

Study and Design of an Application for Measuring the Harmful Character of Computer Equipment and Telecommunications

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Abstract: The office electrical, computer or telecom equipment we use on a daily basis emits electromagnetic waves. These waves would have long-term and short-term effects on the human body. Since the direct proofs of cause and effect are still insufficient, a measurement study will be made of these materials in order to know the value of the magnetic field that each of them emits. A discussion of these values against standards' will lead to the design of a NOCIONDE (application revealing HARMfulness of the WAVES if it exists). Based on the precautionary principle, NOCIONDE is a web application or a tool for measuring the harmful nature of materials that offers recommendations to users to follow so that they will not be victimized one day if the evidence proves to be true. The aim of this study is to show the harmful character of computer equipment and telecommunications through the measuring of the electromagnetic field values compared to the standard required by the World Health Organization. The materials' classification is obtained. In addition, the results of NOCIONDE reveal clearly that the provisions concerning the telephone and other equipment emitting radio waves should be respected.

Keywords: Electromagnetic Waves, Magnetic Field, Standards' Values, Nocionde

1. Introduction

Humans impact the environment in several ways. Electromagnetic waves play an important role in all areas of our life. Especially the use of radio, television, other electronic materials and cellular systems that come out as a result of technological developments has expanded rapidly. This is a part of one of the causes of environmental pollution. Just as the environmental pollution due to the exhaust gases of engines in operation demonstrated by the work of Koffi Sagna et al. [1]. Environmental pollution due to the propagation of electromagnetic waves has become a major concern not to be neglected though this pollution is invisible.

The purpose of this study is to help anyone to go to the precautionary principle to guard against any possible harmful

effects of electromagnetic waves emitted by computer and telecommunications equipment. Research has shown that these waves will result in biological effects and effects due to their overexposure [2-4]. The worry today concerns the effects due to the overexposure of the extremely low frequency and radiofrequency radiation emitted by these materials [5, 6]. These last ones would be sources of the incurable diseases, but until today it is difficult to establish a link cause and effect between these diseases and the overexposure to these waves. Their harmfulness to human health remains uncertain. Following the results of epidemiological studies, in June 2002 exposure to extremely low frequency electromagnetic waves was classified in Category 2B [7, 8] by the International

Agency for Research on Cancer (IARC) attached to the World Health Organization.

No further in May 2011, following a meta analysis, the same organization, classified the radio waves [9] in the same category. This 2B label means possibly carcinogenic. This means the risk is likely but research on its realization remains inconclusive. Thus, in the absence of rational explanations of the real impacts of the extremely low frequency and radiofrequency waves, the ICNIRP (International Commission on Non-Ionizing Radiation Protection) recommends the precautionary principle [10]. Starting from this principle, this article will be devoted to the comparative study of the value of the magnetic field emitted by each material in relation to the limit values of exposure. The measurement tool, the NOCIONDE application designed at the end of this study will incorporate this property of comparison for each time bring out recommendations for users.

2. Measuring Device

Measurements are made using a Teslameter called Gaussmeter Tesla meter WT10A WT-10A. It allows to get the value of the static magnetic field on the surface of a material. Still called fluxmeter, it also allows to measure the magnetic induction of the apparatus emitting the low waves extremely low frequencies or radiofrequencies. It is a portable instrument, which offers a wide range of measurement and easy to use. Thanks to its Ns function coupled with the metal probe, it plays the role of tester of the magnetic field. It has four (04) buttons. The first in red allows to turn it on and off. The second one in the middle, allows to adjust the device before any measurement. The third in yellow makes it possible to choose the range of measurements: 0-200 mT for small measurements and 200mT-2000mT for large measurements. Its sensitivity is 0.1 mT and the accuracy margin is +/- 2%.

3. Experimental Protocol

The purpose of this work is to see in which range of magnetic induction value or static magnetic field materials emit, then compare these values to standards recommended by international organisations. For this reason, a stock-taking in three steps has been made from material to material for an evaluation of their harmfulness.

3.1. Step One: Hardware Approach

The value of the magnetic field decreases as the distance increases. The first step will be to approach the device of the probe tesla meter. The maximum distance in our case is 3 cm.

3.2. Second Step: Passing the Probe on the Device

It is not all parts of the material that emit electromagnetic radiation. For this purpose, we will pass the probe on the different parts of the device to detect the one that emits most. It is the part which will hold our attention. On this part, we

will make three measurements that we will note V1, V2, V3.

3.3. Step Three: Choosing the Best Measure

The value to retain here will not be the average of the values taken. Of all the values, the one that will hold our attention will be the greatest value. The idea is to see the effect that each material has on human health.

Measurement will not be done in relation to a group of materials but in relation to each material, to a specific part.

4. Results and Discussion

The following points are the conclusions obtained by measuring the magnetic field emitted on the equipment, following the experimental protocol described above.

4.1. Distance with Electromagnetic Wave Emission

By approaching and removing the teslameter from the equipment during the measurements, we obtain a variation of the value of the magnetic induction presented in Table 1 below

Table 1. Magnetic induction versus distance.

Materials	Values of magnetic induction in mT	
	At 3cm	At 5cm
Mail server Proliant ML350 Gen9	0,6	0,4
File Server Proliant intel DL 370G6	0,2	0,1
Web server Proliant ML 350P Gen8	0,7	0,2
Inverter Online Interactive UPS	1,2	0,5
Switch 1 Dlink DES 1024R+	0,3	0,1
Switch 2 Catalyst 3500 Series	0,2	0

The characteristics of the magnetic field \vec{B} depending on the type of material and the distance are shown in Figures 1 and 2 below and this in comparison with the short-term standard.

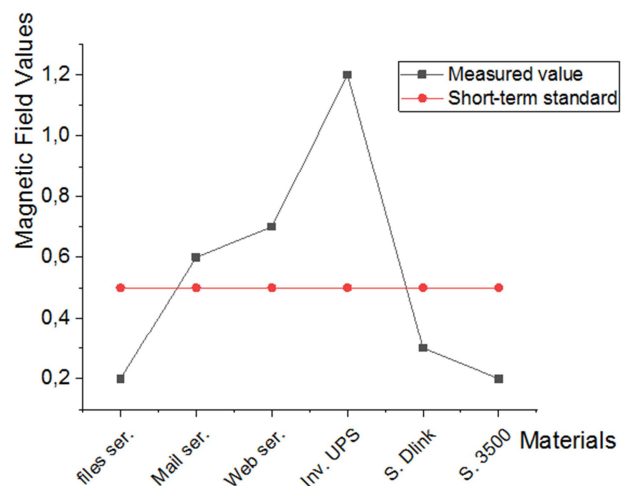


Figure 1. Exposure at 3cm.

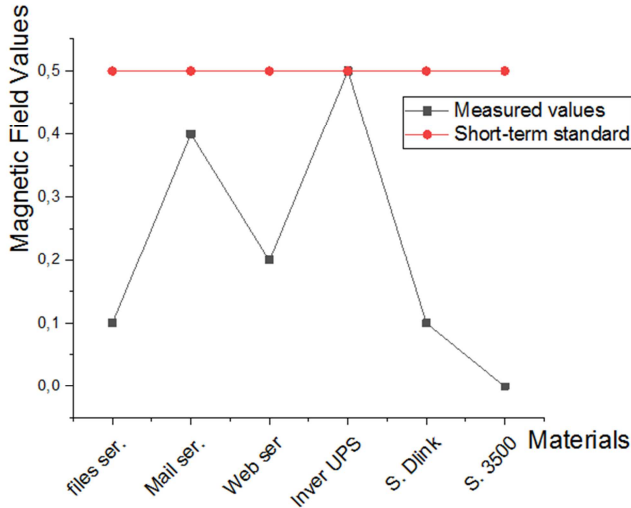


Figure 2. Exposure at 5cm.

We note from these two figures that the value of the magnetic induction decreases once one moves away from the material. *The degree of harmfulness of a material would therefore decrease, when one moves away from this material.* This confirms the results of the AFFSET in its report of collective expertise [11] that the value of the magnetic induction depends largely on the distance that one is in relation to a material.

4.2. Permanent Presence of Waves in Server Rooms

During the measurements, we found that a simple introduction of the teslameter in a server room without being approached to a material brings up a value on its screen. This is not the case when we enter the offices. A combination of these two approaches would better explain this remark.

- a) Server room machines operate without interruption.

This *permanent circulation of charges* would therefore be the cause of a permanent magnetic field at the level of each material;

- b) The promiscuity of computer equipment in the server rooms would also cause an increase in the magnetic field emission value at the level of each equipment. *This would be an amplification of a physical phenomenon due to the fact that each of these devices emits at its level a magnetic field. Close to another, it will be subject to the magnetic field emitted by the latter which would induce an exaltation of the phenomenon to those around him.* This confirms the work of O. Tardy, R. Lennuier in their study of the influence of a magnetic field on the intensity of the airs emitted by some discharge tubes [12].

4.3. Influence of Voltage

An observation made at the voltage level during the measurements is presented in Table 2 below.

Table 2. Magnetic induction values with the voltage.

Materials	Voltage in V	Magnetic field values in mT
Inverter Online Interactive UPS	96 V	$V_1=1,2$; $V_2=0,9$; $V_3=1$
Interrupted Power Supply		
Inverter APC Smart UPS	12 V	$V_1=0,1$; $V_2=0,1$
RT1000		
Inverter EATMON 5E	12 V	$V_1=0,2$; $V_2=0,1$; $V_3=0,2$

The characteristics of the magnetic field \vec{B} depending on the type of material and the distance are shown in Figure 3 below and this in comparison with the short-term standard.

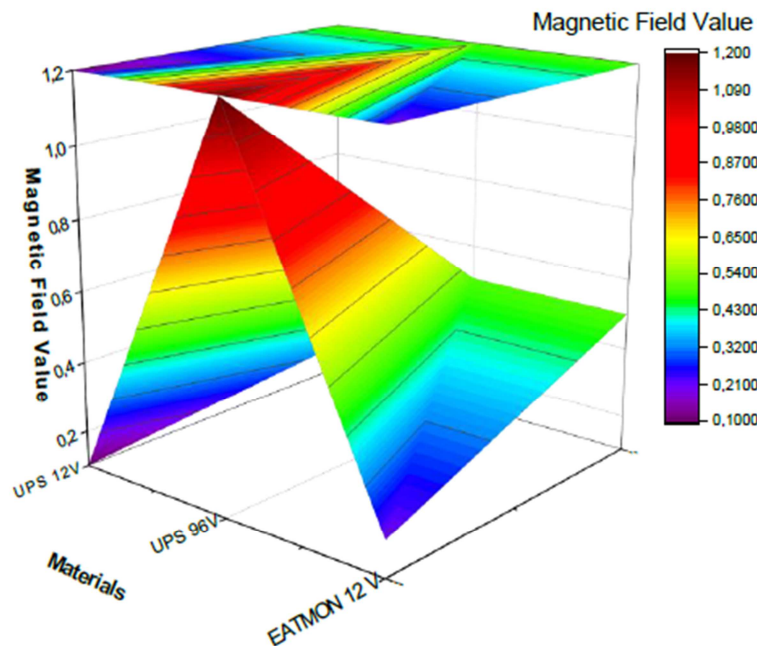


Figure 3. Influence of the voltage on the emission of the magnetic field.

The result obtained shows that *the value of the emitted magnetic field increases with the electric power*. This confirms the work of A. RAGHI who in his article of Magnetic Field Influence on Current Intensity in Rarefied Air found that the transformation of cathodic rays into magnetic rays is accompanied by a very marked increase in the

potential difference [13].

4.4. Electronic Components Constituting the Material

Measurements of the magnetic field values gave different values at the server level as shown in Table 3 below.

Table 3. Magnetic field values of the servers.

Servers	Brands	Magnetic field values in mT
Files Server Proliant intel DL 370G6	HP	$V_1=0,1$; $V_2=0,1$; $V_3=0,2$
Mail Server Proliant ML350 Gen9	HP	$V_1=0,6$; $V_2=0,2$; $V_3=0,3$; $V_4=0,5$
Web Server Proliant ML 350P Gen8	HP	$V_1=0,4$; $V_2=0,7$; $V_3=0,5$
Digital Server Campus System x3650 M	IBM	$V_1=0,1$; $V_2=0,2$; $V_3=0,2$
Voice Server on IP	IBM	$V_1=0,2$; $V_2=0,1$
S2ESup Server	IBM	$V_1=0,2$; $V_2=0,1$
DNS Server intel Xeon CZ25491G03	HP	$V_1=0,4$; $V_2=0,3$; $V_3=0,8$

The characteristics of the magnetic field \vec{B} depending on the type of material and the distance are shown in Figure 4 below and this in comparison with the short-term standard.

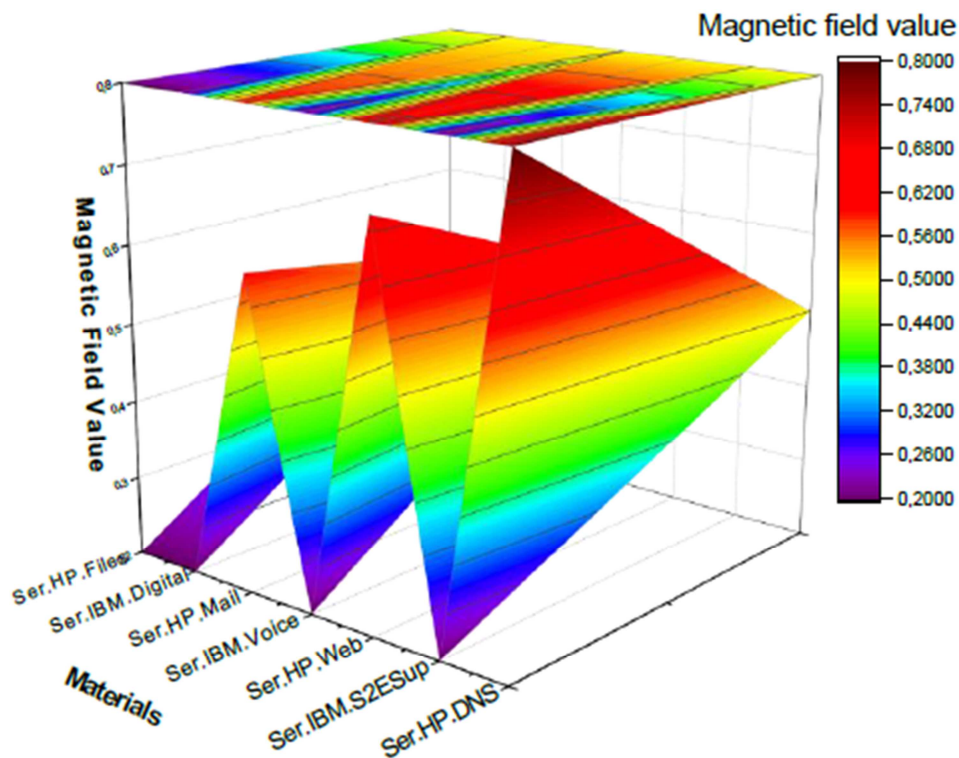


Figure 4. Magnetic induction based on computer servers.

From a physical point of view, these servers look similar. But, we notice a clear difference in their emitted magnetic field value, taken under the same conditions. The results we obtain, show that the electromagnetic field emission would vary from one brand to another. *The emission of the electromagnetic wave of a server would therefore depend on the brand and the server model*. This would come from the fact that certain equipment, considering their functions, would be designed with more sophisticated electronic components that consume much more energy, thus more electric energy. This would lead to a considerable emission

of the electromagnetic wave. In other words, *some brands of servers would be more harmful than others*. This would partly confirm GUILLAUME GUERSAN's work on GreenIT [14].

4.5. Telecommunications Equipment Would Be Harmful to the Human Body

Measurements of the value of the magnetic field emitted, made on the various fixed and mobile telephones are shown in Table 4 below.

Table 4. Field magnetic's values emitted by mobiles.

Telephones	Brands	Magnetic field's values
Fixed	Microtel Model KX-TSC880CID	$V_1 = 5,2$
	Gaoke HCD737TSDL59	$V_1 = 6, 3$
	Panasonic KX-TS840MXW	$V_2 = 7,6$
	Gaoke HCD737TSDL	$V_3 = 6,6$
	Itel it 1508	$V_1 = 8,2$
Mobiles	Illico CAM Togotelecom	$V_1 = 16,8$
	Invens Royal R4	$V_1 = 4,1$
	M. Wiko WiM	$V_1 = 4,2$
	Huawei	$V_1 = 10,7$

To know the level of harmfulness of these telephones to the human body, we will use the comparison relation: $M^2/6 \times 10^{-6} \leq \mu_0^2 H_{NR}^2$.

If $M^2/6 \times 10^{-6} \leq \mu_0^2 H_{NR}^2$ then the material is not harmful.

We will take H_{NR} (A/m) = $0,008335 f^{0,3417}$ according to the evaluation criteria of the magnetic field [15]. f being the

transmission frequency, in this case we will take the GSM transmission frequency equal to 900 MHz. M et μ_0 respectively represent the measurement of the magnetic field and the permeability in the vacuum.

$\mu_0 = 8,85418782 \times 10^{-12} \text{ m}^{-3} \text{ kg}^{-1} \text{ s}^4 \text{ A}^2$. The using of these relations and expressions, give us the following table 5.

Table 5. Harmfulness of phones.

Brands	Magnetic field's values	Harmfulness's verification $M^2/6 \times 10^{-6} \leq \mu_0^2 H_{NR}^2$
Microtel Model KX- TSC880CID	$V_1 = 5,2$	$(5,2)^2 \times 10^{-6} / 6 > (8,85418782 \times 10^{-12})^2 (0,008335 900^{0,3417})^2$
Gaoke HCD737TSDL59	$V_1 = 6, 3$	$(6,3)^2 \times 10^{-6} / 6 > (8,85418782 \times 10^{-12})^2 (0,008335 900^{0,3417})^2$
Panasonic KX-TS840MXW	$V_2 = 7,6$	$(7,6)^2 \times 10^{-6} / 6 > (8,85418782 \times 10^{-12})^2 (0,008335 900^{0,3417})^2$
Gaoke HCD737TSDL	$V_3 = 6,6$	$(6,6)^2 \times 10^{-6} / 6 > (8,85418782 \times 10^{-12})^2 (0,008335 900^{0,3417})^2$
Itel it 1508	$V_1 = 8,2$	$(8,2)^2 \times 10^{-6} / 6 > (8,85418782 \times 10^{-12})^2 (0,008335 900^{0,3417})^2$
Illico Togotelecom	$V_1 = 16,8$	$(16,8)^2 \times 10^{-6} / 6 > (8,85418782 \times 10^{-12})^2 (0,008335 900^{0,3417})^2$
Invens Royal R4	$V_1 = 4,1$	$(4,1)^2 \times 10^{-6} / 6 > (8,85418782 \times 10^{-12})^2 (0,008335 900^{0,3417})^2$
M. Wiko WiM	$V_1 = 4,2$	$(4,2)^2 \times 10^{-6} / 6 > (8,85418782 \times 10^{-12})^2 (0,008335 900^{0,3417})^2$
Huawei P9 Lite	$V_1 = 10,7$	$(10,7)^2 \times 10^{-6} / 6 > (8,85418782 \times 10^{-12})^2 (0,008335 900^{0,3417})^2$

The red color reminds us once how much the mobile phones we use would be harmful to humans and that precautions should be taken to better protect against any effect if it would exist.

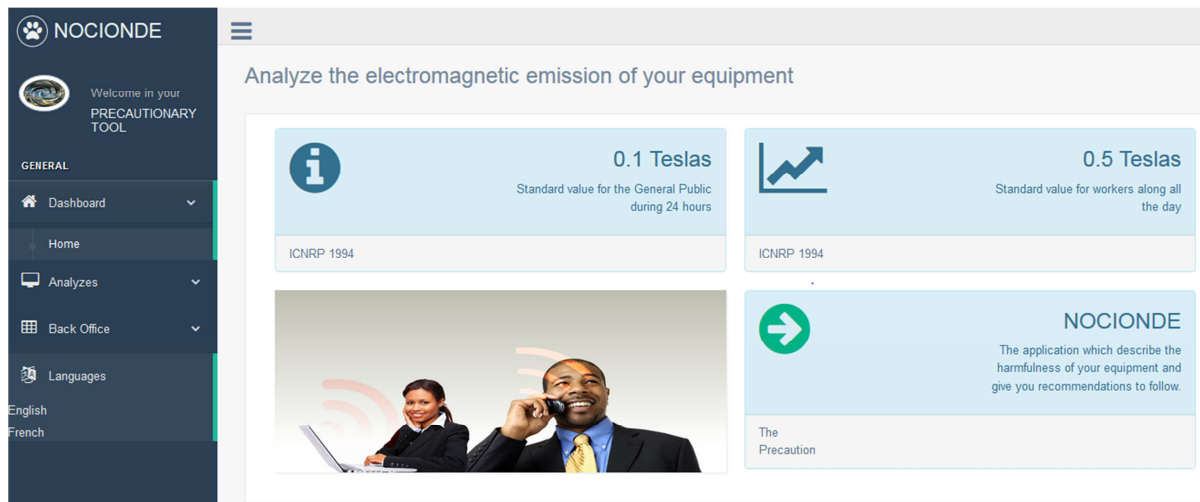
5. NOCIONDE Application

NOCIONDE (HARMfulness of the WAVES) is a Web application set up to see if the amount of an electromagnetic wave emitted by an electronic equipment is harmful to its user. It is an application designed with the Laravel

Framework and based on ICNIRP international standards. By a value input of the magnetic field measured on a material, NOCIONDE presents at the output, a result describing the harmfulness of the material joined to the recommendations. So according to the level of harmfulness we have:

- The green color: The material would not be harmful;
- The orange color: The material would be harmless;
- Red color: the material would be harmful.

The Figure 1 shows the interface of the NOCIONDE application home page

**Figure 5.** Home page.

NOCIONDE offers essentially three (03) major functions:

- Analysis of equipment emitting extremely low frequency electromagnetic waves;
- Analysis of equipment emitting radiofrequency waves;
- Research based on pre-performed analyzes.

V.1 Analysis of the equipment emitting the waves extremely low frequencies

The user on this page, must complete four (04) analysis criteria.

- Material: At this level is several materials. The user will choose the material for which he wishes to analyze.
- Value of the magnetic field (mT): it will be able to

scroll to arrive at the value of the magnetic field emitted by the material or to put directly this value.

- Exposure period and type of exposure: These last two criteria correspond to international standards.

Table 6. Short-Term exposure standards.

Target	Exposure's characterization	Exposure's standard magnetic field in mT
Workers	During the day	0,5
Public	During 24 hours	0,1

Figure 6. Analysis page of a material emitting an extremely low frequency wave.

V.2 Analysis of materials emitting radiofrequency waves

The user on this page must fulfill another criterion in addition to the five (05) primary evaluation criteria. This is the transmission frequency of the material to be analyzed.

This frequency is for example 900 MHz for a phone emitting a single call, 1800 MHz for a 3G connection, 2450 MHz for a Wifi connection. The figure below shows the analysis interface.

Figure 7. Analysis interface of a material emitting radio waves.

V.3 Research based on pre-performed analyzes This is a help function for users who don't have teslameter or don't know how to use a teslameter. All they have to do is to enter the name of the material. The application NOCIONDE will do researches and show them the level of its harmfulness. NOCIONDE is today a tool adapted to any user and allows to go quickly to the principle of precaution.

6. Conclusion

A classification of materials against the short-term standard would therefore give, us:

- a) Materials that would not be harmful: Displays, CPUs, inverters, printers, photocopiers;
- b) Equipment that would be harmless: servers, inverters;
- c) Materials that would be harmful: servers; laptops and cell phones.

Arrangements should be made today concerning the use of these materials since there is still uncertainty about their degree of harm. The application NOCIONDE, set up as a result of this work allows to go to the principle of precaution as advised by international organizations such as ICNIRP, WHO, IARC. It is an application based on the exposure limit values recommended by international standards and recommendations permitting to avoid the harmfulness of the waves. The materials studied emit extremely low frequency and radiofrequency waves. The operation behind this application is to compare these standard values to the measured values.

In addition, the results of this application reveal clearly that provisions concerning the telephone and other equipment emitting radio waves should be respected.

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