DETERMINATION OF THE ELECTROMAGNETIC FIELD IN THE INTERIORS OF FIM&IF, PUT

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Abstract

This study aims to investigate the electromagnetic fields (EMF) generated by different sources located in the interiors of the FIM&IF, PUT. The measurements are performed using the device EHP-50 (electric and magnetic field probe analyzer), which can measure frequencies from 1 Hz up to 400 kHz. The sources of EMF studied are: 12 channels switch located at the faculty library, 12 computers located in the new computer room and the central server of the PUT. Measurements are performed at 20 cm to 1 m from the sources of electromagnetic field. From the measurements carried out resulted that the electric and magnetic fields are few times lower than the reference values set by the International Commission on Non-Ionizing Radiation Protection. (ICNIRP 2010) for the general public, which are 5 kV/m for the electric field and 100 μT for the magnetic field. The highest values of the electric field were measured within the box where was held the switch (approx. 380 V/m at 50 Hz). However, as in all other sources, that value decreases significantly with the distance from the source.

Key words: Low frequency electromagnetic field, electric field, magnetic field, ICNIRP 2010.

Introduction

Electromagnetic fields are always present in nature in the form of electromagnetic waves, example of which is solar energy. Over the centuries, scientific knowledge and technological development have created a growing number of artificial sources of electromagnetic fields: electricity, medical diagnostics, and radio communication instruments. Moreover, most of the artificial sources of electromagnetic fields present in the places where we live and work have become unavoidable. Because of its everyday use, low-frequency radiation, the radiation with a frequency of 50 Hz also called ELF (Extremely Low Frequency), of the alternating current of the electric network and household appliances is of great interest.

Along with the technology, humanity's concern about the effects that non-ionizing artificial radiation can have on human health has increased. There are numerous studies on the biological and health effects of electric and magnetic fields with frequency ranges up to 100 kHz (Barth *et al.* (2010), Cook *et al.* (2002), Juutilainen (2003), Kheifets *et al.* (2007), McNamee *et al.* (2009)). (ICNIRP 1998) and later (ICNIRP 2010) has established guidelines for limiting EMF exposure of general public to 5 kV/m and 100 µT. These guidelines are based on short-term, immediate health effects. These values are protective only for acute effects due to ELF, such as the induction of electric currents in the body. In the case of potential long-term effects of exposure, such as an increased risk of cancer, ICNIRP 2010 has concluded that available data are insufficient to provide a basis for setting exposure restrictions, although epidemiological research has provided suggestive, but unconvincing, evidence of an association between possible carcinogenic effects and exposure at levels of 50/60 Hz magnetic flux densities substantially lower than those recommended in ICNIRP 2010 guidelines. Epidemiological studies have consistently found that everyday chronic low-intensity magnetic field exposure (above 0.3– 0.4 µT) is associated with an increased risk of childhood leukemia Ahlbom *et al.* (2000). International Agency for Research on Cancer (IARC 2002) has classified such fields as possibly carcinogenic. However, a causal relationship between magnetic fields and childhood leukemia has not been established nor have any other long-term effects been established. The absence of established causality means that this effect cannot be addressed in the basic restrictions. However, risk management advice, including considerations on precautionary measures, has been given by WHO (2007a and b).

The aim of this study is to measure the electromagnetic field caused by low frequency exposure due to electric appliances such as computers, switches and servers, in the interiors of FIM&IF and to compare the obtained values with current reference limits.

Methods

The measurements have been performed using EHP-50F, a low frequency electric and magnetic isotropic field probe analyzer. This instrument provides an advanced technology solution for field analysis in the 1 Hz to 400 kHz frequency range in an extremely high dynamic range. The electric and magnetic field values are measured along components X, Y and Z and subsequently the total value is calculated; such data are displayed on the display in real time along with the electromagnetic spectrum. EHP-50F includes a nonvolatile memory which stores frequency and level calibration tables and an internal optical repeater which allows connection to external devices through the optical fiber. This instrument works in Stand Alone Mode as well, in which it can do continuous measurements up to 24 hours.

As sources of low-frequency electromagnetic fields in the interiors of FIM&IF, have been identified some electrical appliances such as a 12 channels switch located at the faculty library, 12 computers located in the new computer room and the central server of PUT located in the server room.

Measurements are carried out in the conditions of the computers switched off, switched on and in downloading in order to create the situation of maximum data flow between switch and computers.

In order to assess the trend of the electric field measurements are performed at different distances of 20, 50 and 100 cm from the source and at 120 and 170 cm in height, assuming respectively the height of the head in an average person in sitting and standing position. The distance of 20 cm from the source has been chosen as required by the law technique reference (CEI 211-6/7 2001), according to which, in the case of monoaxial or triaxial measurements of electric fields, the probe must be placed at a distance equal to at least twice its size. As required by the same law reference technique and previous studies, Bisceglie (2011), the instrument is set up to provide the value of quadratic mean (RMS) of the electric field

During the measurements it was possible to view the spectrum on laptop connected to probe, to verify that the predominant frequencies were those of the alternating current of the electric network (50 Hz).

Results

Table 1 shows the values of the quadratic mean and the maximum of intensity of electric field, calculated by the measuring instrument from the values measured every 60 seconds in 24 hours of sampling, inside the box where is kept the 12-channel switch and outside the box at 20, 50 and 100 cm distance from the box. The 6 computers connected to the switch have been switched on and downloading during the time of measurements. As can be seen in Fig. 1, the electric field in proximity of the switch is stable during the measurement period and has the highest average value. From Figure 2 one can see that intensity of the electric field decreases with increasing distance from the source. That is partly since electric field is inversely proportional to the square of the distance from the source and due to the shielding effect of the box.

All measured values are lower than the reference values, set by (ICNIRP 2010) for the protection of general public exposed to electric and magnetic fields in the low-frequency range (1 Hz to 100 kHz) of the electromagnetic spectrum.

Table 1. RMS and MAX values of the electric field inside and outside the box where the switch is kept. Computers connected to the switch are switched on. The uncertainty is calculated from the Certificate of the Calibration of the apparatus with number 61287.

Distance (cm)	**RMS (V/m)**	**MAX (V/m)**
inside the box	377.119±11.313	519.558±15.586
20 (outside the box, sitting position)	126.868±3.806	132.113±3.963
50 (outside the box, sitting position)	114.133±3.423	128.031±3.840
100 (outside the box, standing position)	91.329±2.739	112.256±3.367

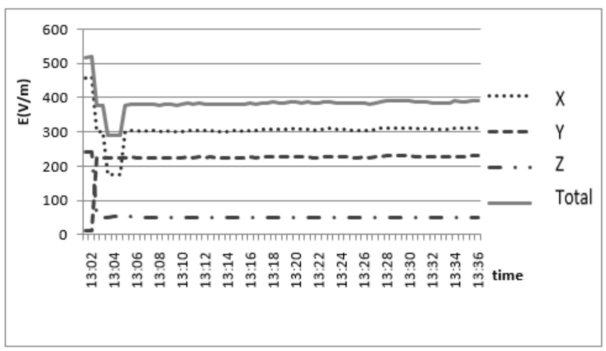

Figure 1. Variation with time of electric field intensity E (V/m), inside the box where the switch is kept.

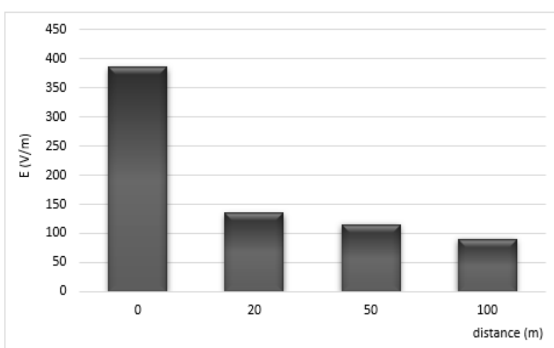

Figure 2. Variation of electric field intensity E (V/m), with distance from the box.

The intensity of electric field from the switch is checked even in the case when all computers connected to the switch are switched off. The measurements are again taken inside the box, 20 cm outside the box, 50 cm outside the box, on the right, left and in front of the box, at the human height of 170 cm and at a meter distance from the box. The average value of electric field intensity inside the box drops drastically from 377.119 V/m of the computers switched on to 1.973 V/m in the case where the computers are switched off. Compare to the electrical intensity inside the box, the electrical intensity outside the box increases little bit telling for the presence of other electromagnetic fields except that of the switch, such as that from electric network in the room.

Table 2. RMS and MAX values of the electric field inside and outside the box where the switch is kept. Computers connected to the switch are switched off.

Distance (cm)	**RMS (V/m)**	**MAX (V/m)**
inside the box	1.973 ± 0.059	3.602 ± 0.108
just outside the box	18.586 ± 0.557	22.327 ± 0.669
50 (outside the box on the right at the height of sitting position)	24.633 ± 0.738	27.253 ± 0.817
50 (outside the box on the left, at the height of sitting position)	8.885 ± 0.266	10.769 ± 0.323
50 (outside the box, in front, at the height of standing position)	26.327 ±0.789	27.918 ± 0.837
100 (outside the box, in front, at the height of standing position)	22.345 ± 0.670	34.196 ± 1.025

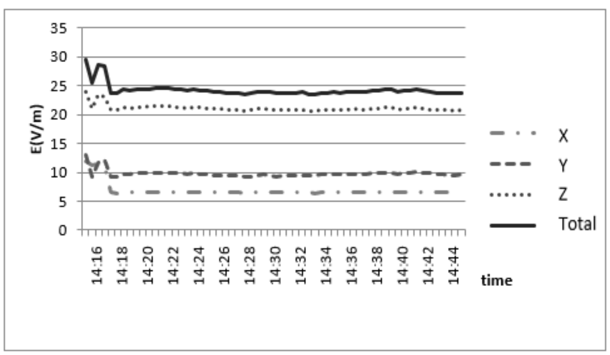

Figure 3. Variation with time of electric field intensity E (V/m), in front of the box at 50 cm distance from the box, at the height of standing position (170 cm). Computers are switched off.

The graph in Figure 3 again shows a constant trend in the intensity of the electric field detected by the measurement instrument.

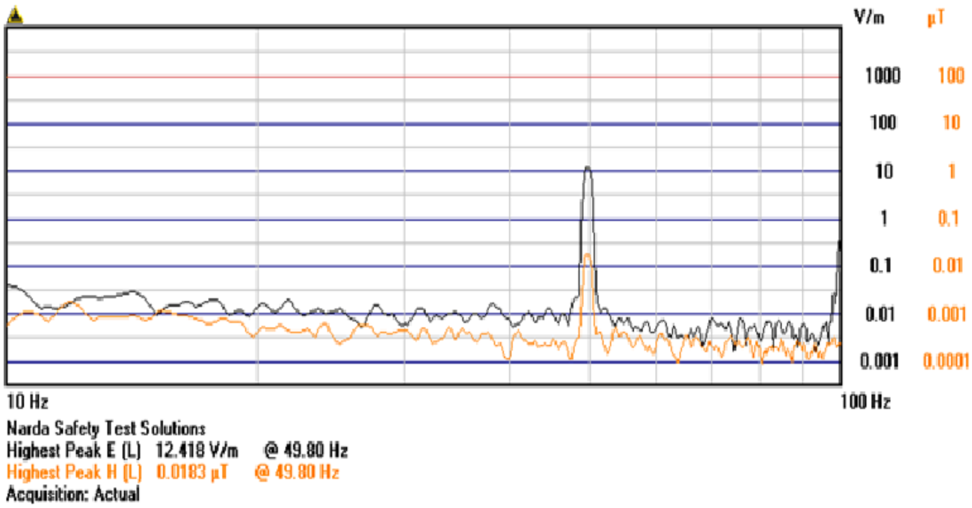

Figure 4. Actual acquisition of electrical and magnetic fields, 50 cm outside the box on the left, at the height of sitting position. Computers are switched off.

From the frequency spectrum in Figure 4 one can see that the predominant frequency is that of the alternating current of the electric network (50 Hz). Highest values of electric field intensity and magnetic flux density in this case are 12.418 V/m and 0.0183 µT respectively.

Table 3. Electric field values measured near the central server of PUT, placed in the server room of FIM&IF.

Distanca(cm)	**RMS (V/m)**	**MAX (V/m)**
Inside the rack mount	8.885 ± 0.266	10.769 ± 0.323
20 (outside the rack mount)	5.142 ± 0.154	10.769 ± 0.323
100 (outside the rack mount)	1.100 ± 0.033	2.121 ± 0.269

In Table 3 we present the results of the electric field measurements taken near the central server of PUT located inside the server room. Measurements are performed inside the rack mount next to the server and outside the rack mounts at increasing distance from the rack mount. In this case the effect of the electric field created by the air conditioner was not considered due to its long distance from the server (over 2.5 m). The data collected confirm what is expected: the highest average values are observed in the vicinity of the server and decrease with increasing distance from the field source. The values measured are within the limits set by (ICNIRP 2010) for the general public.

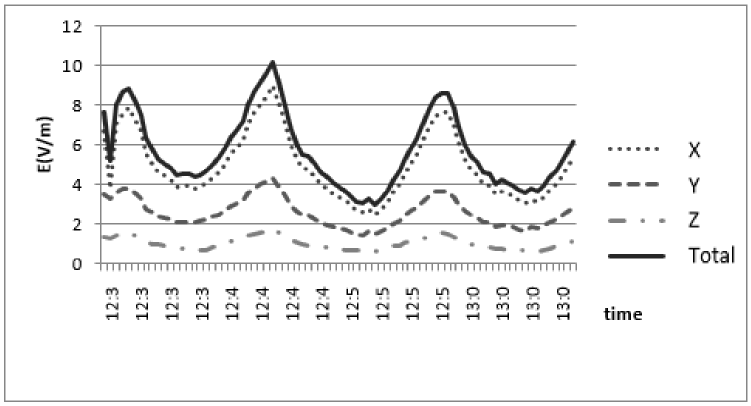

Figure 5. Variation with time of electric field intensity E (V/m), inside the rack mount where is kept the central server of PUT.

Figure 5 shows the trend of electric field inside the rack mount. In this case, as can be seen, the electric field intensity values are significantly lower than the electric field intensity values measured next to the switch inside the box (see figure 1).

We conducted as well a series of measurements in the computer lab as together with the library it is the most frequented places in the faculty. Measurements are performed between switched on computers and in the center of the computer lab with switched on and switched off computers. In the two last cases, the values are very low, however higher than instrument sensitivity limit of 5 mV/m.

From Figure 6 one can see that the electric field between two computers, when all 12 computers are switched on, is stable during the measurement period and has the highest average value of 8.861 V/m.

Table 4. RMS and maximal values of electric field measured in the computer lab, with all switched on and off computers.

MEASUREMENT STATIONS	RMS (V/m)	MAX (V/m)
Between switched on computers	8.861 ± 0.265	9.842 ± 0.295
Center of the room, with switched on computers	0.949 ± 0.028	8.290 ± 0.248
Center of the room, with switched off computers	0.024 ± 0.001	0.308 ± 0.009

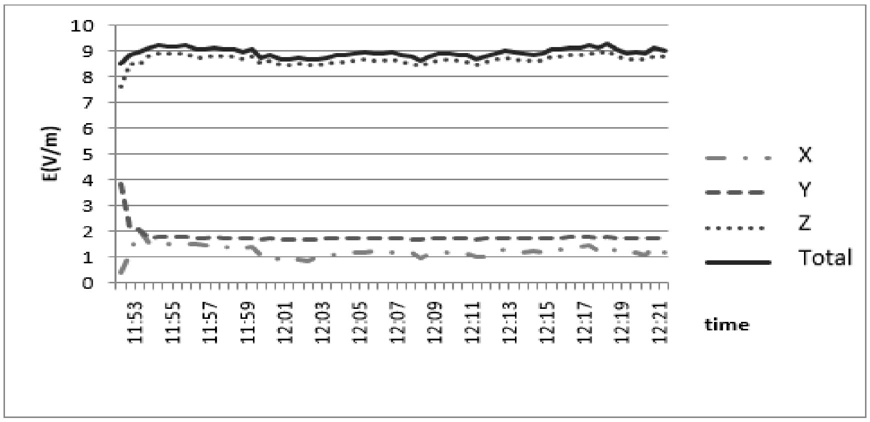

Figure 6. The intensity of the electric field, measured in the computer lab between two computers, when all the computers are switched on, as a function of time.

Conclusions

The study shows the values of electric field from the sources of low frequency electromagnetic radiation present in the interiors of FIM&IF, such as 12 channel switch, server and computers in the computer lab. Relatively high values of about 380 V/m are found near the switch, however, the electric field intensity is reduced to more than 6 times at one meter away. The values we find for electric fields are in any case lower than the reference value of 5 kV/m established by (ICNIRP 2010) guidelines. However, it is useful to bear in mind that the benchmark only defines hedging value against acute effects due to ELF, such as induction of electric currents inside the organism. In relation to long-term effects induced by electromagnetic fields, the scientific community has not drawn unambiguous conclusions.

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