

MEASUREMENT OF ELECTROMAGNETIC RADIATION EMITTED BY DECT PHONES USED IN OFFICE ENVIRONMENTS AND EVALUATION OF THE RESULTS IN TERMS OF OCCUPATIONAL HEALTH AND SAFETY

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Abstract

In our age, depending on the development of technology, the need for electricity and energy is increasing. With these developments, the use of electric tools and equipment in daily life is becoming widespread. Studies have shown that almost all electrical devices emit electromagnetic field (EMF). Therefore, it can be said that all electrical devices used in home and office environments are EMF sources. Some of these devices can be listed as computers, copiers, printers, WLANs and dect phones. Exposure to the electromagnetic field emitted by these devices, which are widely used in office environments where we spend a long part of the day, leads to many health problems. Identifying the factors that threaten the health of the employees and reducing the exposure to EMF in working environments is one of the main objectives of occupational health and safety studies. For this purpose, the amount of electromagnetic radiation emitted by the DECT phones, which is one of the EMF sources used in the office environment, was investigated experimentally. The electromagnetic radiation emitted by the DECT phones was measured on the phone without any action, depending on the distance, and then the same

measurements were repeated at the time the phone was called and during the incoming call. Aaronia Spectrun Analyzer HF - 6085 handheld spectrum analyzer was used in the measurements. The measurement results show that the amount of electromagnetic radiation increases as the distance decreases. However, compared to the amount of radiation emitted during a phone call and an incoming call, it was concluded that the radiation emitted during a telephone call was higher. When the measurement results are compared with the limit values determined by the International Commission on Non-Ionizing Radiation Protection (ICNIRP), it is seen that these values are below the limit values.

Keywords: Electromagnetic Field (EMF), EMA Sources, Spectrum Analyzer, Radiation, Dect Phones, Exposure, Occupational Health And Safety.

Introduction

Technology that facilitates our everyday life and develops continuously brings many risks. One of these risks is that the electrical devices and communication tools surround our lives. The widespread use of electrical devices and communications has led to more and more electromagnetic pollution. All kinds of electrically operated devices generate electromagnetic pollution in the environment by emitting a certain level of electromagnetic radiation while working in a multi-level, inoperative position and with plugs.

Electromagnetic contamination of our existing and unintentional exposure can be the source of high voltage lines, radio, tv transmitters and base stations (Türkkan, 2012). EMF, which causes electromagnetic pollution, occurs in every place where electric energy is used. All electrical devices generate EMF at

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various frequency levels depending on the amount of voltage and current. (Düzgün, 2009). As an EMF source, many devices such as photocopiers, printers, computers, WLAN-Wi-Fi, wireless access systems, communication devices, security detection devices can be given as examples.

EMF is a field of force that contains electromagnetic energy with electric and magnetic field components, which are derived from the movement of electric charges. (Şeker & Çerezci, 1995). The two components of electromagnetic radiation (EMR), the electric field and the magnetic field, are measured separately in different frequency bands. And when electromagnetic radiation or electromagnetic pollution (EMP) expressions are used, both of these components are meant.

The electric field continues to infinity forever, as the tensile or pushing force applied to another loaded object is inversely proportional to the square of the distance. Therefore, the impact outside of a particular region is too small to be measured. In the region where it shows the effect of an electric charge, it is called the electric field of electric charge. Electric field is a vector size with magnitude and direction. The electric field is the presence of electric charges. Each electric charge creates an electric field. As the supply voltage of a device increases, the electric field voltage rises. The electric field unit is V / m . The electric field strength is inversely proportional to the distance to the source. Electric field change creates a magnetic field. The magnetic field unit is A / m or Gaussian (G). The magnetic field strength decreases with distance. Magnets create a magnetic field. The magnetic fields enter the body, causing weak currents to occur even in the internal organs. Actually, the variable magnetic fields form a current in all the conductors around them (we can think of the human body as a conductor). The direction of the current generated by the magnetic fields is perpendicular to the magnetic field. (Raymond, 2018).

At one end of the electromagnetic spectrum (Fig. 1), which shows all the electromagnetic waves together, the gamma rays with high energy and nanometer wavelengths take place, while the other end contains very low frequency rays with low energy and wavelengths per kilometer. The frequency of the electromagnetic spectrum in the frequency range of 3 Hz to 3000 Hz is too low, and the band in the

frequency range 100 - kHz-300 is called the radio frequency band. The high frequency range is mostly used by communication systems such as mobile phones, radio and tv transmitters. The subject of this study is very low frequency electromagnetic radiation in the range of 3-3000 Hz and is mostly composed of man-made sources. (Turkkan & Pala, 2009). The health effects of EMF have been under investigation for many years.

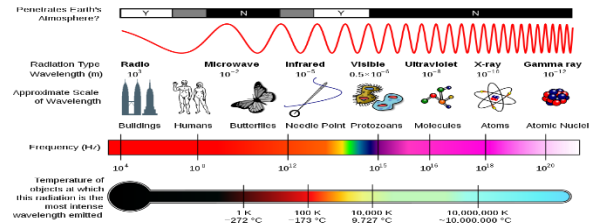


Figure 1. Electromagnetic Spectrum (NIEHS,2002)

In the literature, studies on the relationship between exposure to electromagnetic field and cancer are found. In these studies, it was emphasized that the exposure of electromagnetic field is effective on cancer cases. Thus, cancers are seen as the most prominent disease caused by EMFs. Electromagnetic field caused an increase in leukemia and nervous system tumors (Wasburn et al., 1994; Werthinver & Leeper, 1979). It is associated with childhood leukemia and brain cancers (Linet et al., 2003) and professional exposure to long-term EMF at workplaces is associated with high brain tumor risk (Hardell & Sage, 2008). The risk of leukemia in electrical workers was increased by exposure to EMF (Betwaite et al., 2001), and there was a high correlation between EMF exposure of electrical workers and lung cancer (Armstrong et al., 1994).

There are also studies that claim that exposure to cancer is not related to EMF (Erren, 2001; Davis & Mirick, 2007; Davis et al., 2002). However, the theses of the studies defending the effect of EMF exposure on cancer formation could not be refuted. In fact, the world health organization (WHO) grouped EMFs in the category of group 2 B (possible) carcinogens in terms of their carcinogenic effects. (WHO, 2007) There are studies showing that the health effects of EMFs are effective not only on cancer formation but also on people's behavior. For example, EMF exposure relationship with suicide cases (Van

Wijngaarden et al., 2000) insomnia, headache, weakness (Schreier et al., 2006; Grunner, 1980). It has been observed that people react differently to the electromagnetic field exposed. These health problems, which are not seen as a special disease, are frequently seen as dermatological redness, tingling and burning sensation, as well as fatigue, difficulty in concentration, dizziness, nausea, palpitations and digestive problems. (WHO, 2008).

Studies on the biological effects of EMFs on health have been found to have an effect on the biochemical values of heart, body temperature and blood. (WHO, 1998). In addition, exposure to occupational EMF was found to be an important risk factor for Alzheimer's disease (Qiu et al., 2004, Harmançi et al., 2003) and increased the risk of breast cancer (Demers et al., 1991). The frequency of heart palpitations in healthcare workers exposed to EMF sources was statistically significant at the workplace with high measurement value. (İlhan, 2008). When the effects of EMFs on health are examined, it is seen that occupational exposure is important. Apart from our homes, there are more intensive and powerful EMF resources that can create problems in terms of health in workplaces and offices where people spend a long time outside of home. As a result of technological developments, WLAN, wireless phones, computers, server rooms, printers, photocopiers, etc. are the sources of EMF. Environmental factors in workplaces may adversely affect the health and safety of employees. Long-term exposure will increase the effect of these factors.

What is important is to ensure that the level of environmental factors in the workplace is determined and controlled. From this point of view, all the different sources of electromagnetic radiation that employees are exposed to in their work areas should be identified, and if there is a dangerous situation, information should be given about the measures to be taken. As a matter of fact, in the context of occupational health and safety (OHS) legislation and regulations, employees should check that they are in a safe place in terms of electromagnetic radiation. The European Parliament and its Council, 2013/35 / EU, dated 26 June 2013, stipulated that the employees were exposed to electromagnetic radiation in accordance with the directive on the minimum health and safety requirements for exposure to risks arising

from physical substances (electromagnetic fields). is in a state of emergency.

In our study, Enhanced Cordless Telecommunication (DECT) phones, one of the EMF sources at workplaces, were examined. DECT phones, which are a major source of exposure to low frequency radio waves, are frequently used in offices throughout the day. DECT phones, which are used for providing high quality voice communication, are used in a fixed way in internet, other fixed or wireless communication. They can cause health problems as a result of prolonged exposure, even if they have worked at low forces. In this context, it is aimed to determine the EMF intensity levels of DECT phones in the offices in universities and to determine the EMF exposure of the employees. Thus, the EMF values of the DECT phones used in the offices were measured experimentally and the appropriate level of OHS was compared with national and international EMF values and the results were evaluated.

Materials and Methods

In the scope of the study, while the electromagnetic field measurements are taken by TSI (Turkish Standards Institute) on January 19, 2010 - TS EN 50413 - "Basic standard for measurements and calculation of exposure of people to electric magnetic and electromagnetic fields (0 Hz - 300 Ghz)" The standard measurement method is used.

In this study, electromagnetic field measurements from DECT phones which are used extensively in office environments were taken by Aaronia Spectran Analyzer HF - 6085 handheld analyzer. The device shown in Figure 2. can determine the total combined electromagnetic field intensity generated by the electromagnetic field waves in the environment. In this way, the measurement results can be easily compared with the limit values and the conformity assessment can be done easily.



Figure 2. Aaronia Spectran HF – 6085

Thanks to the USB connection of the device and Realtime Spectrum Analyzer software, the measured parameters can be monitored simultaneously. The measurement time was determined as at least six minutes for the measurement results to be confused with the limit values specified in the method (TSEN 50413) (European Directive 2004/40 / EC Directive). This time was determined by the ICNIRP to prevent the instantaneous rise or descent during the measurement to affect the measurement result. The measurement results are the average values of the instant measurement data received over a six-minute

period. The measurements were taken from the source of electromagnetic field (DECT Telephone) to be 1 cm, 10 cm, 30 cm, 60 cm and 100 cm depending on the distance. Electromagnetic field measurements of DECT phones; during the call, in the in coming call and in three cases without call. Before the measurement was made, the EMF sources on the medium and the measuring person were removed and the reliability of the measurement was ensured. The results were compared with the electromagnetic field strength limit values applicable in Turkey.

Table 1. Limit values derived for workplaces in case of continuous exposure

Frequency range (MHz)	E- Electric Field Intensity (V/m)		H- Magnetic Field Intensity (A/m)	
	Limit for one device	Limit value for the media	Limit for one device	Total limit value of media
0,010-0,15	19,3	65,25	1,1	3.75
0,15-1	19,3	65,25	0,16/f	0,54/f
1-10	19,3/f ^{1/2}	65,25/ f ^{1/2}	0,16/f	0,00082 f ^{1/2}
10-400	6,2	21	0,016	0,054
400-2000	0,305f ^{1/2}	1,03 f ^{1/2}	0,00082 f ^{1/2}	0,0027 f ^{1/2}
2 000-60 000	13,5	45,75	0,035	0,12

Table 2. Frequency-based limit values in our country

Frequency range (MHz)	E- Electric Field Intensity (V/m)	H- Magnetic Field Intensity (A/m)	S- Equivalent Plane Wave Power Intensity (W/m ²)
0,00082-0,065	610	24,4	-----
0,065-1	610	1,6/f	-----
1-10	610/f	1,6/f	-----
10-400	61	0,16	10
400-2000	3*f ^{1/2}	0,008*f ^{1/2}	f/40
2000-300000	137	0,36	50

Derived limit values for workplaces designated by ICNRP are given in table4. in our country, these values are taken as reference for ICNRP; An Regulation on the establishment of safety certificates for electronic communication devices and the determination of the electromagnetic field limit

values from these devices sertifik have also determined the limit values for the environment and for a single device. The specified limit values are shown in Table 1. and Table 2. Derived limit values for workplaces in case of continuous exposure.

Findings

Measurements were made during working hours in offices where employees worked for a long time and were using DECT phones. Figure 3. DECT is the measurement of the electromagnetic field when the phone is in sleep mode. Basically, electromagnetic field measurements consist of the measurement of the electric field strength or the magnetic field strength of the electromagnetic wave.

As shown in Figure 3, the measurement values are given in various measurement units via the computer

interface. The picture shows the measured value taken while the DECT phone was in sleep mode. According to the frequency of DECT phones used in office environments, appropriate measurement intervals were determined and their EMA values were measured.

In the study, electric field magnetic field and magnetic flux density values were measured according to the distance for DECT phones. Each measurement time is set to 6 minutes.

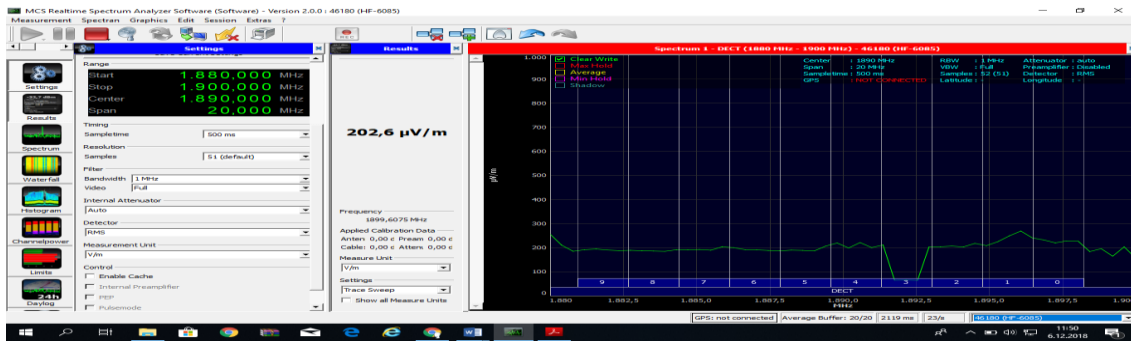


Figure 3. Electromagnetic field measurement when the DECT phone is in sleep mode

Results of The Measurement

The measurements were taken from the electromagnetic field source (DECT phone) depending on the distance to be 1 cm, 10 cm, 30 cm,

60 cm and 1 m as shown in Figure 4. Electromagnetic field measurements of DECT telephones; call – without calling, in three cases during the call

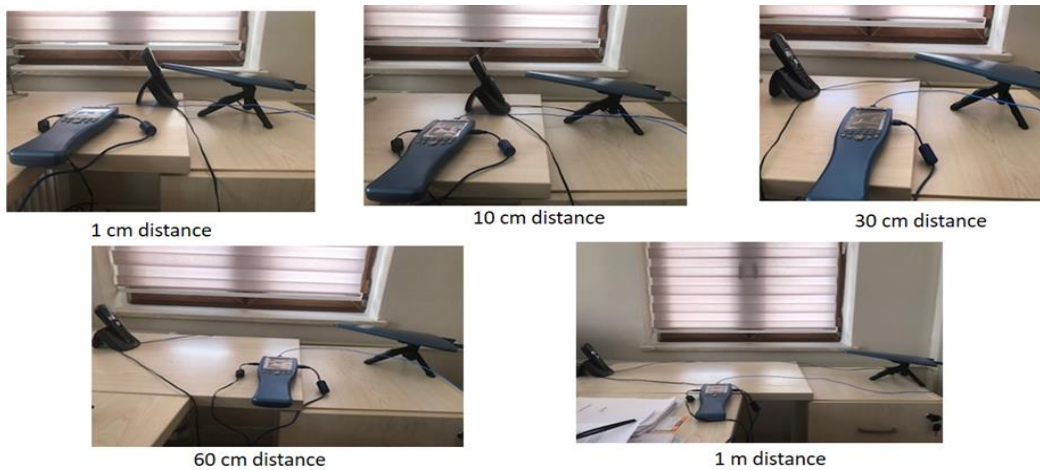


Figure 4. Distance dependent measurement images.

and during the calling Figure 4. Distance-dependent measurement images.

Phone Calls and Values Obtained Without a Call

Electric field, magnetic field and magnetic power density values and sample spectrum values of DECT

phones without telephone and telephone calls are given below. The measured values are shown in Table 6. depending on the distance without any operation by telephone. Figure 2. Measurement charts taken on the phone depending on the distance without any action. The measured values are shown in Figure 2, depending on the distance without any operation on the phone.



Figure 5. Electric Field Value for 1 cm Distance

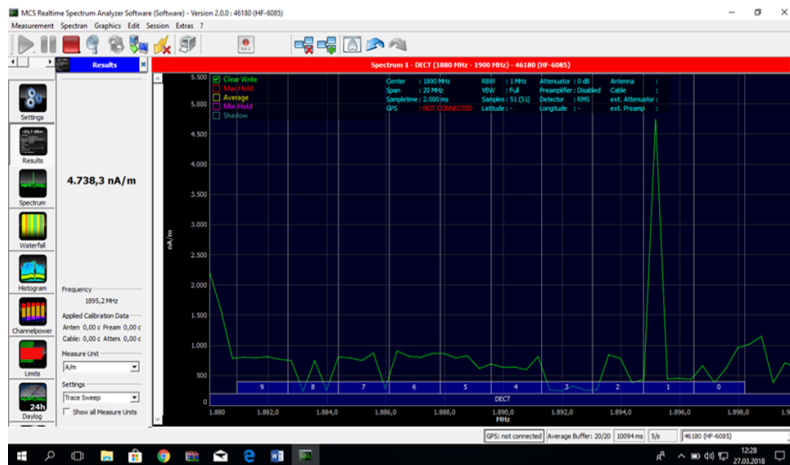


Figure 6. Magnetic Field Value for 1 cm Distance

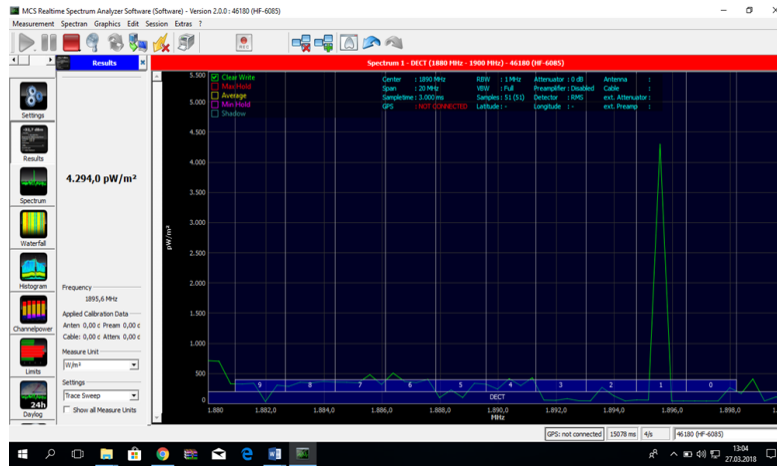


Figure 7. Equivalent Plane Wave Power Density (S) Value for 1 cm Distance

Table 3. The values taken from the phone without performing any operation

Distance (cm)	Electric Field ($\mu\text{V/m}$)	Magnetic Field (nA/m)	Power Density (pW/m^2)	Measuring Time (minute)
1	5.139,3	4.738,3	4.294,0	6
10	1.731,0	3.624,1	2.751,0	6
30	1.072,5	2.093,9	1.555,9	6
60	791,5	1480,3	594,8	6
100	407,8	892,2	439,0	6

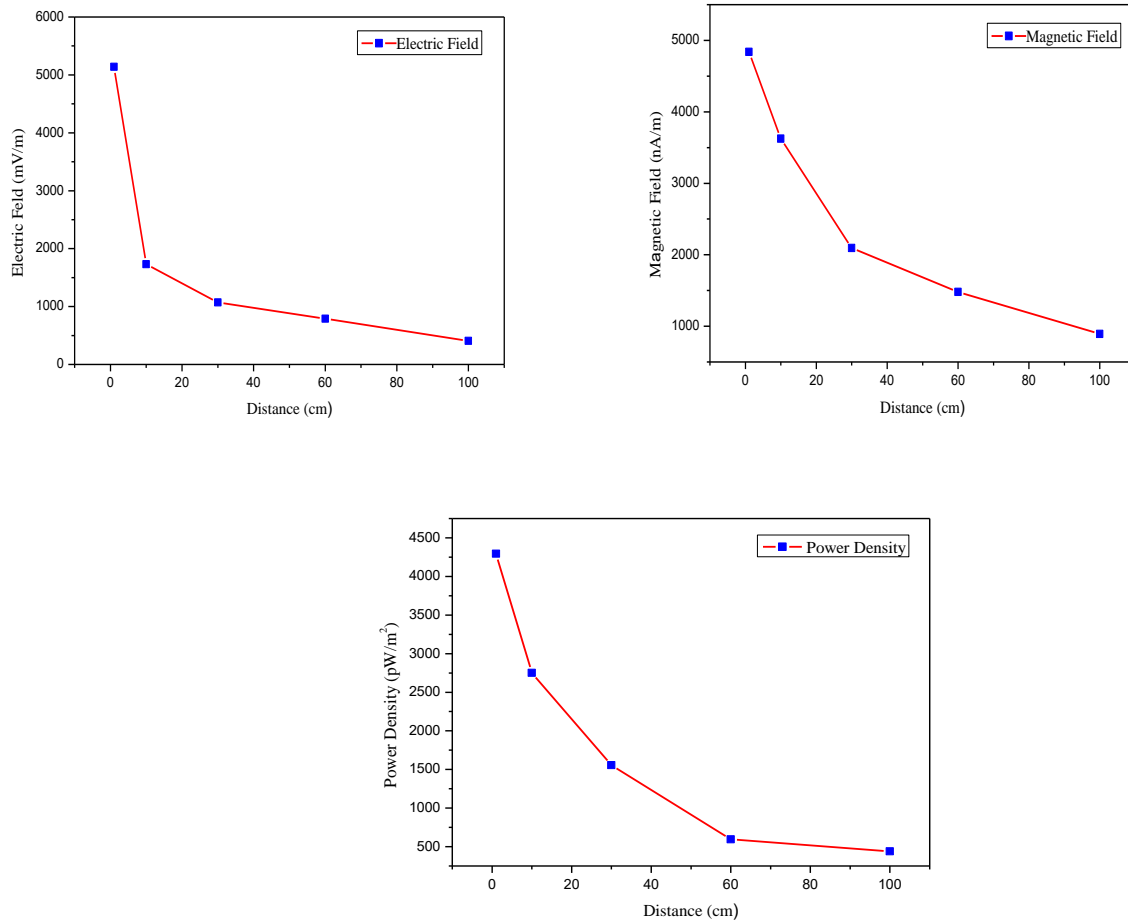


Figure 8. Measurement graphics taken on the phone depending on the distance without any operation.

Values Obtained During a Phone Call

Electric field, magnetic field and magnetic power density values taken during the call with DECT phones and sample spectrum images are given below.

Depending on the distance during the call, the measured values are shown in Table 4.

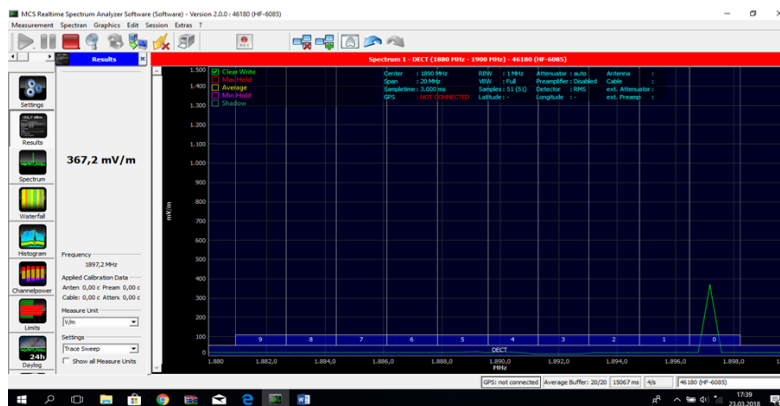


Figure 9. Electric Field Value for 10 cm Distance

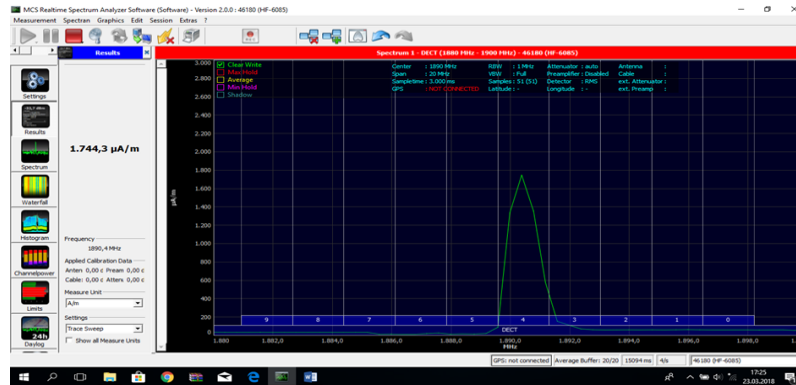


Figure 10. Magnetic Field Value for 10 cm Distance

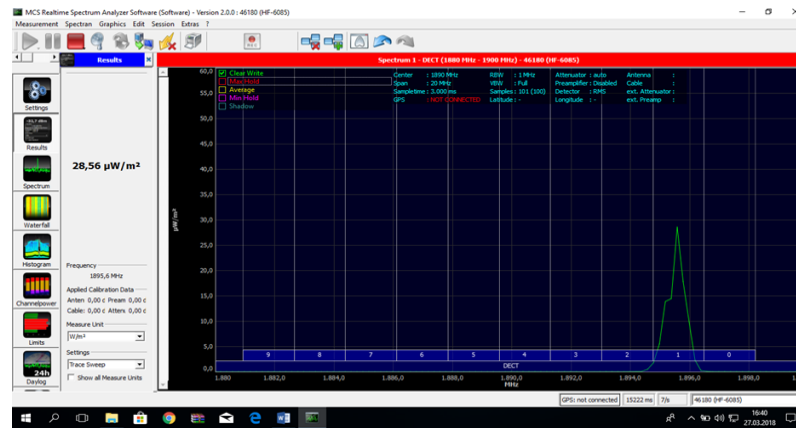


Figure 11. Equivalent Plane Wave Power Density (S) Value for 1 cm Distance

The graphs of the measured values taken in Figure 9, Figure 10 and Figure 11, depending on the distance during the call are shown

Table 4. Measured values during a phone call

Distance (cm)	Electric Field (mV/m)	Magnetic Field ($\mu A/m$)	Power Density ($\mu W/m^2$)	Measuring Time (minute)
1	422,9	1.911,5	28,56	6
10	367,2	1.744,3	23,31	6
30	282,1	1.109,4	19,04	6
60	231,8	954,3	13,16	6
100	193,4	342,5	8,09	6

The graphs of the measured values taken depending on the distance during the phone call are shown in Figure 12.

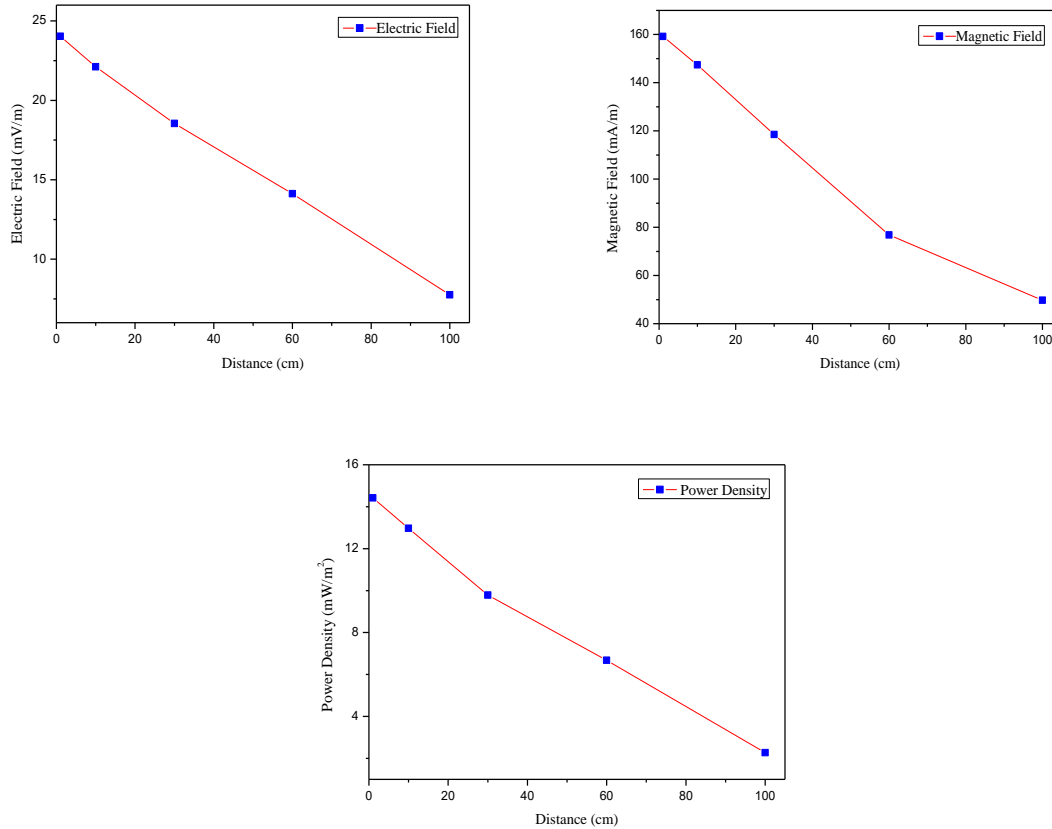


Figure 12. Graphs of measured values based on distance during phone call

Values Obtained During a Call

Electric field, magnetic field and magnetic power density values and sample spectrum images taken during the use of DECT phones are given below. The measured values taken during the phone call are

shown in Table 5. The graphs of the measured values taken depending on the distance during the call of the phone are shown in Figure 13. Figure 14. And Figure 15. graphs of measured values taken depending on the distance during a phone call.

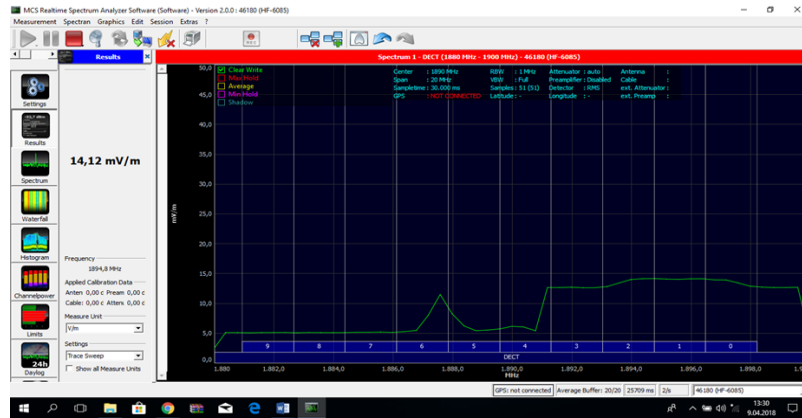


Figure 13. Electric Field Value for 60 cm Distance



Figure 14. Magnetic Field Value for 30 cm Distance



Figure 15. Equivalent Plane Wave Power Density (S) Value for 1 cm Distance

Table 5. Measured values during a call from the phone

Distance (cm)	Electric Field (mV/m)	Magnetic Field ($\mu\text{A/m}$)	Power Density ($\mu\text{W/m}^2$)	Measuring Time (minute)
1	24,03	159,2	14,42	6
10	22,11	147,4	11,97	6
30	19,55	138,5	9,783	6
60	14,12	66,78	6,683	6
100	7,75	49,75	2,273	6

The graphs of the measured values taken depending on the distance during the call are shown in Figure 16.

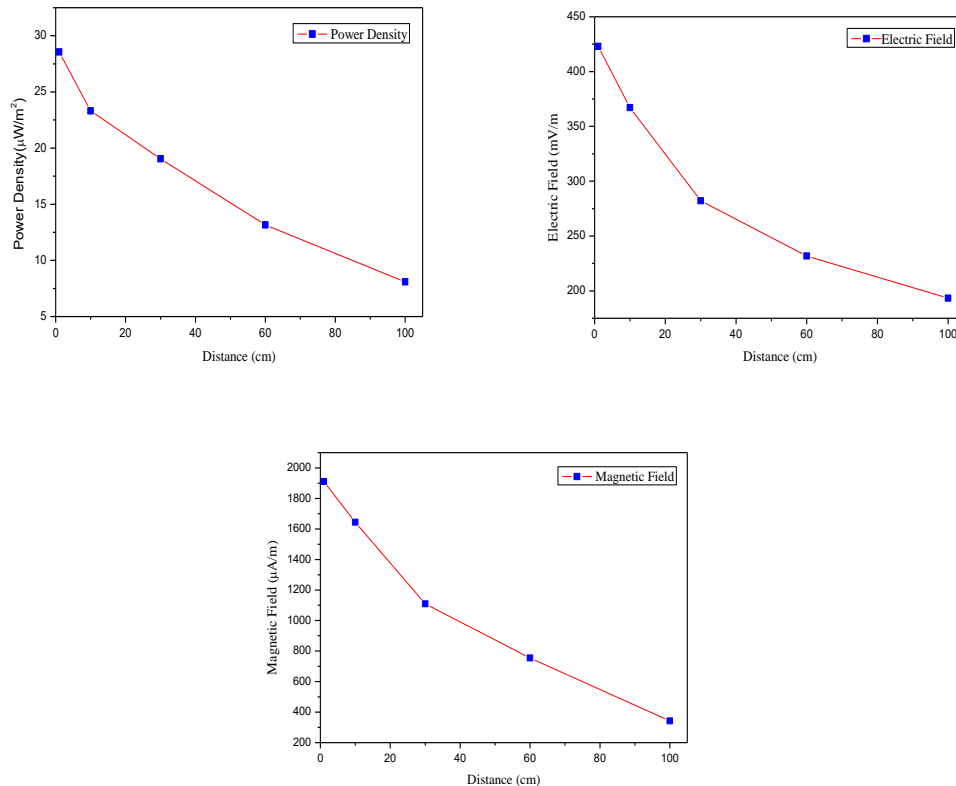


Figure 16. Graphs of measured values taken during distance call

Conclusion And Discussion

Along with the sensitivity regarding occupational health and safety, the importance of OHS improvement activities is increasing. For this purpose, the aim of this study is to evaluate the EMF values for the use of DECT phones in university offices and to evaluate the conformity of the results with OHS. The devices that generate RF waves operating in the frequency bands of 500 kHz to 300 GHz within the university buildings can cause negative health risks for teaching staff, administrative staff, students and other employees.

The electromagnetic field values emitted by DECT phones which are the subject of our study and used as an EMF source in offices were measured and

compared with the limit values. The EMF values measured at the frequency of the DECT phones were taken as 1 cm, 10 cm, 30 cm, 60 cm and 100 cm from the device. Distance-dependent measurement values did not exceed ICNRP's occupational EMF exposure limit.

Similarly, the measured value above the limit values for the single device was not observed in our country. However, depending on the distance, according to the measurement results, it was concluded that the EMF intensity is increased as the distance decreases. In parallel with our study, whether there is a single device or an ambient measurement, many studies have shown that the distance to EMF sources and the effect of exposure to EMF sources on health are increased by decreasing the distance. (Türkkan, 2012;

Aslantaş, 2012, Güler et al., 2010; Uygunol, 2009; Karadağ et al., 2014). However, although these studies suggest that there is a relationship to the effects of distance-related EMF exposure on health, the measurements taken similar to our study were found to be below the limit values.

In another study, EMF was measured for the DECT phones that make up our study and it was seen that the measurement values were below the limit values (Silsüpür, 2014). The highest EMF value obtained as a result of wireless telephone measurements is far below the occupational exposure limit of the ICNRP. The limit values found are valid for 6 minutes of exposure. Even if these values are not a problem for human health, the situation may change as the duration of exposure to EMF increases.

In addition, the measurements we took based on the distance were measured separately with the DECT phones in case of no phone calls, telephone calls and telephone calls. When comparing the emitted EMF values with the electromagnetic field values that were received when the phone was not operated by telephone, the measurement results showed that the measured values were higher during telephone dialing and dialing.

In addition, when compared to the values during the phone call and the phone call, the measured values are higher than the values in the call. In a similar study we found, the electromagnetic field emitted by the mobile phones during the call and the call was investigated and it was concluded that the values were higher than the EMF values when the mobile phone was not used (Kapucu et al., 2011).

Both in our study and in other studies, EMF measurements were calculated as instantaneous values and found below the limit values. However, the fact that the values are below the limit values does not mean that we completely reduce the risk of exposure to EMF. Considering that the health effects of exposure to EMF appear in the long term, the exposure time and dose should be taken into account. As a matter of fact, it is worrying that the limit values determined between countries are different.

The Bioinitiative report of 14 world-renowned medical doctors published in the US and respected by the world of science reveals the inadequacy of existing standards by drawing attention to the biological and non-thermal effects of EMFs at different frequencies. The limit values in the

regulations related to EMFs in our country should be reviewed and revised.

According to the results of our study;

- ✓ Corded phones should be preferred instead of DECT phones.
- ✓ The chargers of DECT phones should be kept away from the permanent living space.
- ✓ DECT telephone conversations should be kept short.
- ✓ Dect phones with sleep mode and low electromagnetic field should be preferred.
- ✓ The phone should not always be talked with the same ear.
- ✓ The phone should be located at least 1 meter away from where the person is located.

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