International Science and Technology Journal
المجلة الدولية للعلوم والتقنية
Volume 37 العدد
Part 2 المجلد
ISTJ

http://www.doi.org/10.62341/hile5060

Received	**2025/11/25**	**تم استلام الورقة العلمية في**
Accepted	**2025/12/12**	**تم قبول الورقة العلمية في**
Published	**2025/12/14**	**تم نشر الورقة العلمية في**

EMF Measurement and Safety Assessment of Household Visual Display Units (VDUs)

SAMIR MOHAMED ISMAIL[1]
ESAM AMHIMMID ALRITEEMI[2]
NAJAH MOHAMMED ALSAEH[3]

[1] Faculty of Engineering - University of Zawia - Libya
[2,3] Faculty of Medical Technology - University of Zawia - Libya
S.hamouda@zu.edu.ly

Abstract

As industrial and technological advancements increase, so do concerns about the potential effects of household electrical appliances (50–60 Hz), which emit extremely low-frequency electromagnetic fields (ELF-EMFs) ranging from 0 to 3000 Hz. These fields may pose health risks, particularly to children. Several international organizations have conducted long-term exposure studies, suggesting a possible link to brain tumors (God forbid), such as the INTERPHONE study. The World Health Organization (WHO, 1998) classifies high-level electromagnetic fields as potentially carcinogenic, though evidence remains inconclusive. Research has indicated a correlation between childhood leukemia and exposure to low-frequency electromagnetic fields (TENFORDE, 1996), with similar findings reported in 2007 by the Scientific Committee on Emerging and Newly Identified Health Risks (SCENIHR), established by the European Commission (EC, 2008). While complete protection from these radiations and their effects may not be feasible, certain measures can mitigate their impact.

Several international bodies, including the International Commission on Non-Ionizing Radiation Protection (ICNIRP), the Institute of Electrical and Electronics Engineers (IEEE), and the American Health Organization, have developed safety standards. In this paper, we will present the results of electromagnetic leakage

http://www.doi.org/10.62341/hile5060

measurements from televisions in different rooms in the home, compare them with international standards, and determine safe viewing distances for each device.

Keywords: Electromagnetic EMF, Extremely low frequency ELF, World health organization WHO, Childhood Exposure.

قياس المجالات الكهرومغناطيسية وتقييم السلامة لشاشات العرض المرئية المنزلية (VDUs)

سمير محمد إسماعيل[1]، عصام امحمد الرتيمي[2]، نجاة محمد السايح[3]

[1]كلية الهندسة – جامعة الزاوية – ليبيا

[3,2]كلية التقنية الطبية – جامعة الزاوية – ليبيا

S.hamouda@zu.edu.ly

الملخص

مع تسارع وتيرة التطور الصناعي والتكنولوجي، تزايدت المخاوف بشأن الآثار المحتملة للأجهزة الكهربائية المنزلية التي تعمل عند ترددات (50–60 هرتز)، والتي تُصدر مجالات كهرومغناطيسية ذات ترددات منخفضة جدًا (ELF-EMFs) تتراوح بين 0 و3000 هرتز ، وقد تمثل هذه المجالات مخاطر صحية محتملة، لا سيما على الأطفال. فقد أجرت عدة منظمات دولية دراسات طويلة الأمد حول التعرض لهذه المجالات وأشارت نتائج بعضها إلى احتمال وجود علاقة مع أورام الدماغ (لا قدّر الله)، كما ورد في دراسة INTERPHONE.

صنّفت منظمة الصحة العالمية (WHO، 1998) المجالات الكهرومغناطيسية عالية الشدة على أنها مواد يُحتمل أن تكون مسرطِنة، على الرغم من أن الأدلة العلمية المتاحة لا تزال غير حاسمة. كما أظهرت بعض الدراسات وجود ارتباط بين إصابة الأطفال بسرطان الدم (اللوكيميا) والتعرض للمجالات الكهرومغناطيسية ذات التردد المنخفض (Tenforde، 1996)، وهي نتائج دعمتها تقارير لاحقة صادرة عام 2007 عن اللجنة العلمية المعنية بالمخاطر الصحية الناشئة والمستجدة حديثًا (SCENIHR)، التي أنشأتها المفوضية الأوروبية (EC، 2008).

http://www.doi.org/10.62341/hile5060

ورغم أن الحماية الكاملة من هذه الإشعاعات وتأثيراتها قد لا تكون ممكنة على نحوٍ تام، إلا أن اتخاذ بعض الإجراءات الوقائية يمكن أن يسهم في الحد من آثارها السلبية. وقد وضعت عدة جهات دولية، من بينها اللجنة الدولية للحماية من الإشعاعات غير المؤينة (ICNIRP)، ومعهد مهندسي الكهرباء والإلكترونيات (IEEE)، ومنظمة الصحة الأمريكية، معايير وإرشادات للسلامة في هذا المجال.

تهدف هذه الدراسة إلى عرض نتائج قياسات التسرب الكهرومغناطيسي الصادر عن أجهزة التلفاز في غرف منزلية مختلفة، ومقارنتها بالمعايير الدولية المعتمدة، إضافة إلى تحديد مسافات المشاهدة الآمنة لكل جهاز.

الكلمات المفتاحية: المجالات الكهرومغناطيسية (**EMF**)، الترددات المنخفضة جدًا (**ELF**)، منظمة الصحة العالمية (**WHO**)، تعرّض الأطفال للمجالات الكهرومغناطيسية.

Introduction

Electromagnetic fields (EMFs) are generated by moving electric charges and are categorized into extremely low-frequency (ELF) fields, ranging from >0 Hz to 3000 Hz. These include EMFs emitted by high-, medium-, and low-voltage power lines, electrical transformers, and household appliances. Concerns have been raised that exposure to these fields may lead to anxiety, neurological effects, eye lens damage, heart disorders, childhood leukemia, and other health issues.

Several global studies, such as INTERPHONE and the WHO(1998), classify high-level EMFs as potentially carcinogenic, though evidence is not definitive. Research has shown a correlation between childhood leukemia and low-frequency EMF exposure (TENFORDE, 1996), with similar conclusions drawn in 2007 by SCENIHR, established by the European Commission (EC. 2008). Some studies also suggest that EMFs may affect sperm quality when mobile phones are carried near sensitive areas, potentially leading to infertility. Additionally, certain research indicates that EMFs may impact the nervous system and contribute to Alzheimer's disease [1,2].

Rapid technological progress has led to an increase in household electrical devices that emit low-frequency EMFs (0–3000 Hz), such as televisions, washing machines, refrigerators, freezers, microwaves, electric ovens, air conditioners, and electric water

http://www.doi.org/10.62341/hile5060

heaters. Since these devices involve prolonged exposure, particularly for homemakers and children, this study aims to measure magnetic field leakage and electric field from television screens, compare older and newer models, determine safe viewing distances for children and families, and assess compliance with international safety standards.

This paper is organized as follows: Section Two discusses the international standards for electromagnetic fields as well as the measuring device used. Section Three covers the measurements and results, and Section Four presents the conclusions and recommendations.

Previous Studies

Researchers over the past decades have focused on the potential effects of exposure to extremely low-frequency electromagnetic fields (ELF-EMFs) on public health, particularly in children. For instance, TENFORDE (1996) reported a possible association between prolonged exposure to low-frequency electromagnetic fields and certain types of childhood leukemia, a finding later supported by reports from SCENIHR (2007) of the European Commission, which emphasized the need to monitor long-term exposure to these fields, although the evidence remained inconclusive. Similarly, the World Health Organization (WHO, 1998) classified high-level electromagnetic field exposure as potentially carcinogenic, which led to the development of precautionary safety guidelines to limit exposure.

In addition to epidemiological studies, several experimental investigations have focused on measuring electromagnetic leakage from household appliances. For example, Gandhi et al. (1996) found that modern television sets emit relatively low levels of magnetic fields compared to older models, with recommended safe distances to minimize direct exposure. Other studies, such as Kavet et al. (2008), observed that kitchen appliances like microwaves, washing machines, and refrigerators emit varying levels of electromagnetic fields depending on their design and model, making it essential to measure leakage and determine safe distances, especially for children who spend significant time near these devices.

Overall, these studies indicate a knowledge base suggesting that prolonged exposure to low-frequency electromagnetic fields may

http://www.doi.org/10.62341/hile5060

pose potential health risks, while also providing scientific guidelines for assessing household appliance safety and establishing optimal safe distances. These findings provide the scientific foundation for the present study, which aims to compare electromagnetic leakage from older and newer television models, evaluate compliance with international standards, and focus on the protection of children and families.

International Standards for Electromagnetic Fields and Description of the Device Used

International standards for electromagnetic fields vary from one country to another, and sometimes even within the same country. For example, in the United States, standards differ from one state to another. Most states have not set specific permissible limits for magnetic fields. The American Conference of Governmental Industrial Hygienists (ACGIH) has set 25 kV/m for the electric field and 10 Gauss (0.001 μT) as the permissible limit for occupational exposure to magnetic fields.

In contrast, New York and Florida have set values of 1.6 kV/m for the electric field and 200 Gauss for the magnetic field. Meanwhile, California considers 1.2×10^{-7} Tesla as the safety threshold in schools, while other cities have set 4×10^{-7} Tesla as the maximum permissible limit. Some cities have even stricter limits, such as 2×10^{-7} Tesla, and others have lowered it to 1×10^{-7} Tesla**.** The average recommended occupational exposure limit is 20×10^{3} Tesla per workday, with 40×10^{3} Tesla set as the threshold for continuous public exposure [1–2].

In Switzerland, the reference values for weak and moderate electromagnetic fields are 1 μT for the magnetic field and 5 kV/m for the electric field [3–4].

In Japan, the permissible exposure limit for the electric field is 3 kV/m.

In Russia, permissible values are linked to exposure time:

- Below 5 kV/m: No specific time restriction.
- Between 5–15 kV/m: Exposure should not exceed 3 hours per day.
- Between 10–15 kV/m: Exposure should not exceed 1.5 hours per day.

http://www.doi.org/10.62341/hile5060

- Between 15–20 kV/m: Exposure should not exceed 10 minutes per day.
- Between 20–25 kV/m: Exposure should not exceed 5 minutes per day.

In China, according to the Ministry of Ecology and Environment (MEE) and the Ministry of Industry and Information Technology (MIIT), the exposure limit for the general public is 4 kV/m for the electric field and 100 µT for the magnetic field—more conservative than the ICNIRP guidelines, which allow 5 kV/m for the electric field and 200 µT for the magnetic field. For occupational exposure, the limits are 10 kV/m and 500 µT for the electric and magnetic fields, respectively [5–6].

- Device Used for Measurement

The device used for measuring low-frequency electromagnetic waves is called the HI-3604**,** as shown in Figure.1 Measurements are taken from electric power transmission lines within the frequency range of 50–60 Hz**.**

- The electric field is measured in V/m.
- The magnetic field is measured in Tesla, Gauss, or A/m, with a mathematical relationship for unit conversions needed: 0.1 µT = 1 mG (milli Gauss) = 80 mA/m

Figure.1 shows the shape of the device used for measurement

http://www.doi.org/10.62341/hile5060

Note
In the International System of Units (SI), Tesla (T) is used to measure magnetic field strength.

Measurements and Results
It should be noted that previous studies indicate that the intensity of electromagnetic fields is influenced by variations in temperature, light, and humidity [7–8].

On Saturday, November 23, 2024, at exactly 4:35 PM**,** with a room temperature of 20°C, measurements were taken of the electromagnetic field emitted by televisions inside the home in Zawiya, Libya**.** The measurements were as follows:

The electric and magnetic fields were measured from a Samsung 50-inch TV (Model: UA50J5100 ARXSK – AC100-240V, 50/60 Hz, 139W)**.** Since the TV was being used for a home surveillance camera system, measurements were taken in two stages:

1. First stage: With the home surveillance camera system connected and operational.
2. Second stage: After disconnecting the surveillance camera system.

1- First Stage:
With the TV turned on and connected to a 220V AC, 50 Hz power source, the measured values were as shown in table.1 below, which presents the electric field (V/m), magnetic field (mA/m), and the distance (m) at which each measurement was taken.

Table. 1 Measured Values (First Stage – With Surveillance System Connected)

Electric Field (V/m)	Magnetic Field (mA/m)	Distance (m)
167.5	**70.8**	**0**
139.5	**38.3**	**0.5**
43.5	**7.1**	**1**
17.6	**5.9**	**2**
6.5	**5.7**	**3**
3.23	**5.2**	**4**
2.52	**5.1**	**5**

http://www.doi.org/10.62341/hile5060

After recording the measurements, Figure 2 was generated, illustrating the curves of the electric and magnetic fields in the first stage (before disconnecting the surveillance camera system)**.**

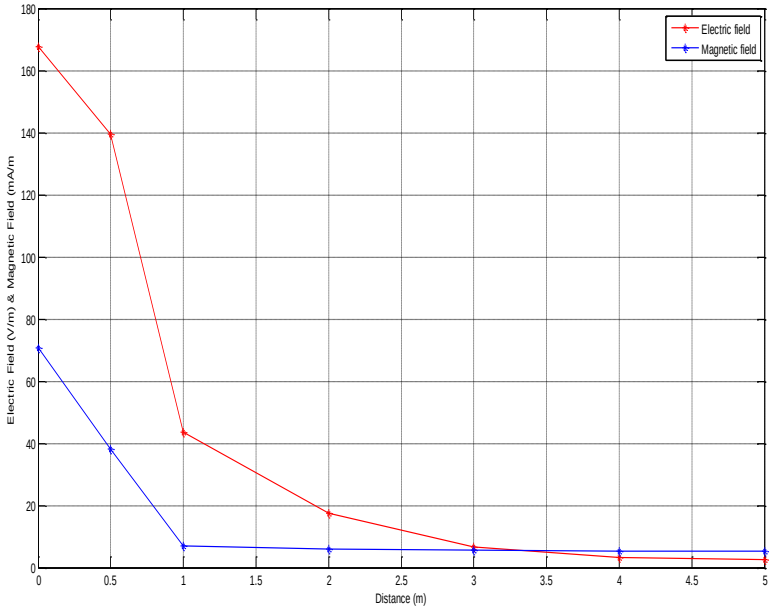

Figure 2. Electric and Magnetic Fields Emitted from the 50- inch Samsung Screen with Surveillance Camera System Connected

2- Second stage:

Measurements after Disconnecting the Home Surveillance Camera System.

The results after disconnecting the surveillance camera system are shown in table 2.

Table 2. Measured Values of Electric and Magnetic Fields at Various Distances (Phase Two – Without Surveillance System)

Electric Field (V/m)	Magnetic Field (mA/m)	Distance (m)
153.8	68.1	0
82.8	10.5	0.5
73.2	5.4	1
14.3	5.1	2
3.51	5.0	3
2.68	4.9	4
2.46	4.6	5

http://www.doi.org/10.62341/hile5060

Table.2 presents the measured values and the corresponding distances during the second stage, in the absence of the surveillance camera operating system.

Following the acquisition of measurement data, Figure.3 was developed to illustrate the behavior of both the electric and magnetic fields in the second stage—i.e., after disconnecting the surveillance camera system. The results demonstrate a noticeable decrease in the values of both fields compared to the first stage, during which the surveillance system was active.

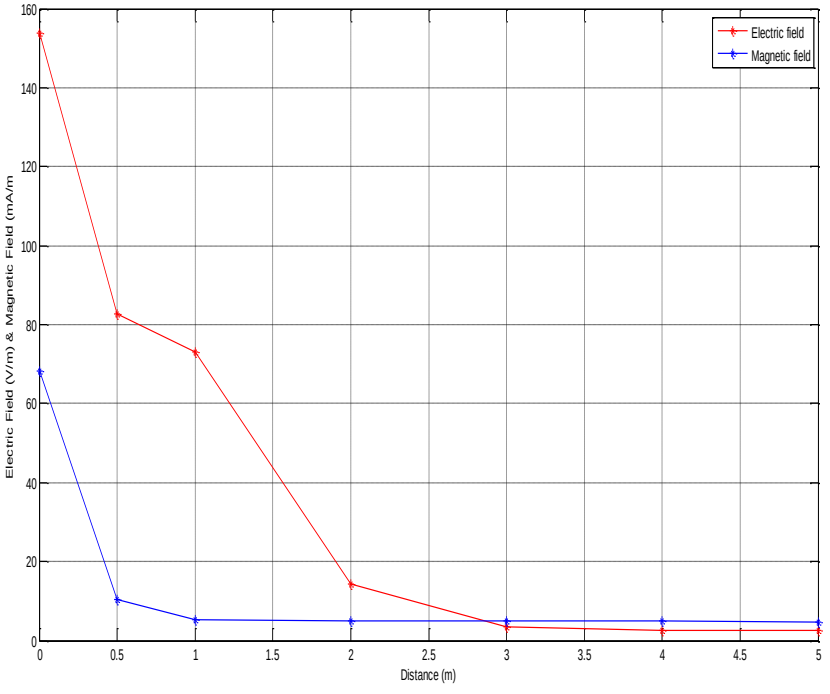

Figure.3 Electric and Magnetic Fields Emitted from the Screen without Surveillance Camera System Connection

- **Room No. 2**

Measurements of the electric field and magnetic field were conducted for a Samsung 49-inch Curved Tv (Model: UA49K6500–AC100-240V, 50/60 Hz, 110W).When the TV was powered on and connected to an AC voltage source of 220V at 50 Hz, the recorded values were as shown in table 3:

http://www.doi.org/10.62341/hile5060

Table.3 presents the measured values of the electric and magnetic fields along with the corresponding measurement distances.

Electric Field (V/m)	Magnetic Field (mA/m)	Distance (m)
846.1	5.6	0
220.0	5.5	0.5
68.2	5.2	1
12.1	5.1	2
2.82	5.01	3

After recording the measurements, Figure.4 was generated, illustrating the curves of both the electric and magnetic fields.

The curve in figure4 demonstrates the electric field and magnetic field emitted by the Samsung 49-inch Curved TV.

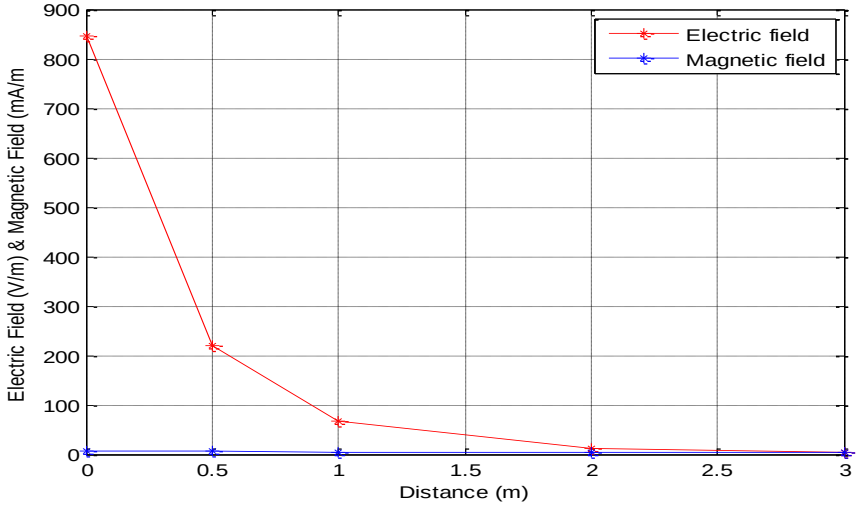

Figure 4. The electric and magnetic fields emitted by the Samsung 49-inch Curved TV.

- **Room No. 3**

Measurements of the electric field and magnetic field were conducted for a Samsung 50-inch Smart TV (Model: UA50KU7000KSK–AC100-240V, 50/60 Hz, 195W). When the TV was powered on and connected to an AC voltage source of 220V at 50 Hz, the measurements were recorded as shown in table 4.

http://www.doi.org/10.62341/hile5060

Table 4. The values of the electric and magnetic fields along with the distances at which each measurement was taken.

Electric Field (V/m)	Magnetic Field (mA/m)	Distance (m)
692.0	60	0
138.5	14.8	0.5
5.2	10.3	1
5.1	5.6	2
3.8	5.16	3

After recording the values for both the electric and magnetic fields, the resulting curve are shown in figure 5.

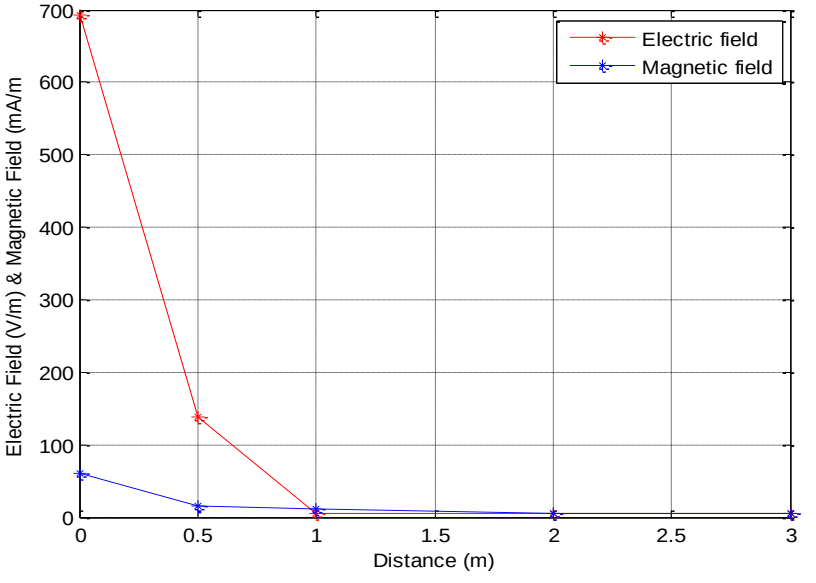

Figure 5. Displays the electric and magnetic field emissions from the Samsung 50-inch Smart TV.

- **Room No. 4**

Measurements of electric and magnetic fields were conducted for a Samsung 40-inch Smart TV (Model: UA40K5300BKXSK–AC100-240V, 50/60Hz, 100W).

When the TV was connected to a 220V AC power source at 50Hz frequency, the measured values were as follows:

http://www.doi.org/10.62341/hile5060

Table 5. The measurement distances and corresponding electric and magnetic field values.

Electric Field (V/m)	Magnetic Field (mA/m)	Distance (m)
334.0	**42.5**	**0**
109.9	**11.2**	**0.5**
42.3	**5.2**	**1**
8.3	**5.1**	**2**

After recording the electric and magnetic field values, the resulting curves were plotted as seen in figure 6.

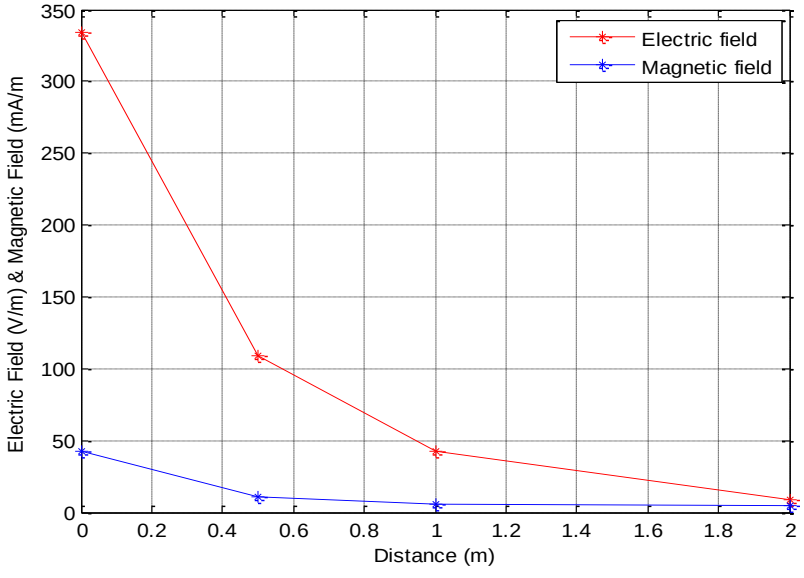

Figure 6. The electric and magnetic fields emitted by a 40-inch Samsung Smart TV.

From the above, it is evident that there is variation among all measured values, as each screen exhibits different readings compared to others. The highest magnetic field value was recorded for the 50-inch Samsung screen at a zero-distance measurement, reaching 70.8 and 68.1 mill amperes per meter (mA/m) for Phase 1 with the surveillance camera system operational and deactivated, respectively.

Conversely, the highest electric field value was observed for the 49-inch curved Samsung screen, measuring 846 volts per meter (V/m) at zero distance. Additionally, we noted that **as** distance

http://www.doi.org/10.62341/hile5060

increases, both electric and magnetic field values decrease across all screens.

When comparing these values to the internationally established exposure limits for electric and magnetic fields, the measured levels are significantly lower and considered safe**.**

Conclusions

The findings of this study indicate that the measured values of electric and magnetic fields around television screens are generally low and remain within safe limits according to international standards.

It was also noted that the 50-inch screen produced the highest magnetic field level among the tested devices, likely due to differences in manufacturing design and technical specifications.

Overall, the results suggest that modern display technologies have contributed significantly to reducing electromagnetic emissions, enhancing safety for regular users.

Recommendations

Based on the study's results, several practical recommendations are proposed:

1. Maintain safe distance: Avoid sitting too close to screens; a viewing distance of at least 3 meters is advisable, especially for smaller or older screens.

2. Limit prolonged exposure: During long viewing sessions, take regular breaks to reduce both physical and electromagnetic exposure.

3. Use protective measures: Wearing protective eyeglasses may help minimize magnetic leakage effects, particularly during extended screen use.

4. Promote healthy habits for children: Instead of prolonged television watching, children should be encouraged to engage in educational or recreational games that stimulate learning and creativity.

http://www.doi.org/10.62341/hile5060

5. Device awareness: Users should be aware that older or larger screens such as the 50-inch model in this study may emit stronger magnetic fields compared to newer models.

References

[1] National Institute of Environmental Health Sciences (NIEHS), (2002). Electric and Magnetic Fields Associated with the Use of Electric Power (EMF). NIH/DOE EMF RAPID Program.
[2] World Health Organization (WHO). (2019). Report on China: Electromagnetic Field Exposure and Public Health.
[3] Swiss Federal Office of Energy (SFOE). (2023). Reports on Protection from Non-Ionizing Radiation.
[4] Local study conducted by the University of Zurich (2020). Measurements of Magnetic Fields Near High-Voltage Power Lines.
[5] National Radiation Laboratory, Ministry of Health, New Zealand. (2008). Electric and Magnetic Fields and Your Health.
[6] Mohamed, Salah El-Din A. (2001). Urban Expansion and Electromagnetic Pollution in Buildings Near High-Voltage Power Lines in Asyut, Arab Republic of Egypt. Assiut University Journal of Environmental Studies, 21, Faculty of Engineering, Assiut University.
[7] Athab, *O.* (2018). Electromagnetic Waves and Their Impact on Human Health. Al-Madar Journal for Communications, Information Technology, and Applications, 4(1).
[8] Smith, J. et al. (2015). The Impact of Environmental Factors on EMF Measurements in Urban Areas.