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The role of furniture in exposure to non-ionizing radiation in a residential apartment

Vasil Bilero

Department of Physics, Faculty of Natural Sciences, University of Gjirokastra, Gjirokastra, Albania; vasilbilero@yahoo.com

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ABSTRACT

This article concerns the sources of non-ionizing radiation in a normal inhabited environment. Measurements show that residents are exposed to non-ionizing radiation in levels both below and above the European normative. Excess is present due to the fact that, producers of electronic equipment and appliances, those who use them, as well as those involved in the construction of housing, have insufficient acquaintance with non-ionizing radiation. Producers are advised to increase the coefficient of safety towards non-ionizing radiation by renewing technology. Users are advised to operate apparatus with the lowest possible power, to minimise time exposed to sources, to maximise the distance from them and to renew their appliances. Construction workers should take non-ionizing radiation more into consideration when furnishing of houses.

Keywords: Role; Furniture; Non-Lonizing; Radiation; Residential; Apartment

1. INTRODUCTION

Rapid development of science and technology is associated with a necessary contaminant: non-ionizing radiation.

This article treats the following areas: the wave nature of non-ionizing radiation, its spread in the electromagnetic spectrum, the physical quantities and units by which non-ionizing radiation can be measured [1-6]. An attempt is made to supply the public with essential and sufficient knowledge of non-ionizing radiation present in their homes (including internal and external types of sources, models, their power as well as invisible sources). With the results of measurements of non-ionizing radiation within their dwelling places, they might judge to act and to suggest to people who deal with projecting and furnishing the houses, with frequent renovation of technology in order to reduce the non ionizing radiation and to avoid as much as possible the exposure to it [3,4,6,7].

2. MATERIALS AND METHODS

1) Materials that are used: field meters up to 300 MHz and up to 3 GHz, an inhabited apartment available in the city of Gjirokastër.

2) Experimental method is applied by direct measurement.

3. THE WAVE NATURE OF NON-IONIZING RADIATION

(For more see 8) [1-6].

4. SOME PHYSICAL QUANTITIES AND THEIR UNITS BY WHICH NON-IONIZING RADIATION IS VALUED

(For more see 8) [8,9].

5. SOURCES OF NON-IONIZING RADIATION IN A NORMAL HABITATION

A normal inhabited apartment is selected for this work (AP.3 **Figure 1**).

6. MEASUREMENTS OF NON-IONIZING RADIATION [7,8,10]

The measurements are done in Apartment 3 of the Block behind the Sports Palace, "18 Shtatori" neighbourhood, Gjirokastër, Albania.

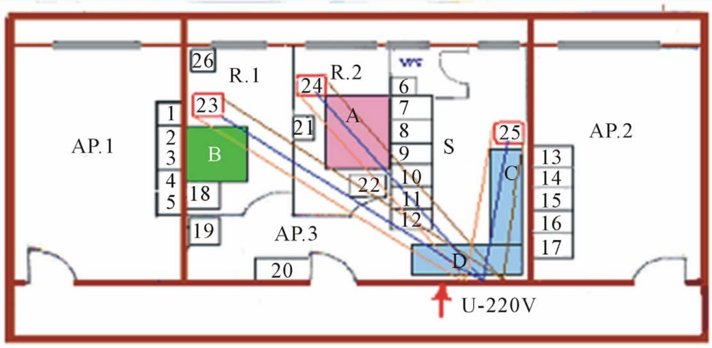
6.1. Measurements

1) The level of non-ionizing radiation of external sources of high frequencies is B = 0.059 μT.

2) The level of radiation of sources of internal environment is as in **Tables 1** and **2**.

6.2. Comments about Measurements

Table 1, the measurements 12 and 13 show the differ-



- AP.3-Apartment study object
- AP.1-Neighbouring apartment of study object
- AP.2-Neighbouring apartment of study object
- R.1-Room of apartment 3
- R.2-Room of apartment 3
- S-Living room of apartment 3
- A-Adults' bed
- B-Children' bed
- C-Sofa
- D-Sofa
- U = 220 V-Entry voltage in apartment 3
- 1,7,17-Fridge
- 2,8,16-Mivrowave oven
- 3,9,15-Electric cooker
- 4,10,14-Kitchen Aspirator
- 5,11,13-Dishwasher
- 12-Fruit mixer and squeezer
- 6-Washing machine
- 18-Baby phone (transmitter)
- 22-Baby phone (receiver)
- 19-Computer set
- 20-Apartment intercom
- 23,24,25-Multi socket
- 21-Televison set
- 26-Intemet antenna

Figure 1. The apartment AP.3 study object.

Table 1. Measure of the electric field intensity (E) and the magnetic induction (B) of some electronic devices and appliances.

Nr.	Type of source	Frequency (Hz/MHz)	Power (W)	Year of production	The position of the meter in relation to the source	Distance from the source (m)	Intensity of electric field E (V/m)	European normative E (V/m)	Magnetic induction B (μT)	European normative B (μT)
1	Fridge	50	164	2005	In front of	0.1	3	10	**0.883**	**0.5**
						0.2	1		0.46	
					Behind wall	0.2	7		**3.01**	
2	Microwave oven	50/2450	800	2006	In front of	0.05	**402**	**10/137**	**16.91**	**0.5/0.45**
						1	6		**1.45**	
					Behind wall	0.05	66		**9.45**	
						0.2	2		**9.28**	
3	Electric cooker	50	50/10600	2004	In front of	0.05	**1656**	**10**	**0.85**	**0.5**
						0.2	6		0.18	
					Behind wall	0.05	**19**		**0.66**	
						0.2	6		0.18	
4	Dishwasher	50	600	2006	In front of	0.1	**116**	**10**	0.18	**0.5**
						0.2	**11**		0.05	
					Behind wall	0.1	**53**		**2.01**	
						0.2	**13**		**1.07**	
5	Fruit mixer& squeezer	50	300	2005	In front of	0.01	**224**	**10**	**4.05**	**0.5**
6	Washing machine	50	820	2002	In front of	0.1	**138**	**10**	0.2	**0.5**
						0.2	**12**		0.06	
					Behind wall	0.1	**67**		**2.17**	
						0.2	**19**		**1.16**	

Continued

7	Kitchen aspirator	50	1800	2005	In front of	0.05	**75**	**10**	**1.23**	**0.5**
						0.2	**34**		0.44	
						0.5	9		**1.28**	
					Behind wall	0.05	**26**		**1.22**	
						0.2	**12**		0.4	
8	Boiler	50	3000	2003	In front of	0.2	**36**	**10**	**0.74**	**0.5**
						1	**28**		0.08	
					Behind wall	0.2	**153**		**5.39**	
						1	**18**		0.05	
9	Vacuum cleaner	50	1600	2004	Above	0.05	**342**	**10**	**13.45**	**0.5**
						0.2	**58**		0.23	
10	Electric micro-vacuum cleaner	50	400	2004	Above	0.05	4	**10**	**2.25**	**0.5**
						0.1	3		0.43	
11	Electric iron	50	1700	2006	In front of & to side	0.05	**79**	**10**	**0.86**	**0.5**
						0.1	**49**		0.15	
12	TV set with cathode tube	50	75	2005	In front of	0.05	**1349**	**10**	**0.74**	**0.5**
						0.2	**359**		**0.59**	
						1	**42**		0.03	
					Behind	0.05	**135**		**2.86**	
						0.2	**28**		**1.83**	
						1	**11**		0.16	
13	Flat screen TV set	50	75	2008	In front of	0.05	**11**	**10**	0.18	**0.5**
						0.2	5		0.11	
						1	3		0.02	
					Behind	0.05	**12**		0.12	
						0.2	4		0.11	
						1	2		0.03	
14	Heating fan	50	2000	1998	In front of	0.05	**351**	**10**	**2.69**	**0.5**
						0.2	**106**		0.45	
					Behind	0.05	**453**		**3.96**	
						0.2	**11**		**0.88**	
15	Electric heater with reflector and protecting metal net	50	5620	2002	In front of	0.1	**35**	**10**	**2.73**	**0.5**
						0.2	**15**		**0.57**	
						0.5	**13**		0.11	
16	Stabilizer	50	1000	2001	In front of	0.2	**69**	**10**	0.338	**0.5**
						0.5	**57**		0.15	
17	Stabilizer	50	5000	2004	In front of	0.2	**94**	**10**	**1.668**	**0.5**
						0.5	**83**		**0.82**	
						0.7	**0.52**		0.34	
						0.5	4		0.02	
					Behind	0.05	8		0.12	
						0.5	2		0.04	
						0.5	**228**		0.09	

Note 1: The measurements on the microwave oven are done with frequency 2450 MHz and the measurement on the electric cooker is done at the power 10600 W; Note 2: The apparatus inaccuracy ± 1% and our mistake 0.52% - 1.3%.

Table 2. Measurements of the intensity of electric field (E) and the magnetic induction (B) of some electronic devices and appliances.

Nr.	Type of source	Frequency (Hz)	Distance form the source (m)	Intensity of electric field E (V/m)	European Normative E (V/m)	Magnetic Induction B (μT)	European Normative B (μT)
1	Box of fuse 220 V	50	0.1	**199**	**10**	**2.03**	**0.5**
			0.2	**29**		**0.49**	
2	Apartment intercom	50	0.1	**39**	**10**	**0.64**	**0.5**
			0.2	4		0.26	
3	Screen and computer reserve battery 220 V - 19 V 3.16A	50	0.1	**73**	**10**	0.18	
			0.2	**13**		0.06	**0.5**
4	Reading lamp	50	0.1	**326**	**10**	**4.01**	**0.5**
			0.2	**55**		0.37	
5	Electric piano (organ)	50	0.1	**103**	**10**	**0.67**	**0.5**
			0.2	**56**		0.09	
6	Electric pillow	50	0.0	**1779**	**10**	0.05	**0.5**
7	Baby phone transmitter	50	0.1	**91**	**10**	0.24	
			1	2		0.22	**0.5**
8	Baby phone-receiver	50	0.2	**97**	**10**	0.23	**0.5**
			1.2	**15**	**10**	0.14	
9	Fax	50	0.1	7		0.02	**0.5**
10	Cordless phone with fixed base (when not ringing)	**2.4×10^9**	0.05	**48**	**137**	0.14	**0.45**
11	Cordless phone with fixed base (when ringing)	**2.4×10^9**	0.05	**54**	**137**	0.28	**0.45**
12	Cordless phone with fixed base reserve battery	50	0.05	**11**	**10**	**3.62**	**0.5**
			0.5	2		0.38	
13	Internet aerial antenna (router)	**2.4×10^9**	0.2	**11**	**137**	0.24	**0.45**
			3	5		0.2	
14	Internet Modem (cable connection)	50	0.05	**11**	**10**	0.28	**0.5**
			0.2	2		0.1	
15	Mobile phone model 1992	1.8×10^9	0.01	-	-	**0.627**	**0.45**
16	Mobile phone model 2000	1.8×10^9	0.01	-	-	0.118	**0.45**
17	Mobile phone model 2005	1.8×10^9	0.01	-	-	0.012	**0.45**
18	Multiple socket U = 220 V	50	0.05	**611**	**10**	0.38	**0.5**
			0.2	**31**		**0.6**	
19	Electric line 220 V	50	0.3	**20**	**10**	0.4	**0.5**

Note: The apparatus inaccuracy ± 1% and our mistake 0.52% - 1.3%.

ence of the radiation level between new and old technology. The radiation level of the a flat screen TV set produced in 2008 with 75 W power is 0.56 μT less than the one with cathode tube with the same 75 W power produced in 2005.

Table 2, the measurements 15, 16 and 17 show the difference in radiation levels of three mobile phones with different technology. The magnetic induction of the phone produced in 1992 was 0.667 μT (the normative is 0.45 μT), the one produced in 2000 had the magnetic induction 0.118 μT and the one produced in 2005 had the magnetic induction 0.012 μT. The difference between the first and the last one is 0.615 μT.

Table 1, measurement 17 shows the use of a stabilizer with 5000 W power near a computer which at 0.2 m distance has a radiation of B = 1.668 μT (1.168 μT above normative). Buying a stabilizer of this power is unnecessary. One with 1000 W or even less is sufficient. Another stabilizer of 1000 W (**Table 1**, measurement 16) was near a TV set which at a distance of 0.2 m had a radiation B = 0.338 μT. The position of the user was 0.5 m away from the 5000 W stabilizer and 5 m away from the 1000 W stabilizer.

The above mentioned stabilizers should have been in different positions and distances. The one with a higher power (5000 W) placed near the TV set should have been 5m away from the viewer and the one with less power (1000 W) placed next to the computer should have been 0.5m away. However such changes were not made due to lack of knowledge.

In **Figure 1**, several objects exposed in space and time are selected:

- The adult's bed A;
- The children's bed B;
- The sofa C;
- The sofa D.

The adult's bed A is exposed to radiation from:

1) The 220V electric line which goes underneath it and according to measurement 19, **Table 2**, is E = 20 V/m and B = 0.4 μT;

2) The baby phone (receiver), No. 22 in legend, according to measurement 8, **Table 2**, is E = 97 V/m and B = 0.23 μT;

3) The devices with legend numbers 6, 7, 8, 9, 10 placed behind the separating wall according to respective measurement 6, 1, 2, 3, 7, **Table 1**, are E = 19 V/m, B = 1.16 μT; E = 7 V/m, B = 3.01 μT; E = 2 V/m, B = 9.28 μT; E = 6 V/m, B = 0.18 μT; E = 12 V/m, B = 0.4 μT.

The adults' bed should be next to the opposite wall in order to avoid this exposure, but it is not because of lack of knowledge.

The children's bed is exposed to the radiation of:

1) The 220 V electric line which goes underneath it and according to measurement 19, **Table 2**, is E = 20 V/m and B = 0.4 μT;

2) The multi socket with legend no.23 according to measurement 18, **Table 2**, is E = 20 V/m and B = 0.4 μT;

3) The baby phone (transmitter) with legend no. 18 according to measurement 7, **Table 2**, is E = 91 V/m and B = 0.24 μT;

4) The Internet antenna with legend no. 26 according to measurement 13, **Table 2**, is E = 11 V/m and B = 0.2 μT (while the respective normative are 137 V/m and 0.45 μT);

5) The devices of the neighbouring apartment (AP.1) with legend no. 1, 2, 3, 4, 5 placed behind the separating wall according to respective measurement 1, 2, 3, 7, **Table 1**, are respectively E = 7 V/m, B = 3.01 μT; E = 2 V/m, B = 9.28 μT; E = 6 V/m, B = 0.18 μT; E = 12 V/m, B = 0.4 μT.

It was difficult to change the position of the children's bed because of the inappropriate house plan. Even when the inhabitants were told that they were exposed to the radiation of the devices in the neighbouring apartment, with legend no. 1, 2, 3, 4, they were indifferent and made no changes.

The best opportunity to prevent the bed from being exposed to the radiation emitted by these devices was available to the architect of the building, who should have taken into consideration the opposite wall (AP.1) when planning the layout of the building.

The children's bed could be protected from the internet antenna radiation, with legend no. 26, if the signal from the modem to the computer, with legend No. 18, were done with a cable.

The sofa C is exposed to the radiation from:

1) The multi socket with legend no. 25 according to measurement 18, **Table 2**, is E = 31 V/m and B = 0.6 μT;

2) The devices in the neighbouring apartment (AP.2) with legend no. 13, 14, 15, 16, 17, placed behind the separating wall, according to respective measurements 4, 7, 3, 2, 1, **Table 1**, is respectively E= 13 V/m, B = 1.07 μT; E = 12 V/m, B = 0.4 μT; E = 6 V/m, B = 0.18 μT; E = 2V/m, B = 9.28 μT; E = 7V/m, B = 3.01 μT;

The sofa D is exposed to the radiation of:

1) The devices of the neighbouring apartment (AP.1) with legend no. 17 according to measurement 1, **Table 1**, is E = 7 V/m, B = 3.01 μT;

2) The electric fuse box of voltage U = 220 V according to measurement 1, **Table 2**, the intensity of the electric field (E) varies between 29 V/m and 199 V/m and the magnetic induction (B) varies between 0.49 μT and 2.03 μT.

The living room where the sofas C & D are placed has no other possibility for the furnishing. Again it was the responsibility of the architect to plan, beginning in his design project, the electric devices 13, 14, 15, 16, 17 on the wall opposite the apartment and the fuse box next to the apartment intercom with legend no. 20.

7. CONCLUSIONS

Based on the above measurements we can draw the respective conclusions:

1) The less electronic apparatus and appliances an environment has, the less a person is endangered by non-ionizing radiation.

2) The passing of the electric lines should be placed away from areas which the inhabitants stay for long periods of time (such as places for beds, sofas etc)

3) The producers of electronic apparatus and appliances should raise the security coefficient towards non-ionizing radiation and the users should be careful to replace over time apparatus of old technology with those of

new technology.

4) The sources of non-ionizing radiation should be placed as far away as possible from areas which the inhabitants stay for long periods of time.

5) Apparatus with low power should be chosen as much as possible.

6) The users of electronic equipment and appliances should decrease as much as possible the exposure time during work.

7) The inhabitants, while furnishing their houses, should pay attention to the sources of non-ionizing radiation in their homes as well as in neighbouring houses.

The architects should "arrange the relation to" non-ionizing radiation while planning dwelling places.

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