

# CONSIDERATIONS REGARDING ELECTROMAGNETIC RADIATION POLLUTION GENERATED BY OFFICE COMPUTERS

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## ABSTRACT

*Considering the potential negative effects of the exposure of the human body to electromagnetic fields, it is necessary to experimentally determine their parameters and compare them with the limit values provided by the regulations. The paper presents an introduction to the issue of electromagnetic pollution, followed by a case study on the evaluation of the parameters of the electromagnetic field generated by office computers in a public institution. The study was based on measurements made in two rooms belonging to a higher education institution, and based on the data obtained, maps of the electromagnetic fields corresponding to the operation of computers were drawn up, to identify any exceedances of the admitted limits. Following the analyses, areas where the electric field parameters exceeded the permissible limits were identified, and remedial measures were proposed for these areas.*

KEYWORDS: electromagnetic pollution, office computers, monitoring, health

## 1. INTRODUCTION

Throughout history, the human species has evolved under the influence of several sources of electromagnetic radiation that have existed and will exist naturally, such as solar radiation, the cosmic microwave background and electrical discharges. Given that the human species has evolved subject to this radiation, it can be said that it does not endanger life on Earth, but on the contrary, without solar radiation, life on this planet would not be possible.

With the production of electricity, the first anthropogenic sources that generate electromagnetic waves appeared. There are currently a multitude of electromagnetic wave/field generating sources used in the domestic, professional and industrial environment. Modern man cannot imagine life without the intense use of electrical and

electronic equipment, this dependence being responsible for the appearance of a specific pollution, electromagnetic pollution.

## 2. EFFECTS OF ELECTROMAGNETIC POLLUTION

Electromagnetic pollution has significant consequences on both the built environment and living organisms.

It has been highlighted (Lingvay et al., 2008) that electromagnetic pollution generated by alternating and direct current sources has an accelerating effect on the kinetic parameters of electrochemical reactions, favoring corrosion processes in environments such as reinforced concrete. In the same text, the negative impact of 50Hz electric fields on the acceleration of the corrosion process at reinforced concrete columns used to support power lines was

highlighted (Radermacher et al., 2017), based on the analysis of real cases.

Regarding the effects of electromagnetic pollution on the human factor, the paper (Jagetia, 2022) should be brought to light, which synthesizes and critically analyzes the existing research on the genotoxic effects of electromagnetic radiation (EMR) from mobile phones. This review of the literature in this field brings to the fore both acute manifestations, such as headache, fatigue or difficulty concentrating, as well as the chronic impact, at the molecular level. In particular, the author highlights the results of studies according to which electromagnetic pollution leads to an increase in the frequency of micronuclei, the formation of DNA adducts and the appearance of DNA strand breaks, phenomena that indicate the genotoxic potential of prolonged exposure.

On the one hand, human life is dependent on electricity sources, and on the other hand, being aware of the destructive and potentially pathogenic nature of the electromagnetic radiation generated by them, we are obliged to assess their cumulative impact on health and the environment.

### 3. MATERIALS AND METHODOLOGY

In higher education establishments there are a multitude of sources generating electromagnetic waves, such as:

- In higher education establishments there are a multitude of sources generating electromagnetic waves, such as:
- High frequency sources: Wi-Fi routers and access points (2.4 GHz and 5 GHz), Bluetooth equipment, NFC, RFID, mobile phones, smartwatches, tablets, Bluetooth headphones, 5G or WiMAX networks in the vicinity, etc.

Most faculties have rooms equipped with computers for conducting applied classes in specialized courses, especially those that involve the use of technical, statistical or numerical modeling software. Due to the density of equipment in such a room, there is the possibility of generating an electromagnetic field of significant intensity, which can vary depending on the number, type, and location of the devices in operation. In view of the above, it is necessary that after equipping a laboratory with such computers, measurements of the electric and magnetic field should be carried out to verify the compliance with the values imposed by the regulations in force.

This study presents the results of the

experimental determinations of low-frequency electric and magnetic fields in two computer rooms of the Faculty of Engineering in Brăila. ICNIRP Guidelines (2020)

### 3.1 MATERIALS AND EQUIPMENT

To perform these experimental measurements, the Erickhill portable instrument, model ER02, fig. 1, used to determine electric (EF), magnetic (MF) and radio frequency (RF) fields, was used. The device uses a 3-axis isotropic sensor, providing a global estimate of the radiation in the measured medium. In the case of the measurements made, only the strengths of the electric and magnetic fields were determined. The technical data of the device for these areas are as follows: resolution 1V/m, 0.1 mG, range 1-1999 V/m, 0.1-999.9 mG, measurement bandwith 5Hz-3500MHz.



Fig. 1 Erickhill ER02  
Meter for EF, RF and MF detecting

### 3.2 MEASUREMENT AND METHODOLOGY

The location of the computers in the two rooms is as shown in fig. 2 a, b. In the first room, fig. 2 a of the computers are in the form of a square, on one of the sides there is the chair for better coordination of teaching activities. The second room is the faculty's reading room, the place where students can consult bibliographic references, fig. 2b.

In the first room, the computers are of the central unit, monitor (LCD) and peripherals type, however, in the second room, the computers are of the All-in-one type and peripherals.

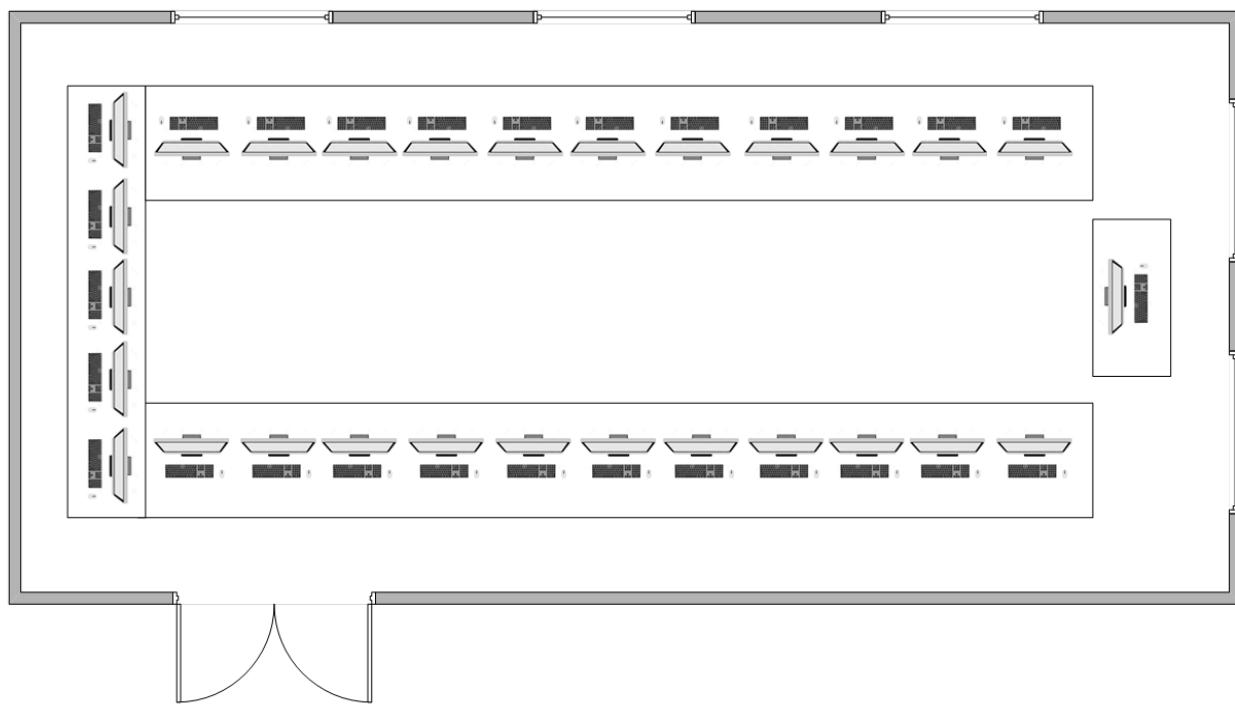


Fig. 2 a Room 1

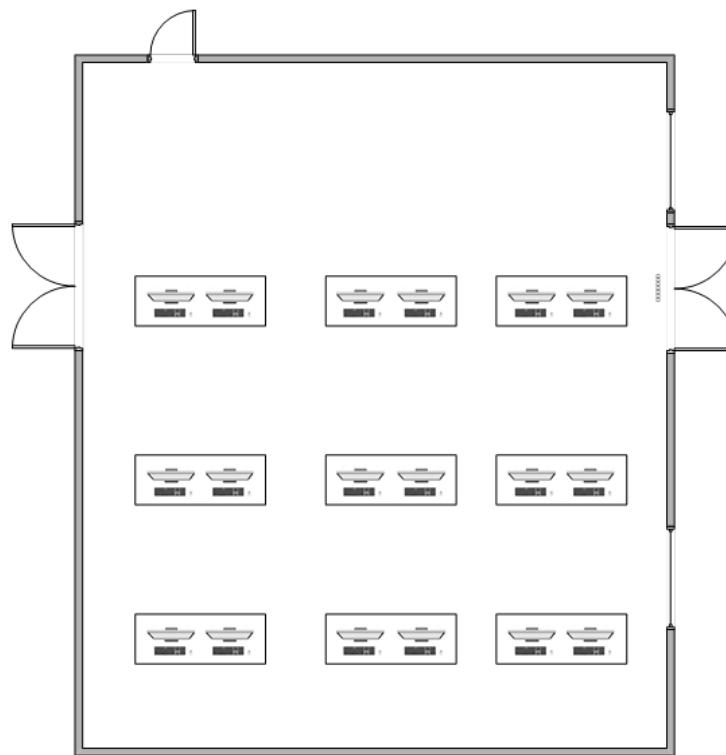


Fig. 2. b Room 2

The determinations were made in front of each monitor/computer All in one (30 cm), near the keyboard, this point being considered of interest from the point of view of the exposure of the human factor to electromagnetic

radiation. To eliminate the possible influences generated by the proximity of the human body on the measuring device, it was placed on a piece of wood, fig. 3 a, b.

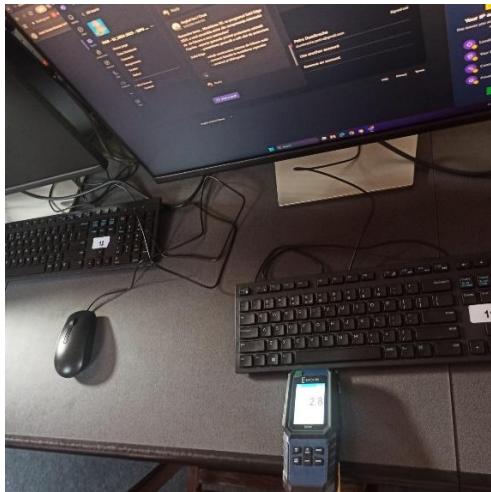


Fig. 3a Experimental determinations in Room 1

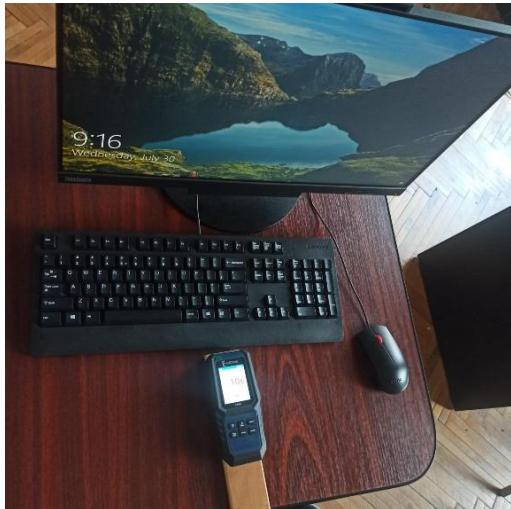


Fig. 3b Experimental determinations in Room 2

#### 4. EXPERIMENTAL RESULTS

The measured values of the electric and magnetic field strengths were used to generate 2D maps of the electromagnetic dispersion around the computers using Matlab R14, following the method proposed by Ghinea & Fireteanu (1997) (see Figs. 4–7).

Considering that desktop computers are in room 1, without Wi-Fi/Bluetooth modules, the dominant emissions are: 50 Hz (power supply fields), respectively 10 kHz – 400 MHz (parasitic electromagnetic noise from sources, monitors, cables).

Based on these maps, a quantitative assessment of the degree of electromagnetic exposure in the vicinity of computers can be performed. Also, identifying the areas with maximum values of the evaluated fields and comparing them with the limits imposed by international safety standards (ICNIRP, IEEE), can highlight possible exceedances of the limit levels.

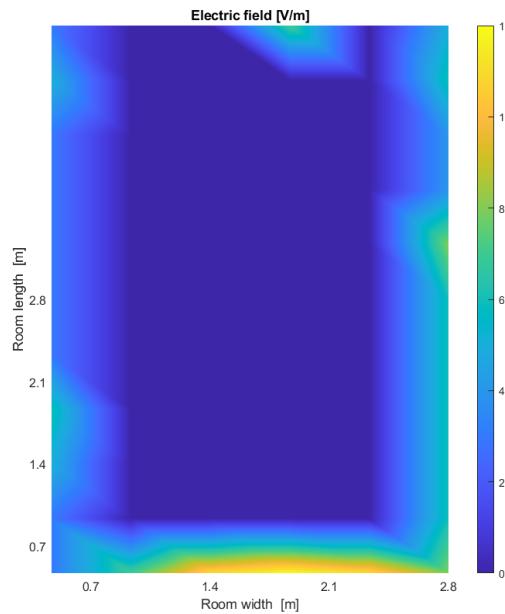


Fig. 4 Electricity Intensity Map, Room 1

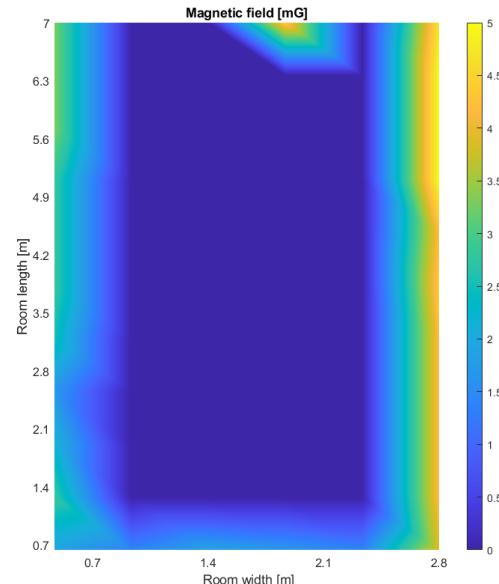


Fig. 5 Magnetic Intensity Map, Room 1

The maximum values determined for this room are 12 V/m for the electric field and 5  $\mu$ T for the magnetic field. The maximum value of the electric field strength, of 12 V/m, falls within the permissible limit of 28 V/m set by the ICNIRP regulations for the frequency band 10–400 MHz. Also, the value of the magnetic field strength, of 5  $\mu$ T, is significantly lower than the permissible limit of 200  $\mu$ T (0.2 mT) imposed by the same body.

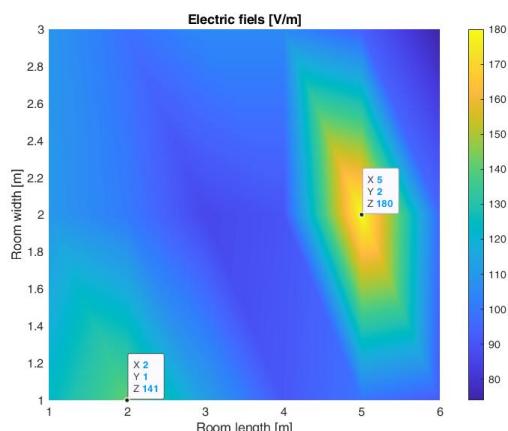


Fig. 6 Electricity Intensity Map, Room 2

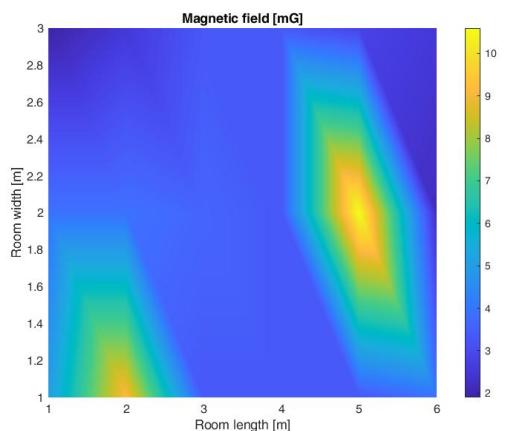


Fig. 7 Magnetic Intensity Map, Room 2

In room 2, the All-in-One computers have integrated Wi-Fi/Bluetooth modules, which involves emitting radio frequency electromagnetic fields in the proximity of users. The maximum value measured in room 2, with all-in-one computers, was 180 V/m for the electric field strength and 10.5  $\mu$ T for the magnetic field strength.

These high values require further investigation to accurately identify the source and dominant frequency of electromagnetic radiation, by using a spectrum analyzer capable of determining the band in which these levels are recorded.

## 5. CONCLUSION

Along with other types of pollution, such as air, soil, water, noise and vibration, electromagnetic pollution is a consequence of the development of human society, in search of better living and working conditions. Throughout human evolution, there have been numerous discoveries that, although at first, they proved to be revolutionary, later it was found that they were also accompanied by side

effects, most of the time harmful to the human factor. Electromagnetic pollution also belongs to this category, which appeared with the discovery of electricity, but gained significant proportions with the diversification of electricity sources.

In other words, given the potential pathogenic effects of exposure to this type of field, the legislation in force imposes exposure limits for electric, magnetic and radiofrequency fields, defined by frequency bands and related to instantaneous or short-term exposure.

It is therefore necessary to quantify the exposure of the human factor to these sources of electromagnetic pollution to verify compliance with the limits established by the legislation.

The case study in this paper focused on quantifying the degree of electromagnetic pollution in a higher education institution where there are rooms equipped with office computers.

If in one of the rooms subjected to the experimental investigation the levels of the electromagnetic field were within the limits estimated as acceptable, in the other room higher values were recorded in the vicinity of two computers. Although all the computers are of the same model, the values recorded in two of them were significantly higher, but due to the limitations of the equipment used, it cannot be said with certainty whether they exceed the regulated limits. It is proposed to repeat experimental determinations with a spectrum analyzer capable of determining the band in which these levels are recorded.

The experimental study within this study demonstrates that the determination of the parameters of the electromagnetic field is necessary in two distinct situations:

- the commissioning of an electrical appliance, a chain of electrical appliances or a computer room;
- periodically (predictive maintenance) to determine possible changes in the correct functioning of the above-mentioned.
- It is proposed that, in the future, a method for quantifying the dose of exposure to electromagnetic pollution that the human factor can bear over a certain period (e.g. the duration of a work shift) should be identified.

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