be helpful for the students to take precautionary measurement who work for long duration in the various laboratories for their practical classes and for the users of the domestic appliances as well as office equipment and industrial instruments.

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1. INTRODUCTION

There is no doubt that electricity is the main factor for today's civilization. Now a days the power from the electricity is the primary source of energy for the contemporary technological world. The electrical power consists of two fields: electrical field (EF) and magnetic field (MF), generally known as electromagnetic field (EMF) which is very much useful. But at the same time, one should be aware about the harmful/ bad effects of radiation from the EMF which is known as electromagnetic radiation (EMR) or non-ionizing radiation (NIR). It is narrative that high power transmission line, video display unit, computer, laptop, fridge, router, many other home appliances, office equipment, Telecommunication equipment, also Laboratory equipment in every schools, colleges and university, radiate energy whatever small it may be [1]–[4]. These high frequency (HF), low frequency (LF) and extremely low frequency (ELF) EMF instruments are reported to be very harmful for human body/living system and has effect on lower-level animals. The MF has more harmful effect than the EF. Because the EF inside human body discharges through ground and other materials but the MF do not discharge from the body, thus generating various health problems, causing sufferings for the users. Because of its harmful effects, scientists have named this EMF/EMR as a silent killer. The long-time use/long time exposure to EMF/EMR has bad effects of the

human health. In the short-term exposure to remarkably high EMF/EMR may produce muscle or nerve stimulation and also may change cell foundation in central nerve system [5]–[8].

In the long-standing exposure to EMF/EMR there is risk for childhood leukemia which may occur average/around 0.3 to 0.4 micro-Tesla (μT). It may also cause other diseases like cancer in adults, childhood cancer, commitment to suicide, disorders due to cardiovascular system, reproductive disfunction, developmental disorders, immunological alterations, neuro behaviors effects and neuro degenerative diseases. The World Health Organization (WHO) has declared the radiation (EMR) from the EMF in the year 2002 as carcinogenic and in 2011 also has declared the mobile phone/tower as harmful to human health [9]–[16]. At the same time radiation from the EMF also affects the lower-level animals. It is reported that the sensitive lower-level animals like rats and bees when living around electromagnetic fields (high voltage/current), they cover up that sides of their hives exposed to EMF with mud to save their off springs.

The radiation from EMF may cause sudden infant death syndrome (SIDS). Furthermore, there are reports that biological effects like sensitive lymphocytes, immune deficiency, cellular breakdown, and disrupting DNA are being influenced by EMR [17]–[22]. This NIR/EMR from various sources in addition to creating health problems it makes difficulties to various electrical and electronics equipment, known as electromagnetic interference (EMI). This EMI interfere with electronic equipment and disturbs their normal functioning. All over the world, the engineers and scientist are very much concern about EMI and try to find out the best way to minimize or overcome the problem as much as possible because it has been proved that EMI cannot be totally erased out from nature [23]–[27].

The public in all over the world are becoming increasingly aware about the potential hazards due to EMF radiation. The ongoing inequality in the safety standards globally and the limitation of understanding on electromagnetic field, non-thermal mechanisms of interaction with biological systems highlights this problem. Although awareness in this field has developed incredibly in the past two decades, which is not enough for setting lawful safety standards [28]–[30]. The effect of EMR on the human body is very much complicated, as it varies with polarization, frequency, corporeal posture, and far-field versus near-field. The research study in this area has usually not been extensive, that created most of the research focusing on slight short duration expression quantities [31], [32].

The progress in wireless technologies has made human exposure to electromagnetic fields (EMFs) increasingly complex, so, monitoring EMF exposure levels and characterizing them are indispensable for risk communications of human exposure to EMFs [33], [34]. Various studies showed that respondents had experienced significant and negative effects of radio frequency radiation (RFR) on their mental health, indicating a critical and urgent need to educate the public on the subject [35], [36]. Data from the large-scale animal studies found animals link RFR with impacts on the heart, brain, and other organs [37]. The fifth-generation mobile network introduces dramatic improvements with respect to the previous technologies [38]. Several studies have been done on the effects of radiofrequency exposure on the health of people living near mobile-phone base stations with contradictory results [39]. The rates of obesity varied with educational stages, while problematic smartphone use increased with educational stages showing male students have higher obesity rates than female students [40].

Quite an extensive research studies have been performed in this field since 2011 in Bangladesh. Epidemiological survey of persons employed in the existence of high frequency EMF field were investigated [41]. Additionally, epidemiological survey on EMF health effects due to photocopy machines used in Dhaka were examined [42]. An epidemiological survey was performed on operators/users of CRT monitors for possible EMF effects [43]. Also, a case report on the effects of EMF on personals in vicinity to the high-voltage transmissionline [44]. Health effects of EMF owing to the utilization of cell phones by public personals at Dhaka and University students were also examined [45], [46]. Furthermore, a review was carried out on NIR, harmful consequences of NIR from mobile/cell phone and towers [47]. Inspections depicting the magnetic fields emitted by various sources like laboratory electronic and electrical appliances and instruments (pharmacy and textile laboratories, computer science and engineering (CSE), and electrical and electronic engineering (EEE) laboratories and classrooms) in Southeast University were performed [48]–[54]. Additionally electrical equipment and laboratory facilities in electronics and telecommunication engineering (ETE) and CSE laboratories of Daffodil International University (DIU), Bangladesh were investigated [55], [56].

The objectives of this specific studies were to find out the EMF/EMR values from various sources: like domestic appliances, office equipment, industrial instruments, telecommunication equipment, also special attention was given on inside and around the various laboratories of DIU situated both in the Dhaka City main campus and permanent campus at Ashulia. Students have to spend normally 3-4 hours a day in the respective labs for their practical classes. The labs are equipped with various types of equipment/instruments which may radiate EMF/EMR. The lab room itself has its electrical wirings on ceilings, walls and floors with power lines running from bench to bench. Therefore, in a lab, the students work in an environment surrounded by EMF/EMR around them. The combinations of all these EMF/EMR may exceed the maximum permissible dose (MPD) recommended by the international regulatory authorities like international

committee for non-ionizing radiation protection (ICNIRP)/ITU/IEEE. If the radiation level is higher than the permissible dose, students may be affected by the EMR causing various diseases/sufferings as already reported by the scientists/engineers from many countries. The findings from this survey will put some light on how to take precautionary measurement from EMR emitted from various sources.

2. RESEARCH METHOD

In this survey measurement of various laboratory equipments from DIU was carried out. measurements on EF, MF and radiated power from every instrument were taken. The present work mainly involved with the measurement of EF, MF, signal power and threshold distance from electrical and electronics devices in laboratory instruments of multiple departmental laboratories of DIU. The highest values as well as the threshold distance were noted down. Measurements from various devices in the laboratories were also carried out where the students spend long time every day. Measurement was taken around the device (front, back, left, right, top and bottom). Magnetic meter from magnetic sciences international (MSI) was used to measure magnetic field. Then threshold distance of the radiation was measured by Coghill field mouse. Also, the measurement of the EF, MF and power was done by electro-smog meter.

A power density meter named Electro-smog meter (Model no. CORNET®ED-78SPlus) was utilized for measuring power density level, Electromagnetic wave field strength, and low frequency MF (Tesla, Gauss) for living environment [57]. It has LF bandwidth of 50 Hz to 10 kHz having sensitivity of 0.1–60 μT and RF bandwidth of 100 MHz to 8 GHz having high sensitivity (0.5 $\mu\text{W}/\text{m}^2$ to 1.8 W/m^2). All main campus data are measured by this meter. This meter gives a pointed value. A Coghill field mouse for biohazards awareness was used for detecting the threshold levels for electric and MF nearby to the device. The threshold voltage setup internal in the Coghill Field Mouse is as per ICNIRP.

Digital EMF meter: All the permanent campus data are measured by this meter. It is a high range frequency meter and shows without pointed value. This EMF meter can measure and display magnetic field, EF, and RF strength simultaneously. The unit of measurement are conveyed in units of magnetic and electrical field strength and power density.

3. RESULTS AND ANALYSIS

This main campus data was taken from power supply for PCs, UPS, and some departmental laboratories. These data and analyses are given below. This Figure 1 contains the main campus CSE, computing and information system (CIS), software engineering (SWE), ETE, EEE all personal computers (PC, especially CPU) data. There were a total 545 PCs in the main campus and data were taken from these labs. These surveys were carried out value for threshold distance from all the PCs. Measured value is applicable for EF only because MF was detected everywhere inside the laboratory room. The EF threshold values ranged from 12.7 to 64.0 cm.

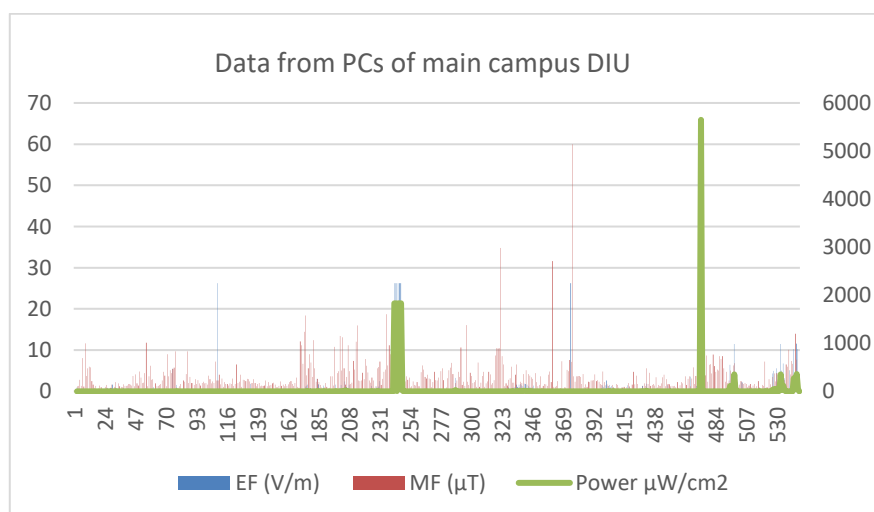


Figure 1. Data from PCs of main campus of DIU

This Figure 2 contains the main campus CSE, CIS, SWE, ETE, EEE all uninterrupted power supply (UPS) data. There are 236 UPS data taken from these labs in main campus. The MF values in most cases were $60 \mu\text{T}$ as the maximum value that can be measured by the MF detector. So, the MF values in most cases were more than that value. The MF and EF threshold distances were also measured for all the UPS. In all cases, the MF threshold distance shown were over the threshold values everywhere inside the labs. The EF threshold values ranged from 3 cm to 13.5 cm.

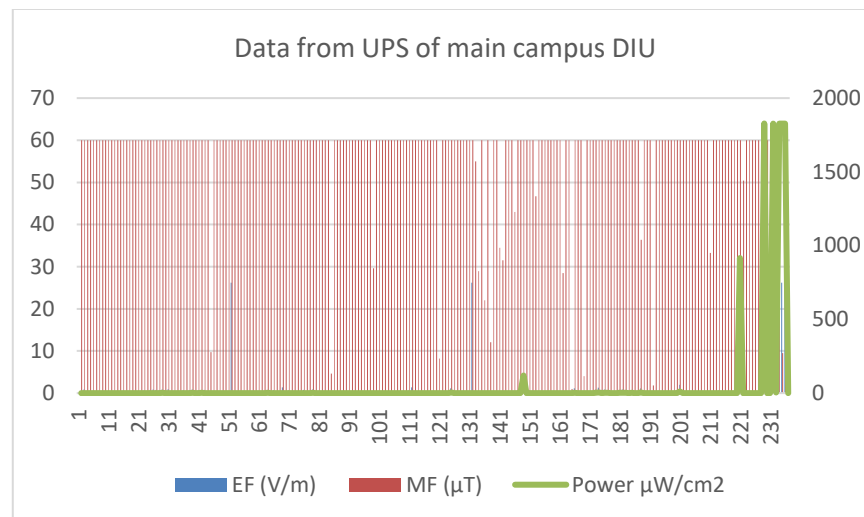


Figure 2. Data from numerous UPS of main campus of DIU

Figure 3 shows oscilloscopes of ETE lab of main campus. ETE lab has two types of oscilloscopes one is analog and another one is digital oscilloscope. Digital oscilloscope is enormously comfortable compared to the analog oscilloscope. Analog device has higher value of electromagnetic field. Amongst the 17 oscilloscopes, most of them have lowered values of both EF and MF. The oscilloscopes were manufactured ranging from year 2014 to 2017.

The EMF threshold distance value was taken for both digital and analog oscilloscope which has shown EF lowest 7.62 cm to highest 60.96 cm. But MF was detected all around inside the lab room. This may be due to the electrical wiring running through the walls, ceilings and floors of the labs as a result, there were interfering of MFs from all the sides.

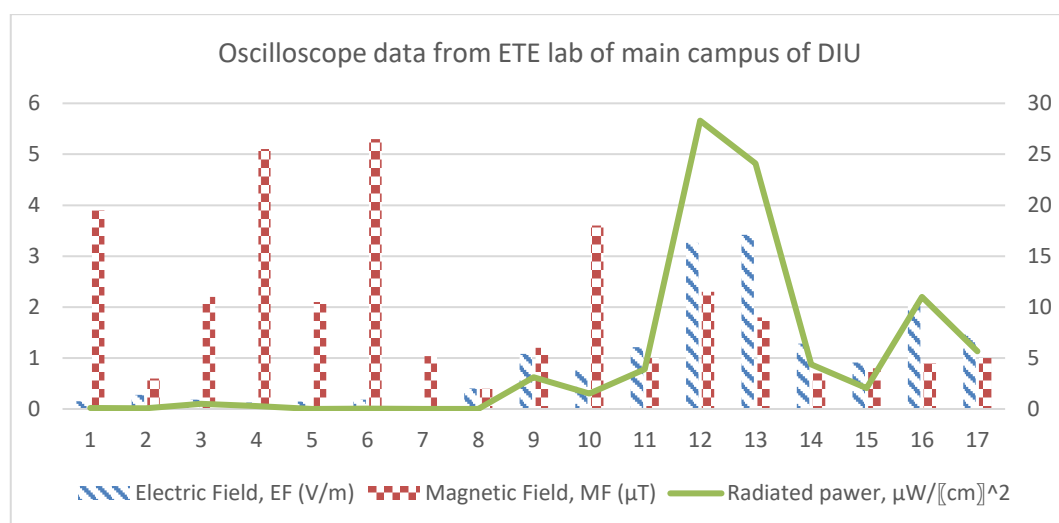


Figure 3. Data from numerous oscilloscopes from ETE lab of main campus of DIU

Given in Figure 4, function generator is very much used in circuit laboratory and electronics laboratory. The cause of low EF and MF values was that the readings were taken at low frequencies that is why the field is exceptionally low. When the frequency was varied to higher values, then the instrument measured higher values of EF and MF.

The EF threshold distances were also measured for all the UPS. The MF threshold distance went over the threshold values and everywhere inside the labs were found over the permissible label. The EF threshold values range 15.24 cm.

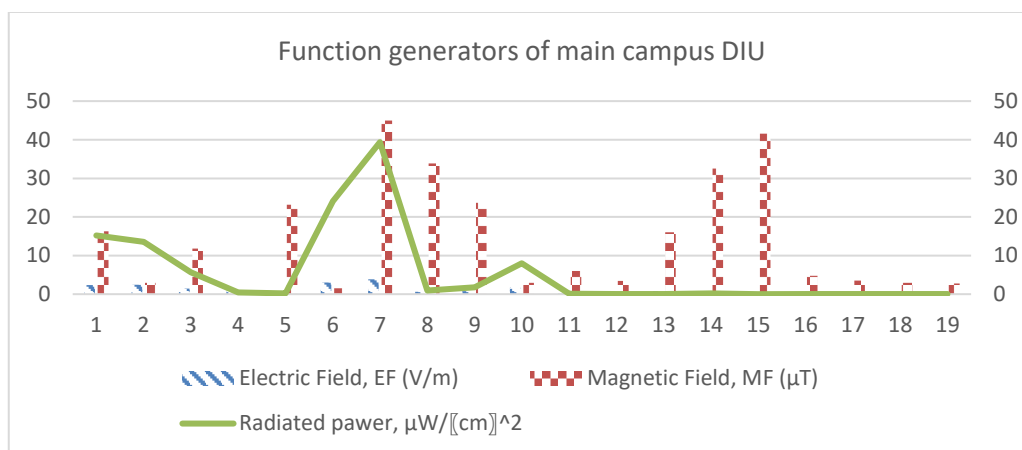


Figure 4. Data from numerous function generators from ETE lab of main campus of DIU

An important note for Figure 5 is that the DC power supply do not shut down during the class hour. Therefore, after one and half hour this device generates hit, and as a result it was found that MF was much higher compared to the EF and radiated power. In all the cases MF crossed the MPD inside the laboratory room. But EF threshold distance value from DC power supply was 97.5 cm.

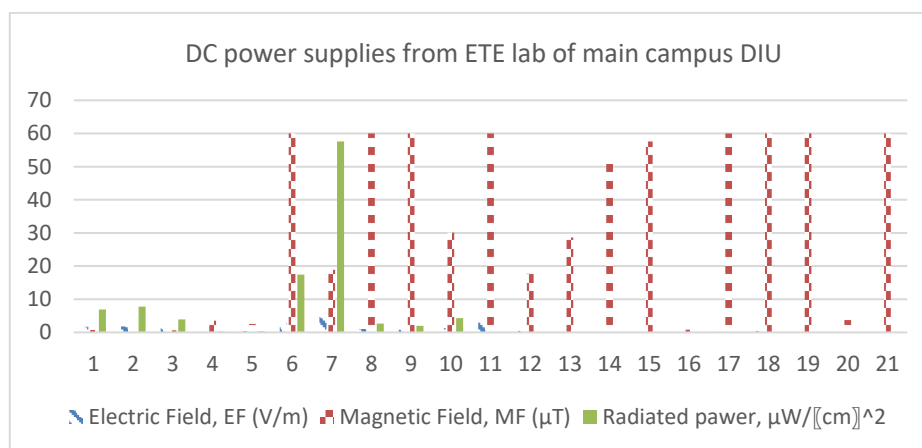


Figure 5. Data from numerous DC power supplies from ETE lab of main campus of DIU

Figure 6 shows six voltage stabilizers in ETE labs of main campus. The EF and the radiated power values are incredibly low and within threshold limit. The MF values were very high and for one voltage stabilizer was 45.3 μT, and the others were less than this value. In all the voltage stabilizer instruments EF threshold distance noted value up to 94.5 cm, which may cause harm to the users.

Figure 7 shows the trainer board which is also a low voltage operated device. We know that low voltage and low current, low EF, and magnetic field. ETE laboratory were covered by MF but the measured EF from the trainer board was 94.5 cm.

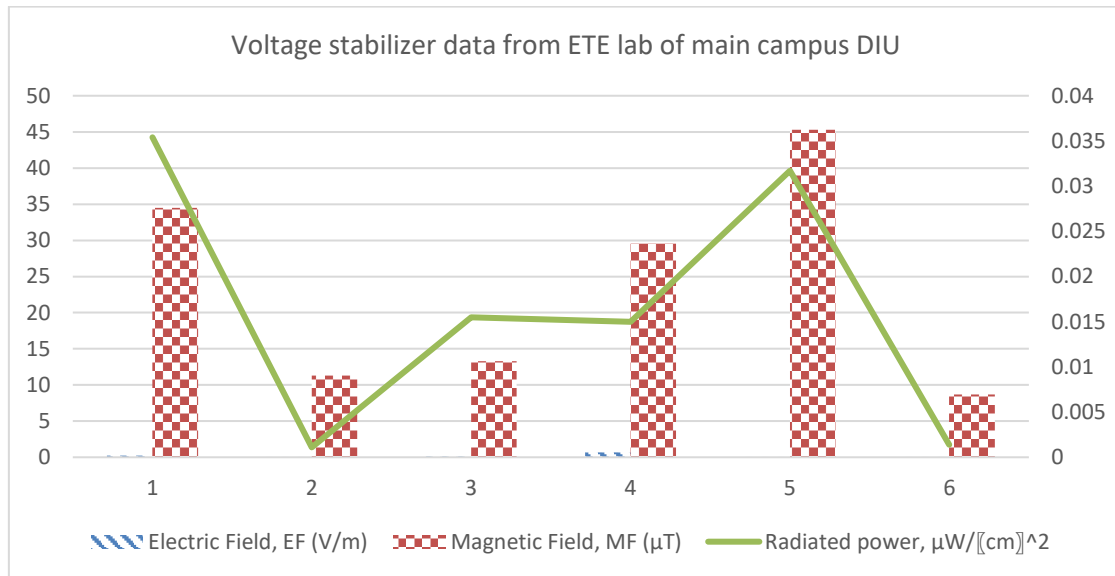


Figure 6. Data from numerous voltage stabilizers from ETE lab of main campus of DIU

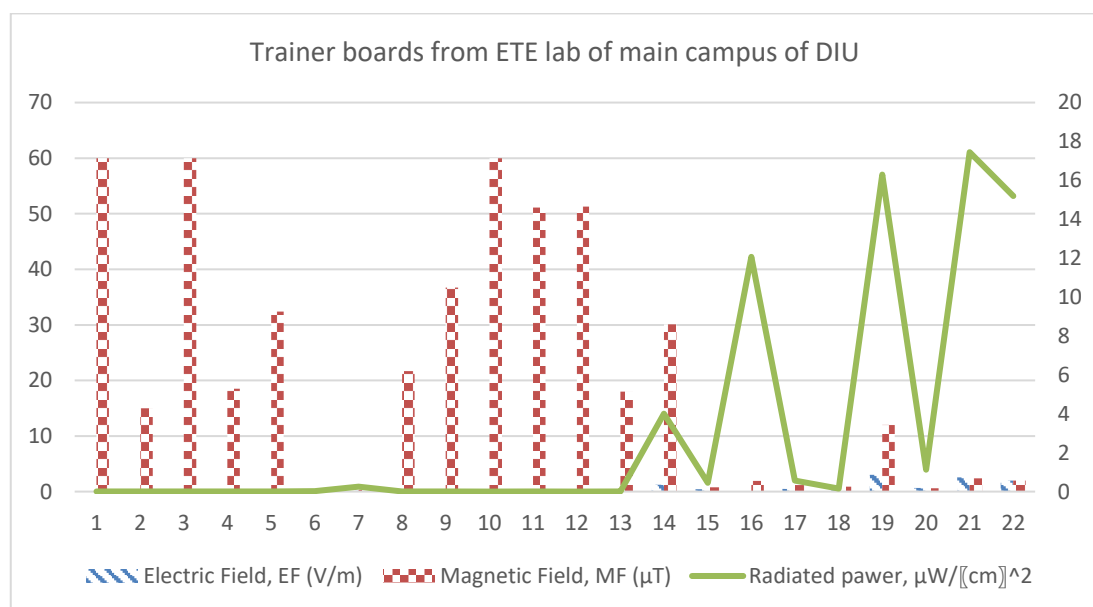


Figure 7. Data from numerous trainer boards from ETE lab of main campus of DIU

Permanent campus data of various instruments obtained from EEE, textile engineering, and civil engineering laboratories are given in Figure 8 until Figure 10. Figure 8 shows EF (V/m), MF (μ T), and radiated power (μ W/cm²) of equipment from the permanent campus EEE lab. This lab consisted of instruments DC supply, DC generator, Induction motor, auto recloser, transformer overhead protection, DC supply, Split phase motor, Power supply, electrodynamic meter, single phase transformer, resistive load, induction load, system power, DC motor control module, DC supply, DC module, system power, and programmable logic controllers (PLC). All these instruments were manufactured recently in the year 2019. The system power has a remarkably high EF (1635 V/m), including MF (201.1 μ T) as well as the radiative power (71.4 μ W/cm²). The highest radiative power is seen for the two DC power supplies (85.6 μ W/cm²). Precautions must be taken for the system power otherwise it may cause harm to the students/ users. The threshold values of EEE lab were taken for every instrument EF 60.96 cm and MF was detected everywhere inside the laboratory room.

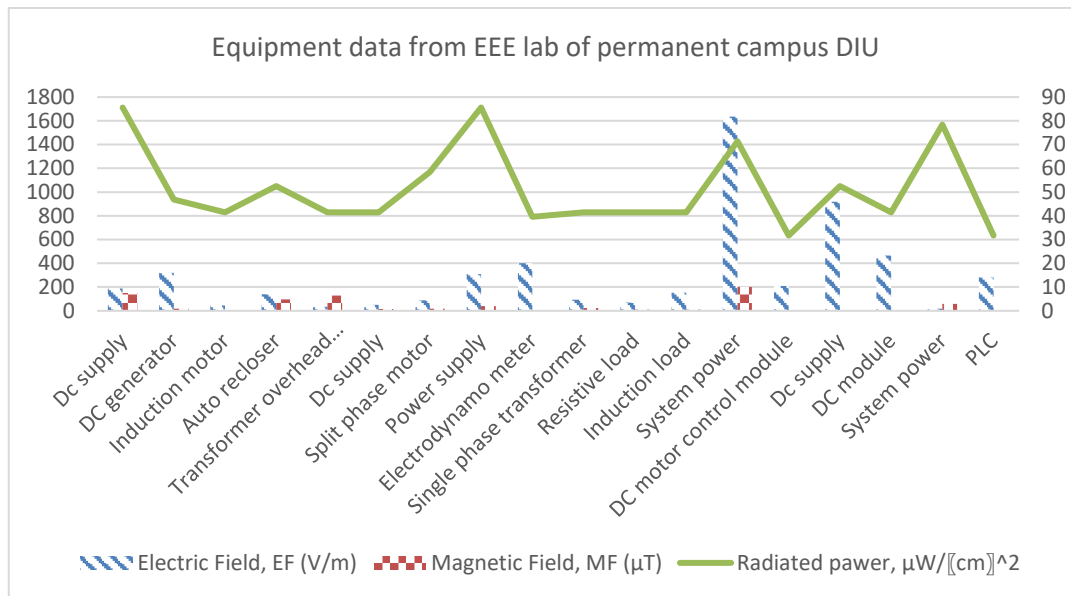


Figure 8. Data from EEE lab of permanent campus of DIU

Figure 9 shows electric field (V/m), MF (μT), and radiated power ($\mu\text{W}/\text{cm}^2$) of equipment from the permanent campus textile engineering lab. This lab consisted of instruments continuous fusing machine, sewing machine, P. M. D. chain switch sewing machine, bartack sewing machine, feed of the ARM chain sewing machine, lock switch button hole, button attaching, colour machine, cabinet D-65, F-light UVB, TL-85, CWF, electric balance, oven, absorption resistance and pilling resister, washing machine (siemens), Sample dyeing machine, WRAP block, WRAP reel, PADDING machine, dyeing and carrying machine. All these instruments were manufactured ranging from the year 2005 to 2014. The feed of the ARM chain sewing machine has an extremely high EF (1179 V/m), including MF (1538 μT) as well as the radiative power ($71.4 \mu\text{W}/\text{cm}^2$). The EF was also very high for oven (1263 V/m), button attaching (650 V/m), absorption resistance and pilling resister (606 V/m), and P. M. D. chain switch sewing machine (590 V/m). The MF found were also high. The feed of the arm which shows very high EF (1179 V/m) MF (1538 μT). This machine must be properly guarded to minimize the EF and MF. Threshold distance of textile laboratory for both EF and MF were measured to be in the ranges from 25.4cm to 30.48cm and 35.48cm to 40.64cm respectively.

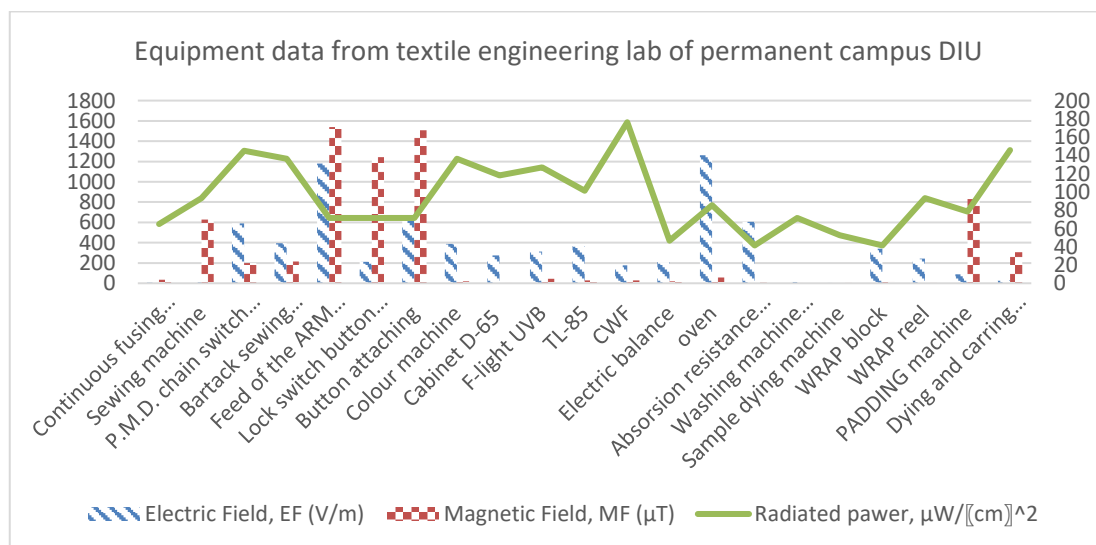


Figure 9. Data from textile engineering lab of permanent campus of DIU

Figure 10 shows EF (V/m), MF (μT), and radiated power ($\mu\text{W}/\text{cm}^2$) of equipment from the permanent campus civil engineering lab. This lab consisted of equipment like hot air oven, Incubator, universal testing machine, concrete core cutter, Los Angeles abrasion machine, concrete mixture machine, and cement testing machine. All these equipments were manufactured recently in the year 2019. The incubator has an exceedingly high EF (814 V/m), but MF is low (0.011 μT) as well as the radiative power (27.4 $\mu\text{W}/\text{cm}^2$). EF for hot air oven is also very high. EF of civil engineering labs had much higher values compared to all other laboratories in DIU.

The threshold distance of EF hot air oven was 66.04 cm, the incubator 60.96 cm, universal testing machine 53.34 cm, concrete core cutter 78.74 cm, Los Angeles Abrasion machine 7.62 cm, concrete mixture machine 7.61 cm, cement testing machine 20.32 cm. The MF was found to be almost everywhere.

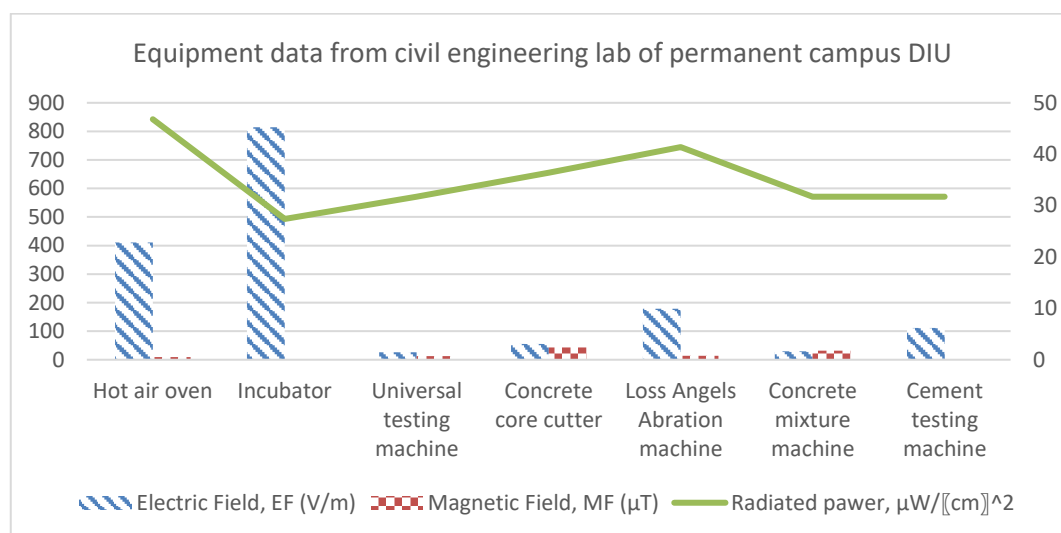


Figure 10. Data from civil engineering lab of permanent campus of DIU

4. DISCUSSION

The EMF is all around us and it causes health hazard from various sources or from electronic equipment. So, people should be aware of this, and it is essential to be informed about the detrimental outcomes of EMR/NIR on living system and on the surroundings. The scientists and engineers should be more active to find out the appropriate solutions for reducing or managing the hazards of non-ionizing radiation before it causes great hazards.

From the EMR measurement results given in Figures 1 to 10, it was obtained that the MF levels are much greater compared to the threshold value. Due to the type of the wiring both in the floor and ceiling, all the rooms had greater EFs than threshold level. Students stay in the laboratory rooms on an average of 3 to 5 hours. So, the value of EMF level, the amount of radiation from various sources, position of equipment must be set up properly, so that there is minimum radiation and minimum interference from EMF.

From the observations and empirical studies, it was found that EMR has adverse effect on living systems, especially people working/living near/under high frequency like laboratories and electrical industries. Most of the people were suffering from various diseases, the common disease found, were insomnia, headache, indigestion, hearing problem, eye itching. It was found that longer the exposure time, more is the sufferings and some of the users complained about their sufferings in their conjugal life.

EMR are capable of initiating consequences in biological organisms. Everyone is endangered to multiple types of EMR daily, as the whole world is covered with EMF from satellites and various other sources. This would not account for the introductory and administrative steps to manage the manufacture, allocation, and usage of EMR for telecommunications.

WHO has established the ICNIRP in 1996 to monitor, regulate and advice on EMF. Many countries of the world including Bangladesh has adopted the Non-Ionizing Radiation Protection Regulations 1998/2018 by ICNIRP effective from November 2019. Bangladesh has adopted ICNIRP Guidelines without any modification or any change, but it should be modified according to the climate and environmental/geographical condition of Bangladesh. India also has adopted the same Regulation in 2012 but they have modified the recommended values to the 1/10th of that values suggested by ICNIRP.

5. CONCLUSION

This survey points out that in most situations the MF had exceeded the threshold level. The MF and EF had a greater threshold value in multiple instruments of the laboratory. The MF highest exposure was close to 60 μT in numerous situations. Electrical wiring ought to be performed as per the Building Code 2012. This survey can be useful as a precautionary step for general users, workers in industries, service people, teachers, lab workers, students and the younger generation who might be affected tomorrow. This survey points out that EF and MF measured in the Permanent Campuss was many times higher than the Main Campus. Therefore, care should be taken to minimize the radiated EF and MF fields wherever possible.

The health hazards instigated by all these things, personals ought to be sensitive of them and preventive steps ought to be taken accordingly. It is essential to be familiar with the detrimental outcomes of EMR on living systems and on the environment that we are living in and to explore suitable remedial steps for reducing the risks of EMR as much as possible.

As MF is more damaging than EF, there ought to be a threshold level for the residential and occupational levels from 0.2 to 0.3 μT . This amount is worldwide established as accepted level in numerous countries. More studies and thorough observations for a longer period are required to learn more about the field which could lead to some acceptable solutions of the various problems specially health hazards arising from the EMF radiation. In addition, certain regulations are necessary for the laboratories (medical, industrial, scientific) utilized for commercial and domestic purpose and the diversity of radiation emitting instruments and installations.

In this paper efforts have been put to focus on the effects of EMR from various sources specifically on the laboratory equipment where students spend a long hour during their study period in the school/college/university. It will help the academic authority to think and modify the present working conditions prevailing in the respective laboratories to set up a better/safer working environment for the students.

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