Critical Analyses of International Standards for Non-ionizing Radiation

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Abstract: ***In the article we will present a comparison between the international norms for non-ionizing radiation and comparative analysis with the norms of Bulgaria.***

Keywords – Non-ionizing radiation, European standard

I. TASK OF THE ARTICLE

A .Introduction:

The concept in this paper is to show the limit emission levels for non-ionizing radiation. In order to make comparison is necessary to define the tasks that be conducted. In the first part will be compared between non-ionizing radiation in industrial sector and the general population. The second part is for the rules adopted by the EU and Bulgaria. The article finishes with conducting a numerical experiment to determine the maximum level of non-ionizing radiation.

B. Comparison of European standards for non-ionizing radiation. Analysis for the values between industrial conditions and the general population.

Following a comparison of the values presented in Tables 1 and 2 it can be seen that the values at industrial conditions are significantly higher - as well as the frequency range within 8Hz ÷ 1MHz is divided into four. In the second table the same frequency range is divided into five parts. Since there are such differences it will be able to be shown the different influence of frequencies.
International Commission ICNIRP (Commission for Non-Ionizing Radiation Protection) proposes to introduce levels of control under production conditions. In 1999 it provides recommended levels which are marked in Table 1 and Table 2
It is best to make a separate table for the range of 400 ÷ 2000MHz because various standards fall in this range. Table 3 was made according to rules announced by the ICNIRP - International Organization for Non-Ionizing Radiation Protection. By the table it is noted that there is a difference of 54.2 percent of the electric field in the protection of the population while the strength of the electric field is 53.8%. There are also differences in the magnetic induction which is 54% and the power of density has a difference of 60%.

C. Comparison with the European standards adopted in Bulgaria.

Confirmation of rules paste in table 3 using published in 2008, "Directive 2004/40/EC of the European Parliament and Council, as the last change made with M3 under Regulation (EC) N 1137/2008 of the European Parliament and Council [1].
The frequency range considered in Table 3 is for types of production limitations in the range of 400 ÷ 2000MHz. The ordinance which is used in Bulgaria for regulation levels of Non-Ionizing Radiation is - N9 [2].

To be conducted comparisons is necessary to adjust the parameters which will be compared because different values are adopted for the equivalent. In Bulgaria the values of the Ordinance are $S = 10\mu W / sm^2$ which is within the frequency range of $f = 0{,}3 \div 30GHz$. To make the transformation is necessary to use the next calculations:

$$S = 10\mu W / sm^2 \Rightarrow S = \frac{10}{10^{-4}}\mu W / m^2 \qquad (1)$$
$$\Rightarrow S = 10^5 \mu W / m^2 = 100mW / m^2 = 0{,}1W / m^2$$

The ordinance does not clearly defined frequency range of the network and there is no defined distance and distinction for the production environment. The graphical comparison between European (ICNIR), U.S. (FCC) and Bulgarian standards is shown in fig.1 and fig.2. Frequency range of analysis is chosen to include WiFi networks. The returnees result shows clearly the low value of the exposure that was accepted in Bulgaria to the rest of the world's recommendations.On the other side to implement the research on wifi networks is necessary to know that the power density depends on the distance measurement which is raised to the second degree [4]:

$$S = \frac{PG}{4\pi r^2} \qquad (2)$$

where: P - transmitted power; G – gain (factor on amplification) of the antenna and r - distance measurement.

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D. Alternative methods of miming

From data obtained (Fig. 3) it is clear that the limit rates for non-ionizing radiation are met after crossing the border of 15m. This is due to the high output power embedded in the testing set. Practically the value of 250mW can be achieved only by changing the Firmware of the router. The reason of such change is to increase the operating range of the router or changing the speed of communication for distance users. But whatever the reason is the limi t of 250mW remains real and must be complied with WiFi networks.

II. CONCLUSIONS

1. There are significantly lower levels in Bulgaria than the recommended standards of ICNIR and FCC. The only addition may be the defined distance measurement and control.

2. After a numerical simulation we can see that the running router with radiated power of 250mW has the limit distance of 15m. Practically the power of the broadcast router is variable and rarely reaches this limit level.

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[5] International Commission on Non-Ionizing Radiation Protection GUIDELINES FOR LIMITING EXPOSURE TO TIME-VARYING ELECTRIC, MAGNETIC, AND ELECTROMAGNETIC FIELDS (UP TO 300 GHz)

TABLE.1. REFERENCE LEVELS FOR OCCUPATIONAL EXPOSURE TO TIME-VARYING ELECTRIC AND MAGNETIC FIELDS [5]

Frequency range	Electric field strength E (V/m)	Magnetic field strength H (A/m)	Magnetic flux density B (μT)	Equivalent plane wave power density Seq (W/m2)
0 ÷ 1Hz	-	1,63.105	2.105	-
1 ÷ 8Hz	20000	1,63.105/f2	2.105/f2	-
8 ÷ 25Hz	20000	2.104/f	2,5.104/f	-
0,025÷0,82kHz	500/f	20/f	25/f	-
0,82÷65kHz	610	24,4	30,7	-
0,065 ÷ 1 MHz	610	1,6/f	2,0/f	-
1÷10MHz	610/f	1,6/f	2,0/f	-
10÷400MHz	61	0,16	0,2	10
400÷2000MHz	3.f1/2	0,008.f1/2	0,01.f1/2	f /40
2÷300GHz	137	0,36	0,45	50

TABLE.2. REFERENCE LEVELS FOR GENERAL PUBLIC EXPOSURE TO TIME-VARYING ELECTRIC AND MAGNETIC FIELDS [5]

Frequency range	Electric field strength E(V/m)	Magnetic field strength H (A/m)	Magnetic flux density B (μT)	Equivalent plane wave power density Seq (W/m2)
0 ÷ 1Hz	-	3,4.104	4.104	-
1 ÷ 8Hz	10000	3,4.104/f2	4.104/f2	-
8 ÷ 25Hz	10000	4000/f	5000/f	-
0,025÷0,8kHz	250/f	4/f	5/f	-
0,8 ÷ 3 kHz	250/f	5	6,25	-
3 ÷ 150kHz	87	5	6,25	-
0,15÷1MHz	87	0,73/f	0,92/f	-
1÷10MHz	87/f1/2	0,73/f	0,92/f	-
10÷400MHz	28	0,073	0,092	2
400÷2000MHz	1,375. f1/2	0,0037. f1/2	0,0046. f1/2	f /200
2÷300GHz	61	0,16	0,20	10

TABLE.3. COMPARATIVE ANALYSES OF THE REFERENCE LEVELS

Exposure limit for	Frequency range MHz	Electric field strength E (V/m)	Magnetic field strength H (A/m)	Magnetic flux density B (μT)	Equivalent plane wave power density Seq (W/m2)
Occupational exposure	400÷2000	$3.f^{1/2}$	$0{,}008.f^{1/2}$	$0{,}01.f^{1/2}$	f /40
Public exposure limit	400÷2000	$1{,}375.\ f^{1/2}$	$0{,}0037.\ f^{1/2}$	$0{,}0046.\ f^{1/2}$	f /200

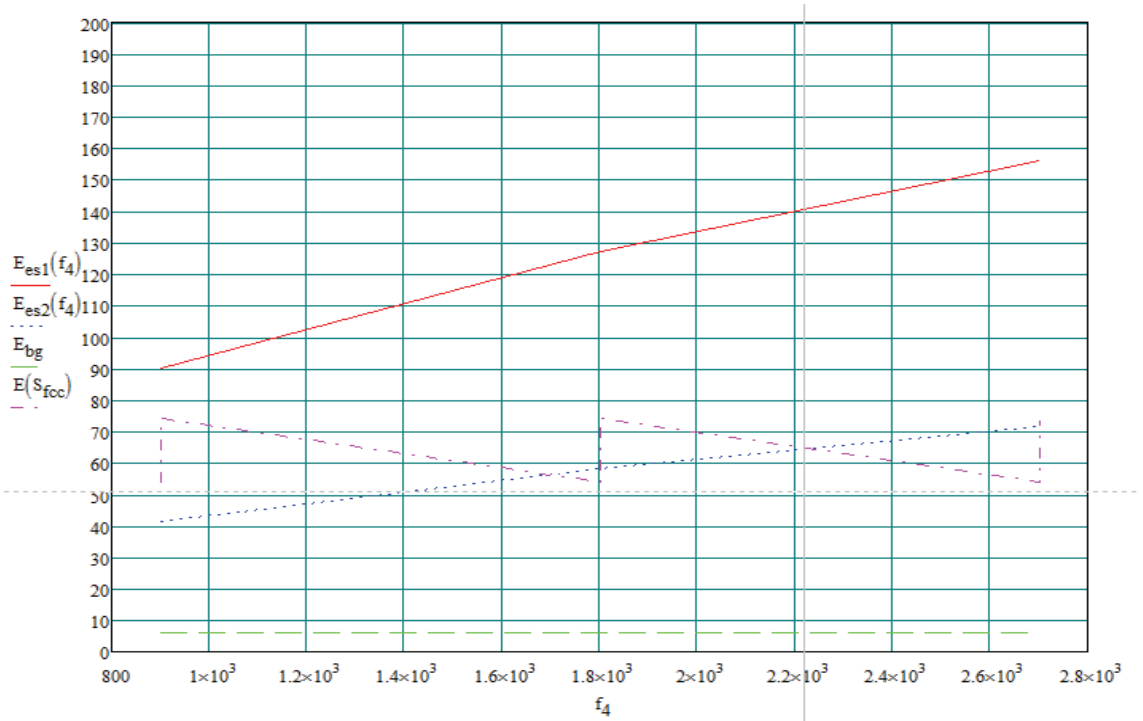

Fig.1. Comparison of Electric field strength in the range of 800MHz ÷ 2800 MHz and accepted standards for electric fields E

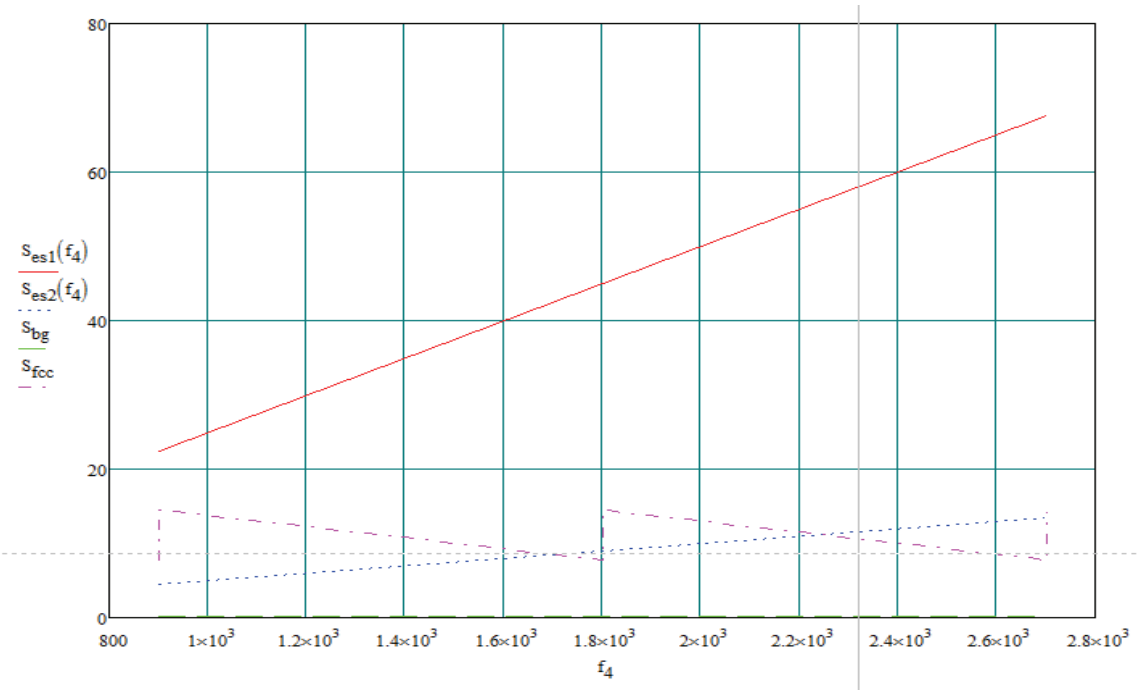

Fig.2. Comparison of accepted standards in the frequency range of 800 MHz ÷ 2800 MHz for the power density S

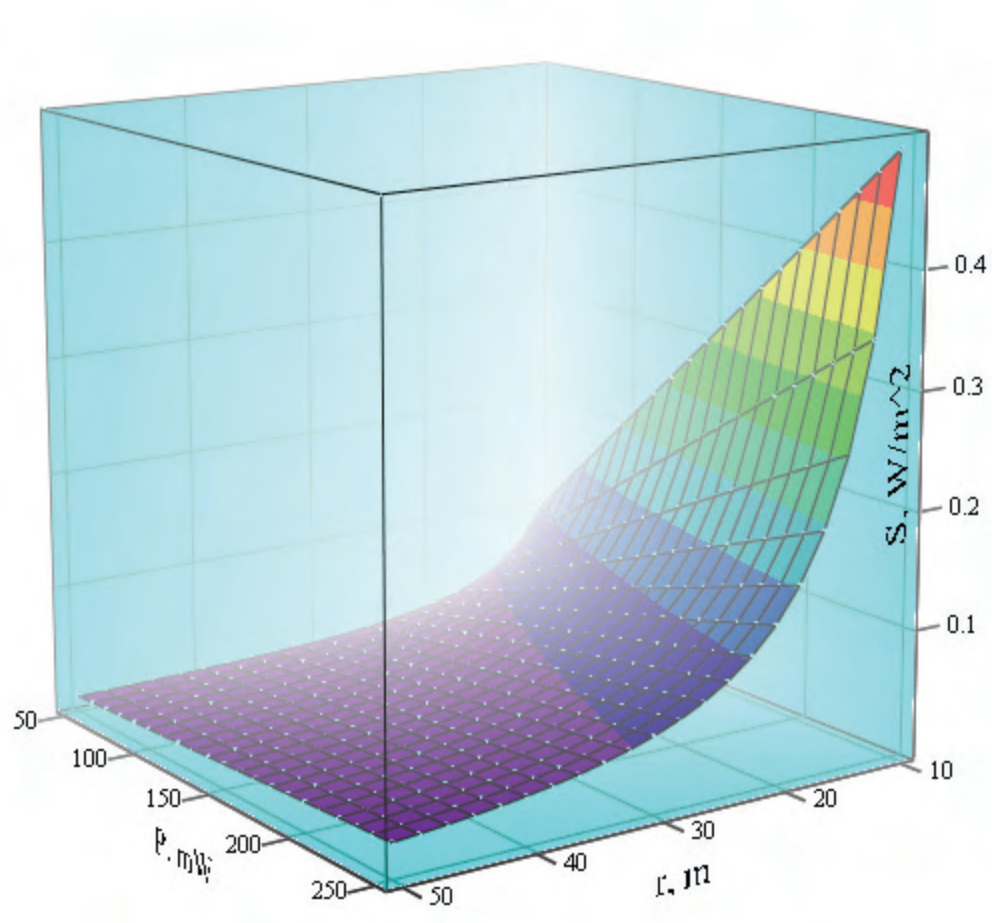

Fig.3. Amendment of the power density S, the modification of transmitter power P = 50 ÷ 250mW, distance r = 10 ÷ 50m and G = 2,5