ORIGINAL ARTICLE

SURVEY OF EMF EMITTED FROM AIR CONDITIONERS AND SWITCHBOARDS IN ELECTRICAL AND ELECTRONIC ENGINEERING LABORATORIES OF SOUTHEAST UNIVERSITY BANGLADESH

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ABSTRACT

The aim of this survey is to investigate whether the Electromagnetic Fields (EMF) emitted from various Air conditioners and Electrical Switch boards at different Labs at the Electrical and Electronic Engineering (EEE) department of Southeast University, Bangladesh, affects the students. There is a standard threshold value recommended by World Health Organization (WHO) for both electric and magnetic fields. Electro-Magnetic Fields commonly known as Non Ionizing Radiation is emitted from high power transmission lines, computer monitor/video display unit, radio waves of different frequencies (extremely low frequency to microwaves), telecommunication, satellite, radar etc. which causes health hazards to living system and environment. There has been no such study performed in Bangladesh. Magnetic Fields around the equipments as well as the threshold values of Electric and Magnetic fields were measured.

***Keywords**: EMF, NIR, WHO, ELF, EF, MF*

INTRODUCTION

Ionizing radiation is the radiation of sufficiently high energy to cause ionization in the medium through which it passes. It may consist of a stream of high-energy particle (e.g. electron, protons, alpha particles) or short wavelength electromagnetic radiation (ultraviolet, X-rays, gamma-rays). Radiation, which does not cause any ionization of the media while passing through it, is known a non-ionizing radiation (NIR). Examples of non-ionizing radiation are ultraviolet, visible light, infrared, microwave and radio wave. Their energy is relatively low; it only manages to cause molecules to vibrate and induces heating effects.

Exposure to Extremely Low Frequency (ELF) electric and magnetic fields does produce biological effects. However, except for fields strong enough to induce current densities above the threshold for the stimulation of nerve tissue, there is no consent as to whether these effects create a hazard to human health. Human data from epidemiological studies, including reported effects on cancer promotion, congenital malformations, reproductive performance and general health, though somewhat suggestive to adverse health effects, are not conclusive. Since magnetic field is more harmful than electric field, there must be a limit both in the residential and occupational levels between 0.2 to 0.3 μT or 2.5 mG (This value is internationally recognized as standard limit in many countries). Also, for electric field this value is 25V/m. It must be ensured that intensity of radiation in the body does not exceed the recommended maximum level (10 mW/cm^2, 195V/m in U.S.A. and 0.1 mW/cm^2, 20 V/m in CIS). These humans made electric and magnetic fields (typically 25 V/m and 2.5 mG or 0.25 μT) are substantially above the naturally occurring ambient electric and magnetic fields of 10^{-4} V/m and 10^{-13} T respectively[1-2].

Lower animals are reported to very much sensitive to electromagnetic fields. It is observed that animals like rats make their living brooding holes away from the high electric field and bees block-up their hives in the chronic presence of NIR/EMF. As a consequence, scientists and health physicians in developed countries have become aware of the effects of NIR[3]. Their research and observations have brought out some remarkable results linking low level alternating electromagnetic fields with serious health hazards. There is also evidence that biological effect like immune deficiency, sensitive lymphocytes, disrupting DNA, cellular breakdown is being affected by NIR[4].

Much research has been performed in this regard. Most recently, Epidemiological survey of people working in EMF field exposed to high frequency have been investigated[5]. Also, research was performed for epidemiological survey on effect of EMF emitted by photocopy machines generally used in Dhaka city Bangladesh[6]. Survey was done on EMF emitted by Lab equipments in various labs of Southeast University in Bangladesh for possible health hazards[7]. A case study was done on EMF near high voltage transmission line[8]. Also, a review was done

on Non-Ionizing Radiation (NIR), its harmful effects especially from Mobile/Cell Phone and Towers[9]. An epidemiological survey was performed on CRT monitors used in Dhaka city[10].

There have been various papers published on EMF of radio, TV etc. but not much on-air conditioners. Since the invention of modern electrical air conditioning unit in 1902 by Willis Carrier, Buffalo, New York[11] there has been tremendous increase in use of air conditioning in the world. In some cases it has been used in cooling the building, theatres, and for commercial purposes. Since air conditioner has been used for comfort, its demand has increased. After the invention of portable air conditioners, it has been easier to purchase one. Especially in tropical countries like Bangladesh, it is in high demand not only at offices, but at homes also. With the increase in the efficiency of the modern air conditioners as well as the attractive decrease in its price, offices and private homes have their own air conditioner systems. At Southeast University, all the offices, labs and classrooms have air conditioners due to very hot and humid weather during the summer. Each office, labs and classrooms have one or multiple switchboards. The students spend around 7-8 hours each day in these classrooms and labs which the faculties and employees also do the same. The aim of this research is to investigate whether the EMF emitted from these air conditioners and switchboards are within threshold values and also if the students and employees are safe from these equipments.

METHODOLOGY

A magnetic Science International MF meter was used for measuring the magnetic field values for the various air conditioners and switch board equipments. This is a single-axis gaussmeter to measure AC magnetic fields from power lines, home and building wiring, and appliances. Its single-axis detachable probe have frequency range 33 Hz - 2000 Hz, maximum field of 50,000 mG with resolution 0.1 mGA[12]. Coghill Field Mouse for Biohazard Awareness was used for measuring the threshold values for both electric field (EF) and magnetic field (MF) around the instrument. The readings were taken to cover all around the equipment.

RESULTS

Findings at different EMF sources: All the readings were taken from different laboratories of Electrical and Electronic Engineering (EEE) department, Southeast University, Tejgaon Permanent campus. Readings were taken from air conditioning units and the switchboards of each EEE laboratory.

ANALYSIS

In Tables 1A and 1B, experimental data of EMF values were measured for Air Conditioner equipments were collected from the from Energy Conversion Lab, Power System and Protection Lab, Electrical and Electronics Lab, Measurement and instrumentation Lab, Communication Labs and Computer Lab. Air conditioners (AC) brand "Carrier" and "General"- having 3 tons and 5 tons of various models were measured for their Electric field and Magnetic field threshold distances as well as the magnetic field values for (i) in front of the equipment measured from the center of the equipment (ii) at right side of the equipment and (iii) at left side of the equipment. Also, the maximum magnetic fields were measured for each AC of this lab. The "*" sign indicates that the threshold distance was above recommended level and out of range.

In Tables 2A and 2B, experimental data were collected from the Electrical Switch Boards of the above mentioned laboratories. Distribution board, switch board, socket points were measured for their Electric field and Magnetic field threshold distances as well as the magnetic field values for (i) in front of the equipment measured from the center of the equipment (ii) at right side of the equipment and (iii) at left side of the equipment. The "*" sign indicates that the threshold distance was above recommended level and out of range.

In Energy Conversion Lab, it has been observed that the (i) room temperature and the electric voltage supplied in Air Conditioners might be different: therefore, the EF and MF varied. (ii) There can be some problems in measurement using the EMF meter. In Power System and protection Lab, it has been observed that the (i) there were some problems to measure the accurate magnetic field and electric field because some pillars were situated beside the socket switch and distribution board. The magnitude of those measurements for these fields in meter was fluctuating which was confusing. In Electrical and Electronics Lab, it has been observed that (i) there were not sufficient space for the Air Conditioner and so there were some problems to measure the accurate magnetic field and electric field and (ii) The scale was too short to measure the right side of the AC.

Table 1A: EMF values measured for Air Conditioner equipments in various EEE labs in Southeast University (SEU), summer 2015.

Serial No.	Equipment info. (Machine #, Machine Model, made country, year made, Date of installation)	Threshold dis. in front of the equipment measured from the center of the equipment (cm)		Magnetic Field (mG) in front of the eqpt.	Threshold dis. at right side of the equipment (cm)		Magnetic Field (mG)at right side of the equipment	Threshold distance at the left side of the equipment (cm)		Magnetic Field (mG)at left side of the equipment	Magnetic Field maximum (mG)
		EF	MF		EF	MF		EF	MF		
1	Power- 3 ton Brand: Carrier Model: 38 VTA 040 …90125Phase-3 Ins. Date: 5-5-2014	10.5	*	143	10	*	160	22	*	188	188
2	Power- 3 ton Brand: Carrier Model: 38 VTA 040 …90125Phase-3 Ins. Date: 5-5-2014	11	*	198	12	*	158	27	*	182	198
3	Power- 3 ton Brand: Carrier Model: 38 VTA 040 …90125Phase-3, 50 Hz Ins. Date: 5-5-2014	10	*	19	0	*	2.3	1.5	*	51	51
4	Power- 3 ton Brand: Carrier Model: 38 VTA 040 …90125Phase-3, 50 Hz Ins. Date: 5-5-2014	15	*	36.8	4.5	*	32.8	16	*	95	95
5	Power- 5 ton Brand: Carrier Model: 38 VTA 040 …90125Phase-3, 50 Hz Ins. Date: 5-5-2014	13	*	182	8	*	60.2	16	*	79	182

EMF readings from the distribution board, switch board and socket points in the same lab it has been observed that it was difficult to measure the right side of the distribution board (DB) because the scale was too long for taking the measurement. From Measurement and Instrumentation Lab, it has been observed that the (i) there were not sufficient space in that lab and so there were some problems to measure the accurate magnetic field and electric field threshold distance on the right side of the AC and (ii) headache and eye ache were felt. From Communication Lab-1, it has been observed that (i) there were not sufficient space in that lab and so there were some problems to measure the accurate magnetic field and electric field distance and (ii) there were some problems taking reading with the switch. From Communication Lab-2, it has been observed that it was difficult to measure the right side of the switch board and socket board because they were situated beside the pillar. From Computer Lab, it has been observed that (i) every element were close to each other, for that reason it was difficult to get required value of EF and MF of each equipment. (ii) There are some technical problem to find EF and MF. (iii) It was very difficult to observe and count the unit value of the MF machine because of fluctuation, (iv) At different times obtained different values.

Table 1B: EMF values measured for Air Conditioner equipments in various EEE labs in Southeast University (SEU), summer 2015 (continued from Table 1A)

Serial No.	Equipment info. (Machine #, Machine Model, made country, year made, Date of installation)	Threshold dis. in front of the equipment measured from the center of the equipment (cm)		Magnetic Field (mG) in front of the eqpt.	Threshold dis. at right side of the equipment (cm)		Magnetic Field (mG)at right side of the equipment	Threshold distance at the left side of the equipment (cm)		Magnetic Field (mG)at left side of the equipment	Magnetic Field maximum (mG)
		EF	MF		EF	MF		EF	MF		
6	Power- 2.5 ton Brand: Carrier Model: 38 VTA 040 …90125 Phase-3, 50 Hz Ins. Date: 5-5-2014	5	*	0.8	0.6	*	1.1	20.5	*	2.8	2.8
7	Power- 5 ton Brand: Carrier Model: 38 VTA 040 …90125 Phase-3, 50 Hz Ins. Date: 5-5-2014	6	*	30.6	1	*	3.7	18	*	48	48
8	Brand: General Model: ASG24ABCW Date: 24.3.2013	17	*	2.4	18.5	*	99.8	3.5	*	3.3	99.8
9	Brand: General Model: ASG24ABAJ Date: 24.3.2013	27.5	*	9.9	16.5	*	1.5	0	*	116.9	116.9
10	Brand: General Model: ASG24ABAJ Date: 24.3.2013	5	*	125	5	*	2.2	10.5	*	125	125

DISCUSSION:

It was found from the results that the magnetic field values are much higher than the threshold level. Because of the nature of the wiring both in the ceiling and floor, all the rooms had higher magnetic field than threshold value. Students work on an average of 3-6 hours a day in those labs. We have in mind to include labs from other departments of Southeast University for the study to continue.

There has been an increase of use of the air conditioners in Bangladesh for the last few years in various offices and organizations to increase the working efficiency of the employees. For this reason, the load shedding of electricity has increased tremendously for the last few years due to excessive air conditioner used in offices, organizations and private homes for comfort living.

CONCLUSION:

It is found that in most cases the magnetic field has crossed threshold value. The electric field also has a higher threshold value in some of the equipments. Wiring must be done according to the building code 2012. As the locations of air conditioners were on the wall near to the roof, because of this height (distance) students are not exposed to much hazards. More studies and thorough observations for a longer period are required to learn more about EMF which could lead to acceptable solutions of various problems arising from EMF.

Table 2A: EMF values measured for switchboards in various EEE labs in Southeast University (SEU), summer 2015. Switchboards location address: (1) Energy Conversion Lab, (2) Power System and Protection Lab, (3) Electrical and Electronics Lab

Serial No.	Equipment info. (Machine #, Machine Model, made country, year made, Date of installation)	Threshold dis. in front of the screen measured from the center of the equipment (cm)		Magnetic Field. measured from the center of the equipment (mG)	Threshold dis. at 45° angle from the normal drawing at the center (cm)		Magnetic Fieldat 45° angle from the normal drawing at the center (mG)	Threshold distance at the top of the equipment (cm)		Magnetic Fieldat the top of the equipment (mG)	Magnetic Field maximum (mG)
		EF	MF		EF	MF		EF	MF		
1a	DB- 1 pcs (m) Ampere rating: (s) 10A- 5 pcs Brand: Legand	4.5	*	196	0	*	22	0	*	6	196
1b	Socket Board 13A- 13 pcs 10A- 6 pcs	2.5	*	61	2.5	*	3	0	*	6	61
1c	Switch Board 2 pcs No. of switch 24 pcs	12.5	*	175	1	*	48	0.5	*	31	175
2a	Distribution board DB (main) Ampere rating- >40A	1	*	120	1	*	31	1	*	14.7	120
2b	Switch board-01 No. of switch-07pcs	6.5	*	60.7	16	*	24	3	*	29.6	60.7
2c	Switch board-02 No. of switch-07pcs	3.1	*	45.7	5	*	48	10	*	19.4	48
2d	Socket- 01, 13 A	5	*	64.1	3.5	*	6.2	1.5	*	17.3	64.1
2e	Socket- 02, 10A	6	*	29	1	*	61	2	*	36.8	61
3a	Distribution board-1 Ampere rating- 40A	3.2	*	13.8	0	*	49.7	0	*	42	138
3b	Socket point 13A- 15 pcs, 10A- 9 pcs	11.5	*	66.2	3.2	*	16.5	3.2	*	15.5	66.2
3c	Switch board-IP No. of switch-24pcs	17.5	*	119	0.2	*	120	0.3	*	143	143

Table 2B: EMF values measured for switchboards in various EEE labs in Southeast University (SEU), summer 2015. Switchboards location address: (4) Measurement and instrumentation Lab, (5) Communication Lab-1, (6) Communication Lab-2, (7) Computer Lab (continued from Table 2A)

Serial No.	Equipment info. (Machine #, Machine Model, made country, year made, Date of installation)	Threshold dis. in front of the screen measured from the center of the equipment (cm)		Magnetic Field. measured from the center of equipment (mG)	Threshold dis. at 45° angle from the normal drawing at the center (cm)		Magnetic Field at 45° angle from the normal drawing at the center (mG)	Threshold distance at the top of the equipment (cm)		Magnetic Field at the top of the equipment (mG)	Magnetic Field maximum (mG)
		EF	MF		EF	MF		EF	MF		
4a	Switch board- 1 pc No. of switch-12pcs	5	*	0.8	6	*	1.1	20.5	*	2.8	7.2
4b	Socket point 13A- 4 pcs, 10A- 5 pcs	6.5	*	1.5	0.7	*	2	0	*	1.5	2
4c	Distribution board DB-1 Ampere rating-40A	5	*	0.5	0	*	0.3	0	*	0.3	0.5
5a	DB 40A Ampere rating-40A	6	*	109.6	1	*	32.5	2	*	4.9	109.6
5b	Socket 13A- 8 pcs 10A- 4 pcs	2.5	*	112.5	4.8	*	165.5	39	*	183.5	183.5
5c	Switch board No. of switch-4	19.5	*	0.9	17	*	0.2	20.5	*	52	52
6a	DB- 1 Date: 24.3.2013	87	*	1.8	1	*	3.5	1.6	*	12.3	12.3
6b	Switch-1 No. of switch- 5 pcs Date: 24.3.2013	10.1	*	8.7	9.5	*	5.1	3	*	18.7	18.7
6c	Socket 13A- 11 pcs, 10A- 6 pcs Date: 24.3.2013	29	*	3.7	17	*	4.4	23	*	2.9	4.4
7a	Switch Board	28	*	2.6	5.5	*	5.9	28	*	5.7	5.9
7b	Distribution Board	1.2	*	4.7	1	*	6.3	1	*	5.1	6.3
7c	Socket	8.1	*	1.1	1	*	0.5	1	*	0.3	1.1

REFERENCES

1. Wertheimer N., Leeper, ED. Electrical wiring configurations and childhood cancer. *American journal of Epidemiology*1979; 109,273-284.
2. Milham, S. Mortality from leukaemia in workers exposed to electrical and magnetic fields. *New English J Med.1982;* 307, 249.
3. Repacholi, H. An Overview of WHO's EMF Project and the Health Effects of EMF Exposure.*Proceedings of the International Conference on Non-Ionizing Radiation at*

UNITEN (ICNIR 2003), Electromagnetic Fields and Our Health.2003;1-13.

4. Nordenson, I., Mild, K. H., Andersson, G. Sandström, M. Chromosomal aberrations in human amniotic cells after intermittent exposure to fifty hertz magnetic fields. *Bioelectromagnetics*. 1994; 15, 293–301, 1994.

5. Quamruzzaman, M., Haque, M. Epidemiological Survey of People Working in EMF Field Exposed to High Frequency. *Proceedings of the Global Engineering, Science and Technology Conference* 2012, 28-29 December, Dhaka, Bangladesh.

6. Haque, M., Quamruzzaman, M. Epidemiological survey on effect of EMF emitted by photocopy machines generally used in Dhaka city Bangladesh. *IJRET: International Journal of Research in Engineering and Technology*. 2015; 4(4): 92-100.

7. Haque, M., Quamruzzaman, M. Survey of EMF emitted by Lab equipments in various labs of Southeast University in Bangladesh for possible preventive health hazards. *IFRSA International Journal Of Electronics Circuits And Systems.*2015;4(1): 26-32.

8. Quamruzzaman, M. Haque, M., Ahmed, F., Zaman, M.S. Effects of electromagnetic fields (EMF) near high voltage transmission line: a case study. *Bangladesh Journal of Medical Physics.2014;*7(1): 66-68.

9. Quamruzzaman, M. Haque, M., Non Ionizing Radiation (NIR), its harmful effects especially from Mobile/Cell Phone and Towers. *Southeast University Journal of Science and Engineering*. 2014; 8(1).

10. Haque, M., Quamruzzaman, M. Survey on Effect of EMF Emitted by CRT Computer Monitors in Bangladesh. *Universal Journal of Electrical and Electronic Engineering*2015; 3(5): 149-158.

11. History of air conditioning. *US Department of Energy*. Retrievedfromhttp://www.energy.gov/articles/history-air-conditioning

12. MS120 Single-Axis AC Gaussmeter. *Magnetic Sciences*. Retrieved from http://www.magneticsciences.com/ms120-single-axis-ac-gaussmeter/