

ELECTROMAGNETIC RADIATION AT COMPUTERIZED WORKPLACES

**Pranas Kanapeckas, Stasys Maciulevičius, Alfredas Otas,
Vytautas Petrauskas, Algis Valys**

*Computer Department, Kaunas University of Technology
Studentu St. 50, LT–51368 Kaunas, Lithuania*

Abstract. Increasing amount of electrical equipment in our work places and at home causes increase in the presence of electrical and magnetic fields. The degree of exposure of users working with this equipment is increasing. Although the impact of low frequency electromagnetic fields over people's health remains not properly explored and comprehensive evaluated, surrounding electromagnetic fields in the office environment do not contribute to the well fare being of the office workers.

The impact of electromagnetic fields on people's health is discussed in this paper. Especially attention is paid to Video Display Units (VDU) and electromagnetic radiation at working place. Some results of measurements are presented.

Keywords: electromagnetic fields, health problems, VDU (Video Display Unit).

1. Introduction

Our statistics shows continuing rapid growth of computers in Lithuania. According to data of LIKS (Lithuanian Computer Society) at the beginning of new millennium there were approx. 230 000 computers installed in our offices, universities, schools. Association INFOBALT of Information Technologies, Telecommunications and Office Equipment (Lithuania) estimates the annually growth of computers by 30 000-40 000. The common tendencies of building of Information Society in Europe and Lithuania allowed us to forecast the accelerating spread of computer equipment in the nearest future. This assumption allows us to suppose that near a million of Lithuanian inhabitants are using the computers at their work and at home.

Some people are taking a dim view of general process of computerization and asking if computers at their work are always harmless helpers. Computer users spent a great number of hours on computer (simple calculations give us approx. 65000 hours per career). Limited space at work desk, under lightness and insufficient ventilation in some cases as well can rise a question: doesn't come additional risk for health together with computer at our work desk?

2. Electromagnetic fields and people's health

The amount of electrical equipment in our work places, at home and everywhere is increasing. This

process causes an increase in the presence of electrical and magnetic fields. On the one hand, they have very positive properties for diagnosis of some health problems and for treatment of some diseases (medical scanners use magnetic fields, hyperthermia technique for the treatment of the cancer uses microwaves; see [10]). The effects of external exposure to electromagnetic fields (ELF) on the human body depend mainly on the frequency and magnitude (strength) of electromagnetic fields. The biologists and the physicians have proposed maximum values for radiated electromagnetic fields to taken into account when using electromagnetic radiation for treatment of people. These values were obtained using computational electromagnetic and modelling of distribution of electromagnetic fields in human body [4, 10].

On the other hand, we are surrounded by power systems and diverse electric and electronic equipment, which are source of low frequency (LF) electromagnetic fields. In many rooms of student hostel we can find several household electrical appliances, electronic devices, and computers. Such a room is working place, lounge, bedroom and dining-room in many cases at the same time. We doubt whether young people estimate the maximum values for electromagnetic fields radiated by appliances and electronic equipment in their rooms.

The impact of LF electromagnetic fields on people's health remains not properly explored and

comprehensive evaluated. Many papers and research reports concerning this problem can be found [3, 5, 8, 14, 15]. Here are some statements and conclusions made on the basis of theoretical studies and experimental research:

- according to expert scientific working group of WHO’s International Agency for Research on Cancer (IARC) ELF magnetic fields were classified as possibly cancerogenic to humans [10];
- exhaustive analysis of research done in many countries allows to find correlation between childhood leukaemia or brain and nervous system tumours, overall reproductive health and occupational magnetic field exposure levels exceeding 0.2 μT [2];
- U.S. National Institute of Environmental Health Sciences (NIEHS) concluded in 1999 that the dependence of human health upon exposure in magnetic fields is weak, but that it is still sufficient to warrant limited concern. The overall pattern of results for some methods of measuring exposure suggested a weak association between increasing exposure to EMF and increasing risk of childhood leukaemia [9].

Some sources point out notably aggressive influence over people’s health, other sources express generous doubt. It is so, because data analysed by authors of studies are statistical, so it is difficult to ensure overall objectiveness, pureness, and reproducibility of results because of difficulty in evaluating all factors and distinguishing crucial ones in situation being explored.

3. Electromagnetic radiation of VDU

Most critical device in respect of electromagnetic radiation is computer video display unit; most of them in our country still are of CRT (Cathode Ray Tube) type. The basic electronics of VDUs produce electromagnetic fields of wide frequency range – from several hertz up to half of megahertz. For designs with power transformers, a 50/60 Hz sinusoidal field may be generated. The electronic circuits used to process the video signal may produce radiofrequency fields. The deflection yoke and the circuitry used to drive it, in particular the flyback transformer, are the major sources of magnetic fields. According to Technical

Information Statement prepared by the VDT Subcommittee of the IEEE Committee on Man and Radiation [1] the energy generated by a VDT extends over a broad spectrum, including:

- x-ray and ultraviolet light (wavelengths below 400 nm),
- visible light (700-400 nm, 4.3-7.5x10¹⁴ Hz),
- infrared radiation from heat generated by the electronics,
- very low and low frequency (VLF and LF, 3-300 kHz) energy,
- extremely low frequency (ELF, 30-300 Hz) energy, and
- static electric fields.

The x-rays and ultraviolet rays are harmless because they are absorbed by the glass screen. Visible light is the useful and harmless component of radiation emission from a VDU, if the brightness level of the display is adjusted to suit the operator comfort. The infrared radiation also is low.

VLF and LF magnetic energy is generated by the horizontal deflection system of VDU, and ELF magnetic energy is generated by the vertical deflection system. Many information sources contain anxiety about potential health effects of direct magnetic fields over all these frequencies. Of course, different units have diverse field strengths depending on device type and producer. Electric field strengths and magnetic flux densities at a distance of 30 cm from the CRT screen were measured for many different models. These data are summarized in Table 1 (field levels are given as root-mean-square values; 0.1 μT = 1 mG).

The measurement distance is less than the typical distance at which a user sits from the screen and represents a worst-case distance.

Display faces allways in front of computer user, which spends a lot of time creating and editing documents, accessing databases, browsing in Internet and so on.

Today new computers are equipped with LCD monitors. These monitors only emit the harmless visible portion of the electromagnetic spectrum. Possible affects on health due to electrical or magnetic fields have only been proved at CRT workstations but not at LCD workstations [12].

Table 1. Electric field strengths and magnetic flux densities of VDUs

<i>Frequency Band</i>	<i>Maximum Electrical Field Strength</i>	<i>Typical Electrical Field Strength</i>	<i>Maximum Magnetic Flux Density</i>	<i>Typical Magnetic Flux Density</i>
VLF (3-30 kHz) and LF (30-300 kHz)	≤ 50 V/m	1.6 V/m	≤ 1.5 μT	0.02-0.50 μT
ELF (30-300 Hz)	≤ 65 V/m	1-20 V/m	≤ 1.2 μT	0.2 μT
Static (0 Hz)	≤ 25,000 V/m	2-500 V/m	-	-

4. Measurement of electromagnetic radiation

Computer equipment testing laboratory (CETL) was established at Kaunas University of Technology (KUT) and accredited in Lithuanian National Accreditation Office as institution for exploring of electromagnetic radiation of computer displays. CETL together with employees of Ergonomic dept. of KUT and Environment and labour safety dept. of Kaunas University of Medicine published in Web information concerning electromagnetic radiation and other problems of secure work at computer. This homepage (<http://www.kompirsveikata.lt>) is permanent and it is being periodically updated that every computer user in Lithuania be able to find quite proper and exhaustive information about risk factors nascent in computer environment, measures to avoid such negative impact on health, time limitations for different users, specific requirements for pupils and schoolchildren, prevention of illness caused by long-lasting work at computer. This homepage and CD-ROM contain the information useful for schoolteachers, sanitary technicians, and planners of computerized workplaces, work safety

professionals responsible for work safety in public and private institutions.

Some measurements of electric field strength were carried out in our Computer equipment testing laboratory:

1. Power cable of VDU was unshielded. Net-feed system has three lines, including ground connection. Measurements were carried out when the head of measuring device center was positioned in 50 cm distance from the centerline of the screen and monitor was rotated during measurement. Results were sampled every 22.5°.
2. The same measurements were carried out after changing plug position to opposite. The difference in results is shown in a diagram (Figure 1).
3. All the measurements were carried out again after replacing power cable with shielded one. The diagram looks like shown on Figure 1 but field strength decreased significantly.

All the measurements were performed according to European Standard EN 50279 [13].

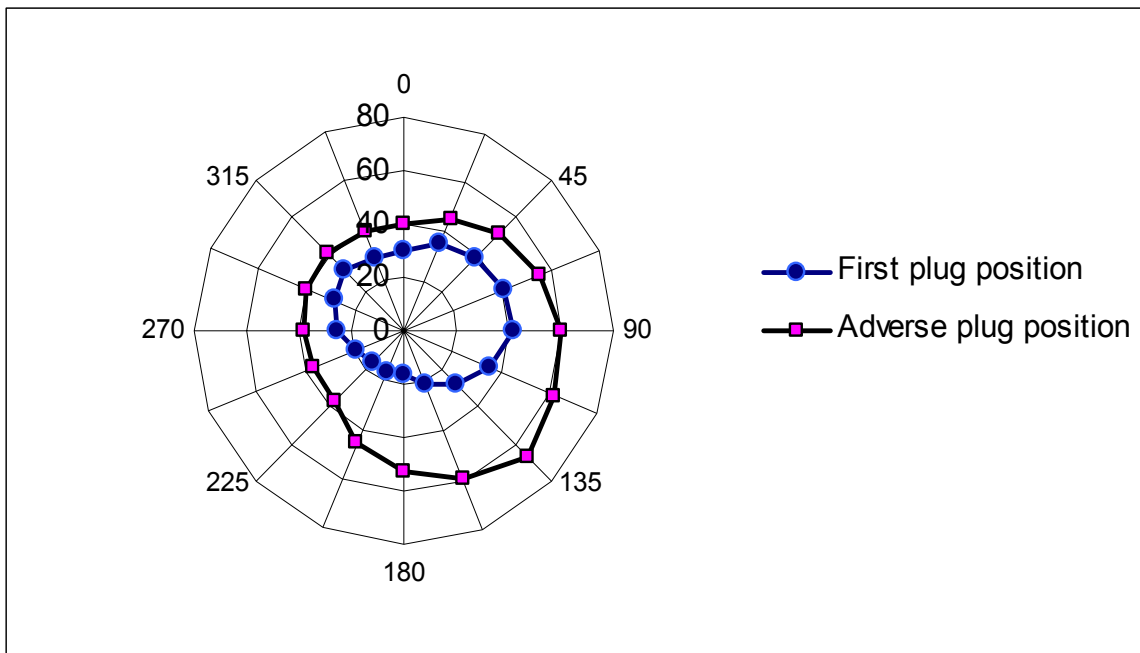


Figure 1. Impact of plug position on electric field strength of VDUs

5. Electromagnetic radiation at working place

The levels of most radiations and electromagnetic fields emitted from modern VDUs are much less than those from natural sources, such as the sun, and all are well below levels considered harmful by responsible expert bodies such as the International Radiation Protection Association. Radiation emissions from modern VDUs are not considered to be harmful to health.

The sources of electromagnetic radiation are:

- power network in room (often hidden under plaster),
- sockets and power cables,
- household electrical appliances,
- computers and various electric devices (fans, fax machines, etc.).

Most of these devices can be removed outside of workplace to eliminate influence of their radiation.

Some results of measuring of electromagnetic fields (frequency range 5 Hz - 2 KHz) in computerized workplaces are presented in Table 2.

Table 2. Electric field strengths and magnetic flux densities in some situations

	<i>Characterisation of workplace and measuring situation</i>	<i>Strength of electric field, V/m</i>	<i>Density of magnetic flow, nT</i>
1	Power cables are shielded, three-poled sockets with third plough connected to earth	2-21	30-160
1.1	Printer and reading-lamp are plugged in three-poled sockets	Insignificant changes	Insignificant changes
2	Power cables are both shielded and not shielded, computer cable plugged in three-poled socket	2-21	30-160
2.1	Reading-lamp is plugged in two-poled socket	45-160	40-180
2.2	Copy machine and fax machine are plugged in two-poled sockets	80->200	140-230
2.3	Uninterruptible power supply (UPS) device placed on floor and plugged in two-poled socket: <ul style="list-style-type: none"> • at 10 cm from floor • at 80 cm from floor 	15-50 20	>2000 530-830
2.4	Two-poled socket behind back, rest on three-poled socket	60-110	-
3	Only two-poled sockets used for power supply. Computer, copy machine, and reading-lamp are plugged in two-poled sockets	120->200	190-390
3.1	Only reading-lamp is plugged in two-poled socket	110-160	-
4	Side effects from neighbouring rooms. Power supply cable is under plaster. Desk abuts on wall	25-82	180-390
4.1	Power supply cable is under floor: <ul style="list-style-type: none"> • at floor • in 80 cm from floor 	- -	900-2000 530-1000
4.2	Equipment unshielded, workplaces equipped over power transfer box: <ul style="list-style-type: none"> • at floor • in 80 cm from floor 	>200 -	560-1250 440-530

Table 3. Permissible levels of electric field strengths and magnetic flux densities [6, 11]

<i>Field</i>	<i>Frequency range</i>	<i>MPR II, TN01:1998</i>	<i>TCO</i>
Electric	0 Hz	500 V	500 V
	5 Hz – 2 kHz	25 V/m	10 V/m
	2 kHz – 400 kHz	2.5 V/m	1.0 V/m
Magnetic	5 Hz – 2 kHz	250 nT	200 nT
	2 kHz – 400 kHz	25 nT	25 nT

Note: according to MPR II measuring device should be located in 50 cm in front of the VDU; according to TCO - in 30 cm in front of the VDU and at 50 cm around the VDU.

We obtained measurements of VLF electric and magnetic fields from 124 workplaces in 42 rooms of Kaunas University of Technology (KUT). The results of measurements are presented in Table 4.

The results of our measurements show necessity to pay more attention to equipping of workplaces in our labors, institutes, and at home as well. In some cases measurements of electric and magnetic fields should be carried out.

6. Conclusions

The number of computer users is growing every year. At the same time the amount of computer and electrical equipment in our work places, at home and everywhere is increasing also. This process causes an increase in the presence of electrical and magnetic fields which together with electromagnetic radiation from other sources can affect the people's health.

Table 4. Measured electric field strengths and magnetic flux densities

Subdivision	Measurements were done in		Number of workplaces where HN levels were exceeded			
	Number of rooms	Number of workplaces	electric fields		magnetic fields	
			5 Hz – 2 kHz	2 – 400 kHz	5 Hz – 2 kHz	2 – 400 kHz
Main building of KUT	17	41	13 (3)*	1	19 (7)	4 (1)
Secondary School of KUT	1	14	1	-	-	5
IT development Institute	5	16	3 (3)	-	8	-
Hostel No. 2	3	7	7 (7)	-	-	-
SC Vibrotechnics	5	6	3 (2)	-	-	1
Computer classes of Informatics faculty	3	23	-	-	-	-
Management faculty	8	17	6 (2)	-	2	-
Total	42	124	33 (17)	1	29 (7)	10 (1)

*/ The first number corresponds to workplaces where electromagnetic radiation exceeds HN levels, the second one – to workplaces where electromagnetic radiation more than twice exceeds HN levels.

Although the impact of electromagnetic fields on people's health remains not properly explored and evaluated, some measures should be taken to measure electric field strengths and magnetic flux densities at computerized workplaces and decrease them. It can be done by:

- using proper installation of power network in room,
- using computer equipment satisfying requirements of international standards,
- moving part of computer equipment and various electric devices farther from workdesk,
- regular measurement of electromagnetic fields.

This enables to decrease the negative and possibly dangerous influence of electromagnetic radiation in the case when it exceeds internationally recognized norms.

References

- [1] E.R. Adair, R. Ashley, C. K. Chou et al. Biological and health effects of electric and magnetic fields from video display terminals. *IEEE Engineering in Medicine and Biology Magazine*, 1997, No.16(3), 87-92.
- [2] A. Ahlborn, E. Cardis, A. Green, et al. Review of epidemiologic literature on EMF and health. *Environmental Health Perspectives*, 2001, Vol.109, Suppl. 6, 911-933.
- [3] F.S. Barnes (Ed.), B. Greebaum (Ed.) Biological and Medical Aspects of Electromagnetic Fields. *CRC*, 3rd Ed. 2006, 480.
- [4] A. Bossavit A theoretical approach of the question of biological effects of low frequency fields. *IEEE Magetics*, 1993, Vol.29, No.2, 1399-1402.
- [5] Electro-Magnetic Pollution and Health in the Workplace. <http://www.powerdome.ie/research/The%20Facts/EM%20in%20the%20Workplace.htm>.
- [6] EMF Exposure Standards & Guidelines. <http://www.lessemf.com/standard.html>
- [7] HN 32:2004. Darbas su videoterminalais. *Saugos ir sveikatos reikalavimai. Valstybės žinios*, 2004, Nr.32-1027; 2005, Nr.151-5566.
- [8] J. Mercola. Are EMFs Hazardous to Our Health? http://www.mercola.com/article/emf/emf_dangers.htm.
- [9] NIEHS. NIEHS report on health effects from exposure to power-line frequency electric and magnetic fields. *NIEHS*, 1999, 80.
- [10] N. Siauve, R. Scorretti, N. Burais et al. Electromagnetic fields and human body: a new challenge for the electromagnetic field computation. *COMPEL: The Internat. J. for Computation and Mathematics in Electrical and Electronic Engineering*, 2003, Vol.22, No.3, 457-469.
- [11] TCO'03 Displays. *CRT Displays Ver. 3.0. TCO Development*, 2005, 100.
- [12] TFT versus CRT: A comparison of advantages and disadvantages. http://www.nec-display-solutions.com/coremedia/generator/index,realm=Monitorizing_BG Article_Details,spec=x_uk_en,solutionId=,docId=56396.
- [13] Visual Display Units – Measuring methods for low frequency electric and magnetic near fields. *European Standard prEN 50279*, 1997, 30.
- [14] WHO. Establishing a dialogue on risks from electromagnetic fields. *WHO*, 2002, 68.
- [15] В.Н. Кудряшов, Л.Г. Макарова, Л.А. Рыглова, А.В. Лаврентьев. Компьютер-убийца. «Эксмо», Москва, 2006, 320.

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