Assessment of Electromagnetic Radiation with Respect to Base Station Types

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***Abstract*—In this paper, radiation of base stations (BSs) in different installation types was measured in order to determine how the electromagnetic pollution level is affected by the installation types of them. Measurements were carried out on 8 BSs in Konya, Turkey. Additionally, a survey including 10 questions was applied to Sel çuk University students (334 people) to show how informed about radiation of mobile phones and BSs they are. As a result of measurements, the maximum radiations from BSs were observed at an apartment across BS on a tower, and at an apartment across BS on an apartment, respectively. Yet, the most of mobile phone users participating in the survey believes that a BS on their apartment roof has more radiation than the others.**

***Index Terms*—Base station, electromagnetic pollution, mobile phone, radiation measurement.**

I. Introduction

Wireless technologies are inevitable results of today's world. Although they were known as status of prosperity in the beginning, they are now used even by people having low income. Due to abundance of users of them, they have a very large worldwide industry [1].

Mobile phone is a major telecommunication system among wireless technologies [2]. The mobile phone or cellular technology works via BSs. Because each BS works for the mobile phones only in a limited region, called cell, the name of cellular technology is used too [2].

The mobile phones were firstly started to be used in the 1980s. While they were becoming widespread, the number of installed BSs increased in cities at the same time. Because a BS serve only a limited number of mobile phone users at the same time, multiple BSs are essential to cover a region [2], [3]. Since mobile phones providing continuous communication have a high usage rate among people, the number of BSs is nearly 700 in a city having a 1,000,000 population. Consequently, mobile phones and BSs are parts of our modern life [4]. Cellular technology, used only voice communication in the beginning, provide also photo, music and video sharing and TV viewing via a high speed internet connection now [1].

BSs emit low power, two way RF radiation via multichannel [4]. Installation of BSs may be seen on a tower specifically built for only cellular service, a roof and side of a building. Sometimes camouflaging them inside something such as an advertisement board, is preferred [1], [5].

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To communicate with a mobile phone, it is connected to the closest BS. The mobile phone and the related BS emit RF radiation to serve a qualified communication. Hence the people in the vicinity of BS are exposed to the RF radiation [4], [6]. Fortunately, the RF radiation is a non-ionizing radiation which has not ample energy to break off electrons [2]. As a result of the RF radiation absorption by people, thermal effect is observed on their bodies. This effect varies directly proportional to the magnitude of the radiation. Over a specified magnitude of radiation, body temperature cannot be kept constant in spite of the circulatory system. The adverse effects on a body are observed when the temperature rise reaches 1℃ [4], [7]-[9]. The allowable levels of RF radiations were determined on this basis by the international organizations such as the International Commission on Non-Ionizing Radiation Protection (ICNIRP) and the National Council on Radiation Protection (NCRP) [10], [11]. Because the RF radiation is many orders of magnitude below the allowed limit, it is said to be safe in terms of thermal effects by especially sectorial representatives [1], [12]-[14]. However, nonthermal effects are not taken into consideration [15].

In the early 1980s, BSs were assumed safe even in populated areas because broadcast transmitters having higher power than BSs were assumed safe as long as they were below the allowed limits [1]. However, the broadcast radiation can cause adverse effects such as cancers [16]; childhood leukemia clusters [17]-[19]; adult leukemia and lymphoma clusters, and mental illness [20]-[22]; brain tumor incidence [23]; sleep disorders, decreased concentration, anxiety, elevated blood pressure, headaches, memory impairment, increased white cell counts, and decreased lung function in children [24]; motor, memory, and learning impairment in children [25], malignant melanoma [26]; and nonlinear immune system changes in women [1], [27]. Because the cellular technology is a newer technology than broadcasting, observing the result of real effects will take more time. Actually it was partially discerned with the complaints of people experiencing adverse effects of living near a BS. Hence, some professional organizations were founded by physicians to infer these complaints such as International Committee on Electromagnetic Safety (ICEMS), Catania Resolution, the Irish Doctors Environmental Association (IDEA) and the Freiburger Appeal [1].

In this study, the radiation levels of BSs were analyzed in respect of installation types. It was aimed to show which installation type emitted the highest level of radiation in our daily life. Additionally, a survey was carried out to understand how much knowledgeable about mobile phone and BS radiation the mobile phone users were.

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II. Material and Method

In this study, 6 min averaged measurements of different type BSs were carried out. Narda EMR-300 radiation meter was used as measurement device. It can both measure averaged value and record measurement values on a pc via fiber-optic connection. It has an electric probe measuring electromagnetic radiation from 100 kHz to 3 GHz. The measurement values were recorded in V/m.

Some BSs representing BS types were determined in Konya, Turkey. Totally, 8 BSs were determined to make measurements. Different positions near each base station were used to measure electromagnetic radiation level.

A survey was also applied to 334 students of Selçuk University in Konya, Turkey in order to measure their knowledge about the electromagnetic radiation of mobile phones and BSs. The reason for selecting university students is that they use mobile phone more often and they are more sophisticated than the other people. The survey totally contained 10 questions.

III. Radiation Measurement Results of Base Stations

TABLE I: Type of BSs and Their Measured Radiation Values

TYPE OF BS			POSITION	V/m
Apartment roof	Open form(1)		Near BS	3,40
			Under roof	1,17
			1 level under roof	0,90
			3 level under roof	0,60
			Ground level	0,40
			An apartment across BS	2,20
	Hidden form	Smokestack (2)	Under roof	1,44
			Ground level	0,80
		Advertisement (3)	BS level	1,65
			1 level under roof	0,65
Side of apartment (hidden) (4)			BS level	2,40
			Ground level	2,10
Tower	Open form (5)		Near BS	3,60
			Ground level	0,75
			An apartment across BS	2,50
	Open form (6)		Near BS	4,19
			Ground level	0,90
			An apartment across BS	3,29
	Hidden form (7)		Near BS	4,60
			Ground level	1,15
Mobile (8)			Near BS	2,40
			Ground level	1,88

Eight determined base stations are given in Table I by Arabic numbers in parenthesis. Also the radiation amount measured near these base stations are given in this table.

Number 1, 2, and 3 were mounted on the roof of the apartments. Number 1 can be seen by people while number 2 and 3 cannot be seen. Number 2 and 3 were hidden BSs on the roof as smokestack and advertisement, respectively. Number 4 was mounted in a hidden way at the side of an apartment. It was hidden in an advertisement. Number 5, 6, and 7 were mounted on towers. While number 5 and 6 can be seen by people, number 7 cannot be seen. Number 7 was hidden in an advertisement. Number 8 was mounted on a trailer for mobile usage in a visible way.

The BS (number 1) was mounted on an apartment of 10 floors. Its coordinates are +38 ° 0' 16.7", 32 ° 31' 29.1". The location of the BS (number 2) is 37 ° 52' 0.60", 32 ° 27' 41.50".The location of the BS (number 3) is 37°54′1.26″ ,32°30′3.65″. The location of the BS (number 4) is 37 ° 52' 0.71", 32 ° 30' 2.88". The location of the BS (number 5) is 37°54′59.17″, 32°33′10.46″. The location of the BS (number 6) is 38 ° 1' 12.39", 32 ° 31' 4.04". The location of the BS (number 7) is 37 ° 54' 26.8", 32 ° 32' 0.5". The location of the BS (number 8) is 38 ° 16' 30.08", 31 ° 53' 12.08".

The maximum radiation values were recorded near BS for each installation types as expected. As for measurements except for BS level the maximum radiation value (3,29 V/m) was recorded at an apartment across BS (Number 6) on tower (open form). After this measurement, a recording (2,5 V/m) stood out again at an apartment across BS (Number 5) on tower (open form). As third one, a recording (2,2 V/m) was observed at an apartment across BS (Number 1) on an apartment (open form). The minimum radiation value (0,4 V/m) was recorded at ground level of an apartment whose roof had BS (Number 1).

IV. Survey Results

A survey was prepared to measure the knowledge of people about the radiation of mobile phones and BSs. There were totally 10 questions. The first question is about characteristic of the person. The others are about mobile phones and BSs. The survey was applied to 334 students of Selçuk University in Konya, Turkey.

The first question is about personality. The responses to this question shows that only 8.68% of the people surveyed do not regard themselves as 'worried or anxious' people. The majority (37.72%) of the people say that they are sometimes 'worried or anxious' people. The second question relates to precaution to radiation of mobile phones. Although the majority (35.33%) seldom uses headphones, considerable part (32.34%) never uses headphones. The third and fourth questions are about experiences of people. Although the majority (41.32%) had no health problem from mobile phone or BS, 29.34% had seldom a health problem. The selections about disturbance caused by BS are nearly equally distributed. The minimum rate (15.87%) is selection of people always disturbed by BS. The fifth question is about radiation amount of mobile phone. 54.79% know that the maximum level of a mobile phone radiation is for nearly 5 seconds duration after a call is just started. In the sixth question, reliance on the foundations is questioned. The

majority (28.44%) trust none of them. Maximum reliance (22.75%) is on World Health Organization (WHO). In the seventh, eighth, and ninth questions, the amount of mobile phone usage is questioned. The majority (29.94%) speak with mobile phone between 250-500 minutes a month. 24.25% speak between 500-1000 minutes a month. As for SMS usage, the majority (30.84%) send more than 1000 SMS with mobile phone a month. 23.95% send 500-1000 SMS with mobile phone a month. Concerning 3G internet usage, the majority (38.62%) use less than 100 MB data for internet connection with mobile phone a month. 17.66% use 500-1000 MB data a month. The last question is about people's opinion on installation types of BSs. The majority (40.12%) regard BS on roof of the apartment as the most dangerous. In second place, 'on a side of the apartment' is selected with a rate of 26.05%. Afterwards, 'on a tower', 'on roof of the neighbor apartment' and 'on minaret of a mosque' are sorted with rates of 14.97%, 11.98%, 6.89%, respectively.

V. Conclusions

In this study, how electromagnetic pollution levels of BSs vary with respect to installation types of them was determined by measurements. Additionally, a survey was applied to mobile phone users to find out knowledge level of them about radiation of BSs. As a result of measurements, the maximum radiations from BSs were observed at an apartment across BS on a tower, and at an apartment across BS on an apartment respectively. However, the most of mobile phone users participating in the survey believes that a BS on their apartment roof has more radiation than the others. The surveyed people are the most sophisticated of mobile phone users. The fifth question in the survey shows their knowledge. Although they are knowledgeable on mobile phone and radiation, guessing wrongly the installation type of BS emitting maximum radiation may be based on lack of knowledge or psychological reasons.

Appendix

Questions of Survey

1. I am usually a worried/anxious person.	Never	Seldom	Sometimes	Usually	Always
	o	o	o	o	o
2. I use headphones while speaking with mobile phone.	o	o	o	o	o
3. I had a health problem caused by mobile phone or BS such as headache and insomnia..	o	o	o	o	o
4. I am disturbed by BS in my neighbourhood.	o	o	o	o	o
5. I know that the maximum level of a mobile phone radiation is for nearly 5 seconds duration after a call is just started.	Yes				No
	o				o
6. Which foundation do you trust about the effect of mobile phone and BS on our health?	Ministry of Health	Information and Communication Technologies Authority	Universities	World Health Organization	None
	o	o	o	o	o
7. How much do you approximately speak with mobile phone a month (in minutes)?	<100	100-250	250-500	500-1000	>1000
	o	o	o	o	o
8. How many SMS do you approximately send with mobile phone a month?	o	o	o	o	o
9. How much data do you approximately use for 3G internet connection with mobile phone a month (in MB)?	o	o	o	o	o
10. If a BS was mounted nearhere your home, which installation would you regard as most dangerous.	On roof of my apartment	On roof of the neighbour apartment	On a side of my apartment	On a tower	On Minaret of a mosque
	o	o	o	o	o

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