RADIATION EMISSIONS ASSESSMENT FROM ELECTRONIC DEVICES: CASE STUDY AT FACULTY OF GRADUATE STUDIES AND ENVIRONMENTAL RESEARCH BUILDING

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ABSTRACT

Exposure to electromagnetic fields has been a concern for decades, with regulations establishing upper limits. Various standardization bodies have developed regulatory guidelines setting limits to exposure to electromagnetic fields. This work uses the electromagnetic field meter (GQ EMF 390). The device EMF 390 is installed with multiple sensors to ensure maximum range measurement. The Faculty of Graduate Studies and Environmental Research (GSER) was selected as a case study. GSER starts its steps toward sustainability. One of these steps is to measure and evaluate the emission level of the Electric Field (EF), Radiofrequency (RF), and finally Electromagnetic Field (EMF). The results of this work are the room of Staff room-9 (STF9) is more than 80 V/m. The library which had a maximum rate of occupancy, achieve EF of 50 V/m. When the safe limits of EF values ranging from 1-10 V/m. The minimum value of EF (5 V/m) was observed in Staff room-6 (STF6). The IT rooms achieved acceptable RF values, ranging from 0.001–1 mW/m^2. The room of the Basic Science Department (BSD) had a value of EMF of 8 mG. Meanwhile, the safe limits and EMF values range from 0.5 to 1 mG. The study explains that the BSD room had high measures

Vol. (51); Iss. (3); No. (6); March 2022
ISSN 1110-0826
ONLINE ISSN 2636 - 3178

of radiation and emission due to the BSD being the nearest room to the electrical panels of GSER.

Keywords: Assessment, Effect, Radiation Emissions, Electronic Devices. Case study.

INTRODUCTION

Radiofrequency (RF) fields are a type of electromagnetic field that falls within the range of frequencies used for communication and broadcasting. The sources of RF fields include radio and television broadcast towers, cell phone towers, and wireless communication devices such as cell phones, Wi-Fi routers, and Bluetooth devices. Electric Fields (EF) are a type of field generated by the presence of electric charges, either static or changing. The sources of EF include charged objects, electrical devices such as power lines and transformers, and electric motors (Viel *et al.* 2009). In addition, the distribution of charges in conductors and insulators, as well as the movement of charges within a circuit, can also generate EFs (Wijayasinghe and Karipidis 2013).

Electromagnetic fields include a broad range of frequencies, while RF fields are a specific subset of electromagnetic fields that fall within a certain frequency range, and electric fields are generated by the presence and movement of electric charges (Wijayasinghe and Karipidis 2013). Electric emission sources for electromagnetic fields (EMF) are the sources of electromagnetic energy in the form of electromagnetic waves. The main

Vol. (51); Iss. (3); No. (6); March 2022
ISSN 1110-0826
ONLINE ISSN 2636 - 3178

sources of EMF are natural sources such as the sun and artificial sources such as power lines, electrical appliances, and communication devices.

Deep studies have been examined to find a link between non-ionizing radiofrequency (RF) radiation and harmful health impacts on humans from RF fields in the scientific and educational communities. Most of the worries stem from contentious news stories tying base station radiation to cancer studies (Olorunsola *et al.* 2021). Therefore, for the cellular system to function and control RF interference, a controlled level of radiated power is needed. System capacity can be accomplished by increasing the number of cells in the system and correspondingly reducing the number of users with low-power transmitters in the cell to reduce interference with other cells using the same frequencies (Olorunsola *et al.* 2021). The effects of signal power exposure from a single point on the ground that currently varies continuously due to the systemic radiation energy proliferated in complex environments (i.e., inner-city areas) based on the cellular call traffic of the base-stations are one aspect of base station pollution that is poorly understood, except for system planners and engineers. These effects can cause irregular, fluctuating, or large variations in the level of exposure and are frequently unpredictable (Besset *et al.* 2020).

Medical care is increasingly utilizing high-tech equipment. Although these tools improve the standard of treatment, they could subject patients and medical staff to Electromagnetic Fields (EMF) (Besset *et al.* 2020). This is

Vol. (51); Iss. (3); No. (6); March 2022
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ONLINE ISSN 2636 - 3178

particularly valid in Neonatal Intensive Care Units (NICU), where RF-EMFs are generated by a variety of sources. For example, modern monitoring devices that connect to Wireless Fidelity (WiFi) networks, mobile phones that use the Global System for Mobile Communications (GSM) and Universal Mobile Telecommunications System (UMTS) standard, cordless phones that use the Digital Enhanced Cordless Telecommunications (DECT) standard, and a particular frequency for emergency calls (Besset *et al.* 2020).

During call commencement or cell tower handover, this cell phone power control causes a brief peak in transmission power for the duration of the journey (Wall *et al.*2019.). Studies on EMF's direct and indirect effects are discussed; direct effects are those caused by fields coming into direct contact with the body, while indirect effects are those caused by interactions with objects that have a different electric potential than the body. The offered guidelines are applicable to occupational and public exposure, and they include basic exposure parameters, reference values for practical hazard assessment, and results of laboratory and epidemiological investigations (Manivannan 2016). The International Non-Ionizing Radiation Committee (INIRC) guidelines on high-frequency and 50/60 Hz electromagnetic fields have been replaced by the current guidelines, which encompass the complete frequency range of time-varying EMFs (up to 300 GHz).

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ONLINE ISSN 2636 - 3178

The scientific issue of the impact of the electric field, radiofrequency field, and electromagnetic field from electronic devices on public health is known as electromagnetic field (EMF) exposure. This refers to the exposure of individuals to various forms of electromagnetic radiation, including radiofrequency (RF) fields, which are emitted by electronic devices such as cell phones, computers, Wi-Fi routers, and other wireless devices (Matthes *et al*. 1999). Concerns about the potential health effects of EMF exposure have been raised, but scientific research has not yet established a clear link between exposure to these fields and negative health outcomes. However, the World Health Organization (WHO) states that some studies have suggested a possible link between long-term exposure to certain types of EMF and an increased risk of cancer, while others have not found any such association (Viel *et al*. 2009; Zekavat *et al*. 2014). It is important to note that more research is needed to fully understand the potential health effects of EMF exposure and to develop appropriate guidelines to protect public health.

This work aims to do the required research to answer this vital matter on the public health of determining the allowable exposure time for the employees, academic staff, and visitors at the building of the Faculty of Graduate Studies and Environmental Research, (GSER).

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MATERIALS AND METHODS

The set used in this study is an advanced GQ EMF-390 Multi-Field, Multi-Function EMF Meter, and RF Spectrum Power Analyzer. This set is annually calibrated to ensure reading accuracy (Matthes *et al*. 1999).

Main Corridor	Library	It room

Fig. (1): Example of the Proper Positions for the device of GQ EMF 390 at the building of Graduate Studies and Environmental Research.

The description of the EMF-390 multi-function digital EMF meter is designed to be a portable device. It can be used for industrial, commercial maintenance, research, evaluation, simulation, and other analytical or scientific applications in areas such as industrial plants, public utilities, universities, laboratories, and electronic repair shops (Besset *et al.* 2020; Paniagua *et al.* 2020). The device-integrated testing features include three-axis Electromagnetic Fields (MF), Electric fields (EF), Radio Frequency (RF), and Radio Spectrum Power analyzers. The meter is able to identify the common source from EMF measured, such as Power Line, WiFi, etc. It also

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ONLINE ISSN 2636 - 3178

comes with built-in audible and visual alarms. It can be used for EMF, EF, RF, and 5G network detection and monitoring both indoor and outdoor (protected), as well as in other similar environments (Wall *et al.* 2019). It can continually monitor the radiation. When connecting the device to a PC, PC software can download the radiation data to the computer and the user is cancer. The device also installed a high-contrast black/white LCD module and one front LED indicator. The built-in electronic gyroscope lets the user read the data from an upside-down view easily. EMF-390 has onboard flash memory for data logging and saving. The data can be logged every second and can be downloaded into a (*.csv) format file with the free software EMF-PRO. GQ RF Browser is specifically designed for Cellphone, Cell towers, Smart Meters, WiFi- RF radiation monitoring (Paniagua *et al.* 2020).

The features of the GQEMF 390 set are:

- Audible alarm: beep/siren
- Visual alarm: green, red LED
- Operating temperature and humidity: 5 to 40 degrees C, below 80% RH
- Working Voltage: 3.6-3.7V
- Display: LCD dot matrix, backlighted.
- Power Consumption: 25mW to 125mW (backlight dependent)
- Power: Supply 3.7V Li-Ion battery / USB power
- Dimensions 135 x 78 x 25 mm (5.25'x 3' x 1')

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The procedures to use the device is easy when the device is equipped with an USB port, utilized for communication and external power supply/charging of the internal rechargeable Li-Ion 3.6V/3.7V battery. The GQ EMF-390 internal rechargeable battery can be charged with a standard USB port, USB charger, or with computer USB port. Using external power, continuous data monitoring is possible. Using either power adapter you will not have to worry about the battery's charge condition or any data loss. The EMF-390 also has a real-time clock on board for time-related data measurement.

High-sensitivity meters let you check EMF/RF radiation easily. Examples: computer mouse, car remote key, cell phone, cell tower, cordless phone, static electricity, electric field, WiFi, computer laptop, microwave, electric heater, hair dryer, vehicle engine, light, outdoor power line. With RF spectrum power analyzer, you can monitor the WiFi signal power, Smart meter signal power, spy wireless video camera signal, and even track radio/TV signals in the air. The following table (1) has examples of the locations under investigation.

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Table (1): The abbreviation and location manes.

#	Abbreviation	Location name
1.	PT1	Passage between rooms
2.	STF1	Staff Room
3.	BSD	Basic Science Department
4.	PT2	Outside Dean's room
5.	STF3(EED)	Engineering Science Department
6.	Dean	Dean's room
7.	CL1,2,3	Computer lab room- 1,2,3
8.	CLR3,4,5	Classroom 3,4,5
9.	EDD	Education Department
10.	AGD	Agriculture Department
11.	PT3	Passage between rooms
12.	STF4-5-7-8	Staff Room
13.	Converter	Power room
14.	STF9	Staff Room-9
15.	RL2	Agriculture-biology lab
16.	PT4	Passage between rooms
17.	IT1	Outside room
18.	IT2	inside room
19.	Library	Library
20.	Control	Control
21.	STF6	Staff Room-6

RESULTS AND DISCUSSION

- **The allowable limits:** It is important to be aware of the potential health effects of exposure to EMF, RF, and EF, and to take steps to reduce exposure when possible. It is also important to follow exposure limits set by regulatory agencies, The International Commission on Non-Ionizing

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Radiation Protection (ICNIRP) provides scientific advice and guidance on the health and environmental effects of non-ionizing radiation (NIR) to protect people and the environment from detrimental NIR exposure., to ensure that exposure levels are safe. EMF, RF, and EF are types of electromagnetic fields that are commonly encountered in our daily lives. Exposure to these fields has been a topic of concern in recent years due to their potential health effects. Here are some scientific notes and recommendations based on safety emission exposure values.

Table. (2): Recommendations Based on Safety Emission Exposure Value.

Recommendations Limits					
Radiation Type	**Short**	**Low (Best)**	**Acceptable (Good)**	**High (Need to reduce)**	**Avoid (Must reduce)**
Electric Field, EF					
volts per meter	**V/m**	0 - 1 V/m	1 - 10 V/m	10 - 50 V/m	>50 V/m
Magnetic Field, MF (EMF)					
milliGauss	**mG**	0 - 0.5 mG	0.5 - 1 mG	1 - 2.5 mG	>2.5 mG
microtesla	**µT**	0 - 0.05 µT	0.05 - 0.1 µT	0.1 - 0.25 µT	>0.25 µT
Radio Frequency, RF					
milliWatts per square meter	**mW /m²**	0 - 0.001 mW/m^2	0.001 - 1 mW/m^2	1 - 10 mW/m^2	>10 mW/m^2

- **Electro-Emission Theory:** The photoelectric effect, first described by Albert Einstein, explains that electrons can be released from a material by absorbing photons of light with enough energy to overcome the material's binding energy. This effect can be explained by treating electrons as

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particles, with definite energy and momentum, rather than just as waves (Ramirez-Vazquez *et al.* 2019; Wall *et al.* 2019).

The wave-particle duality is a concept in quantum mechanics that states that particles, such as electrons, can exhibit both wave-like and particle-like behavior. In the context of electron emission, this duality can be used to explain how electrons can be emitted as particles when they absorb enough energy to overcome the material's binding energy (Wall *et al.* 2019).

The quantum mechanical model of the atom provides a more complete explanation of electron emission by considering the behavior of electrons as both particles and waves. In this model, electrons occupy specific energy levels, or orbitals, around the nucleus (Paniagua *et al.* 2020). When an electron absorbs enough energy to overcome the binding energy, it can jump to a higher energy level or be completely emitted from the atom. The quantum mechanical model also predicts the probability of electron emission and can be used to calculate the energy and momentum of the emitted electrons (Paniagua *et al.* 2020). The following is table (3) for summarizing the theories and their explanations for electron emission collected by (Matthes *et al.* 1999).

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Table. (3): Theories and Explanations of Electron Emission.

Theory	Explanation
Photoelectric effect	Electrons are released from a material by absorbing photons of light with enough energy to overcome the material's binding energy. This effect can be explained by treating electrons as particles, with definite energy and momentum.
Wave-particle duality	Electrons can exhibit both wave-like and particle-like behavior. In the context of electron emission, this duality can be used to explain how electrons can be emitted as particles when they absorb enough energy to overcome the material's binding energy.
Quantum mechanical model of the atom	Electrons occupy specific energy levels, or orbitals, around the nucleus. When an electron absorbs enough energy to overcome the binding energy, it can jump to a higher energy level or be completely emitted from the atom. This model predicts the probability of electron emission and calculates the energy and momentum of the emitted electrons.

- **Effect of Electric Field (EF) Emission.** The results of an electron field emission measurement can vary greatly depending on the parameters being measured and the specific instrument used. To accurately summarize the results, it would be helpful to have more context and details about the measurement that was performed with the GQ EMF 390 emission multimeter (Ängskog 2012).

Electromagnetic fields (EMFs) produced by electrical devices, including Extremely Low Frequency (ELF) electric fields, have been studied for potential health effects, but the evidence remains inconclusive (Wijayasinghe and Karipidis 2013.). Prolonged exposure to ELF electric fields has been suggested to be potentially associated with a small increased risk of certain

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types of cancer, such as leukemia, but more research is needed to confirm this (Kerner *et al*., 2013.).

As for the potential effect of increasing exposure time to ELF electric fields on human health, it's not clear what the specific impact would be as the level of exposure and the frequency of the fields can also play a role in determining potential effects(Viel et al. 2009).

Regarding deafness, there is currently no scientific evidence to suggest that exposure to ELF electric fields can cause deafness(Zekavat *et al*. 2014). However, exposure to high levels of certain types of electromagnetic fields, such as those in the radiofrequency range, can cause temporary hearing loss or tinnitus (ringing in the ears) (Ängskog 2012).

It's important to note that the levels of ELF electric fields to which people are typically exposed in everyday life are generally considered to be safe by regulatory agencies such as the World Health Organization (WHO) and the International Commission on Non-Ionizing Radiation Protection (ICNIRP) (Zekavat *et al*. 2014).

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ONLINE ISSN 2636 - 3178

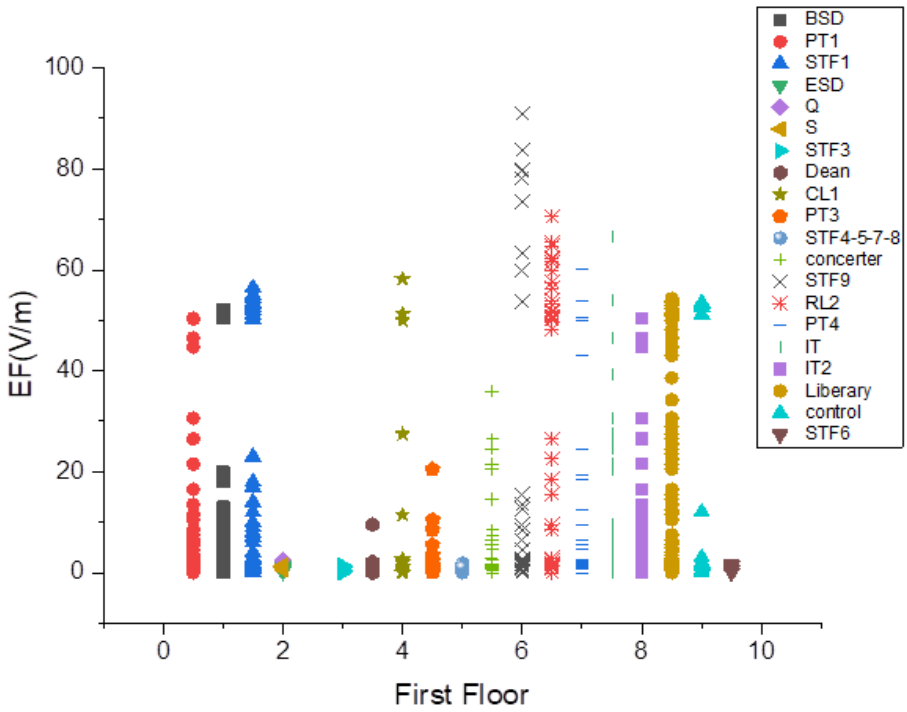

Fig.(2): Effect of the Electro-Field Emission on the Different Rooms at the faculty.

This work illustrates the results of the electric field EF in the fig. (2). the effect of EF practice emissions on the different rooms on the first floor of the GSER we observed the maximum value in the room of STF9 is more than 80 W/m, meanwhile the minimum value was observed at the room of an S at a value less than 10 W/m. unfortunately, the library of the faculty which had a maximum rate of occupancy has a value of 50 W/m, also the study observes from the figure (2) that the IT rooms achieved a range of 50 to 70 W/m and

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safe limits and EF values from 1 to 10 W/m. the study explains that the STF9 room had high measures of radiation and emission due to the presence of a lot of the main power lines of the faculty is near to the room location (Department of Health Services 2014).

- **Radiofrequency (RF) Emission Effect.:**The effects of increasing exposure time to radiofrequency (RF) emissions on human health are not well understood and the topic is the subject of ongoing scientific research. RF emissions are a type of non-ionizing radiation that is produced by devices such as cell phones, Wi-Fi routers, and microwave ovens (Australia 2017).

While RF emissions are generally considered to be safe for human exposure, some studies have suggested that prolonged exposure to high levels of RF emissions could have negative health effects (Manivannan 2016). For example, some studies have suggested a potential link between long-term exposure to RF emissions and an increased risk of cancer, though this has not been definitively proven.

It's important to note that the levels of RF emissions emitted by most devices are well below internationally established safety limits, and the vast majority of people experience no negative health effects from exposure to these emissions. However, as a precaution, it is recommended to limit exposure to RF emissions by keeping cell phones and other devices at a safe

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distance from your body, especially during prolonged use (Cansiz *et al.* 2016).

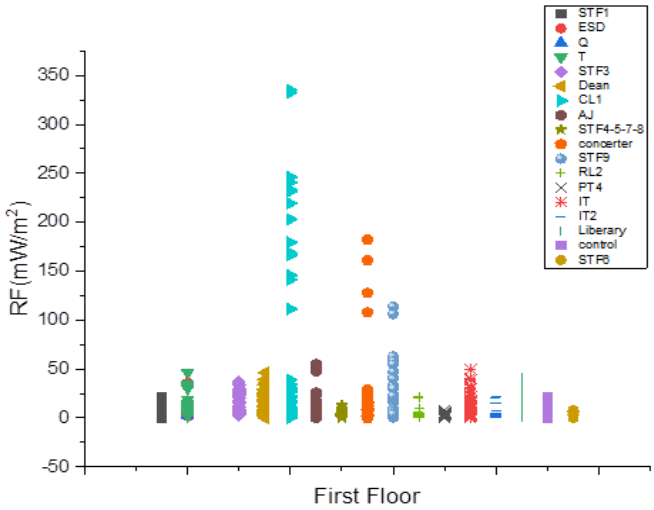

Fig. (3): Radiofrequency (RF) Emissions Effect on Different Rooms at the faculty.

Explanation of figure (3) the effect of radio frequency or FM practice emissions on the different rooms on the first floor of the GSER we observed the maximum value in the room of computer lab room-1 (CL1) is more than 300 mW/ m^2, meanwhile the minimum value was observed at the room of the staff room-6 (STF6) at a value of 9.5 mW/ m^2. Fortunately, the library of the faculty which had a maximum rate of occupancy achieved a minimum value of 50 mW/ m^2, also the study observes from figure (3) that the IT rooms achieved acceptable and safe limits, and RF values ranged from 0.001 - 1 mW/m^2. the study explains that the CL1 room had high measures of radiation

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and emission due to the presence of a lot of electronic devices like servers and computers and others (Choi *et al.* 2018).

- **Electromagnetic Field (EMF) Emission Effect :**There is ongoing scientific research and debate on the relationship between exposure to electromagnetic fields (EMF) and the risk of cancer. Currently, the available evidence does not establish a clear cause-and-effect relationship between exposure to electromagnetic fields and cancer. Several studies have reported that RF-EMF exposure of animal models increases blood-brain barrier permeability, impairs intracellular calcium homeostasis, alters neurotransmitters and increases neuronal loss and damage in brain tissue (Gallastegi *et al.* 2018).

However, some studies have suggested that prolonged exposure to high levels of electromagnetic fields, particularly radiofrequency fields, may increase the risk of certain types of cancer such as leukemia and brain tumors. These studies suggest that electromagnetic fields can affect the behavior of cells and damage DNA, potentially leading to the development of cancer(Sagar *et al.* 2018).

It is important to note that these findings are not conclusive, and more research is needed to fully understand the potential health effects of exposure to electromagnetic fields. Additionally, the levels of electromagnetic fields that people are typically exposed to in everyday life are usually much lower

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than those associated with an increased risk of cancer in the studies that have been conducted(Australian 2017; Gallastegi et al. 2018).

Overall, it is still not clear if electromagnetic fields can cause cancer, and more research is needed to fully understand the potential health effects of exposure to these fields(Ramirez-Vazquez et al. 2019). As with any potential health risk, limiting exposure to high levels of electromagnetic fields and following guidelines established by regulatory agencies for safe exposure levels (Australian 2017).

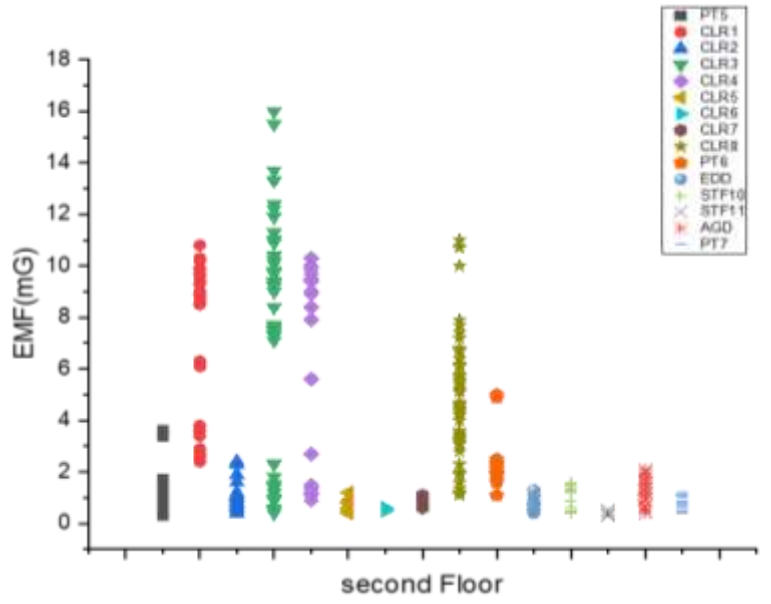

Fig. (4): Electromagnetic (EMF) Emissions Effect on Different Rooms of the faculty.

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Explanation of figure (4) the effect of electromagnetic EMF emissions on the different rooms on the first floor of the GSER we observed the maximum value in the room of BSD is more than 10 mG, meanwhile the minimum value was observed in the staff room-3 (STF3) at a value near to 1 mG. Unfortunately, the library of the faculty which had a maximum rate of occupancy achieved a minimum value of 8 mG, also the study observes from figure (4) that the IT rooms achieved an unacceptable 8 Mg, meanwhile the safe limits and MF values were from 1 to 10 mG (Olorunsola *et al.* 2021). The study explains that the BSD room had high measures of radiation and emission due to the presence of a include power lines, electrical wiring, and electrical appliances such as shavers, hair dryers, and electric blankets (Wall *et al.*, 2019).

CONCLUSION

The study highlights the need for ongoing research on dosimetry and exposure evaluation to better understand the effects of EF, RF, and EMF. The results of the study provide important information on the exposure levels and sources in urban environments and can inform the development of regulatory guidelines for exposure.

In summary, the allowable time for exposure is Four hours per day according to the Egyptian Environmental low number four for 1994. So, the discussion maker of the faculty of graduate studies and environmental

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research has to plan for reducing the exposure time in rooms of the Basic science department, library, and staff room number 9.

In conclusion, the current scientific consensus is that while further research is needed, the emissions from electronic devices are not harmful to public health at levels typically encountered by the general population. However, as with any scientific question, new evidence may emerge over time, and it is important to continuously monitor and assess the scientific evidence to ensure operational time in the safe zone.

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ISSN 1110-0826
ONLINE ISSN 2636 - 3178

تقييم الانبعاثات الإشعاعية من الأجهزة الإلكترونية
دراسة حالة في مبنى كلية الدراسات العليا البحوث البيئية.

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المستخلص

كان التعرض للمجالات الكهرومغناطيسية مصدر قلق لعقود من الزمن ، مع وجود لوائح تحدد الحدود العليا. طورت هيئات القياس المختلفة إرشادات تنظيمية تحدد حدود التعرض للمجالات الكهرومغناطيسية. يستخدم هذه الدراسة جهاز قياس المجال الكهرومغناطيسي (GQ EMF 390). تم دعم جهاز EMF 390 بأجهزة استشعار متعددة لضمان أقصى قياس للمدى. تم اختيار كلية الدراسات العليا والبحوث البيئية (GSER) كدراسة حالة. تبدأ GSER خطواتها نحو الاستدامة. تتمثل إحدى هذه الخطوات في قياس وتقييم مستوى انبعاث المجال الكهربائي (EF) والتردد الراديوي (RF) وأخيراً المجال الكهرومغناطيسي (EMF). نتائج هذة الدراسة هي قياس غرفة رقم ٩ – ٩ (STF9) أكثر من ٨٠ فولت / م. المكتبة التي لديها معدل إشغال أقصى ، تحقق EF 50 V / m. عندما تتراوح الحدود الآمنة لقيم EF من ١–١٠ فولت / م. لوحظ الحد الأدنى لقيمة EF (٥ فولت / م) في غرفة رقم ٦ –٦ (STF6). لوحظت غرف تكنولوجيا المعلومات ان لها قيم تردد لاسلكي مقبولة تتراوح بين ٠,٠٠١–١ ميغاواط / م ٢. بينما غرفة قسم العلوم الأساسية (BSD) لها قيمة EMF تبلغ ٨ مللي جرام. وفي الوقت نفسه ، تتراوح الحدود الآمنة وقيم EMF من ٠,٥ إلى ١ مللي جرام. توضح الدراسة أن غرفة BSD بها مقاييس عالية للإشعاع والانبعاثات بسبب كونها أقرب غرفة للألواح الكهربائية للكلية لـ GSER.

الكلمات المفتاحية: التقييم، الأثر، الانبعاثات الإشعاعية، الأجهزة الإلكترونية. دراسة الحالة.