Safety Engineering

UDC 331.45:613.648.2
DOI: 10.7562/SE2012.2.01.07
Review article
www.safety.ni.ac.rs

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OVERVIEW ON THE REFERENCE LEVELS FOR LOW FREQUENCY ELECTRIC AND MAGNETIC FIELDS IN THE LEGISLATION OF SOUTHEAST EUROPEAN COUNTRIES

Abstract: *In order to prevent adverse health effects from exposure to low frequency electric and magnetic fields, numerous national and international regulations have been published. They regulate the basic threshold and reference levels of exposure, exposure durations, measurement procedures and precautionary measures in case of exceeding the prescribed values. While many countries have implemented these regulations, in some countries they are only partially implemented or there is the absence of such regulations into their national legislation.*

This paper gives an overview of the applied regulations in the countries of Southeast Europe, concerning public and occupational safety from low frequency electric and magnetic fields. The aim of the paper is to determine the level of implementation of these regulations in the region.

Key words: low frequency, electric field, magnetic field, occupational exposure, public exposure.

INTRODUCTION

The health effects of exposure to low frequency electric and magnetic fields have been investigated over a long period. With the current research database covering several thousand studies, the direct correlation between the low frequency electric and magnetic fields and long term adverse health effects have still not been confirmed. Among the most notable results of these studies are: determination of weak statistical association of the childhood leukaemia with the long term exposure to intense low frequency magnetic fields [1] and proven short-term biological reactions as reduced perception, anxiety, nerves and muscle stimulations.

Based on the currently available knowledge, in 1998, the International Commission on Non-Ionizing Radiation Protection (ICNIRP) published "Guidelines for limiting exposure to time-varying electric, magnetic and electromagnetic fields" [2]. The reference levels provided by ICNIRP for low frequencies have been defined to prevent short-term, immediate effects such as nerves and muscle stimulation, associated with exposure to intense electric and magnetic fields. In 2010, ICNIRP made revision of the guidelines from 1998 [2] and published new guidelines for low frequencies (1Hz – 100 kHz) [3], which have not yet led to changes in the EU legislation. In this document, it is stated that the results of the epidemiological studies do not justify further decrease of the reference levels, since they do not indicate direct correlation of the low frequency electric and magnetic fields with specific health problems. However, considering the weak correlation of the low frequency magnetic fields and the childhood leukaemia, the International Agency for Research on Cancer classifies these magnetic fields as "possibly carcinogenic " to humans, group 2B [1].

In order to prevent adverse health effects from the exposure to low frequency electric and magnetic fields, many countries implement national and international regulations as binding into their legislation or use them in the form of advice that indicate the health risks.

The majority of European countries follow the recommendation of European Council (1999/519/EC) [4] and use the standards and limits based on the guidelines provided by [2]. Many countries implement stricter limits than those provided by ICNIRP. These limits depend on the frequency, vicinity of the sources and the target groups (sensitive groups, general public or professionals) [5]. However, some countries only partially implement these regulations or there is the absence of such regulations in their legislation.

The following text gives an overview of the applied regulations in the Southeast European countries, in order to determine the level of their implementation in the region.

REGULATIONS IN THE REGION

Serbia

The "Law on non-ionizing radiation protection" (Official Gazette of RS No. 36/09) regulates the conditions and measures for environmental and human health protection from the adverse effect of the non-ionizing radiation while using sources of non-ionizing radiation [6]. On the basis of the article 6, paragraph 6 of this law, the "Rulebook on the limits of exposure to

non-ionizing radiation" (Official Gazette of RS No.104/09) [7] was issued. This rulebook prescribes the basic restrictions and reference levels for public exposure to electromagnetic fields. The reference levels provided by this rulebook are given in Table 1.

Table 1. *Reference levels for public exposure on low frequency electric and magnetic fields in Serbia*

Frequency	Electric field strength E [V/m]	Magnetic flux density B [uT]
< 1 Hz	5600	16 000
1-8 Hz	4000	$16\,000/f^2$
8-25 Hz	4000	2 000/f
0,025-0,8 kHz	100/f	2/f
0,8-3 kHz	100/f	2,5
3-100 kHz	34,8	2,5

The comparison of the reference levels in Serbia, provided in [7] and those provided by ICNIRP [2],[3] for public exposure, is illustrated in Fig. 1.

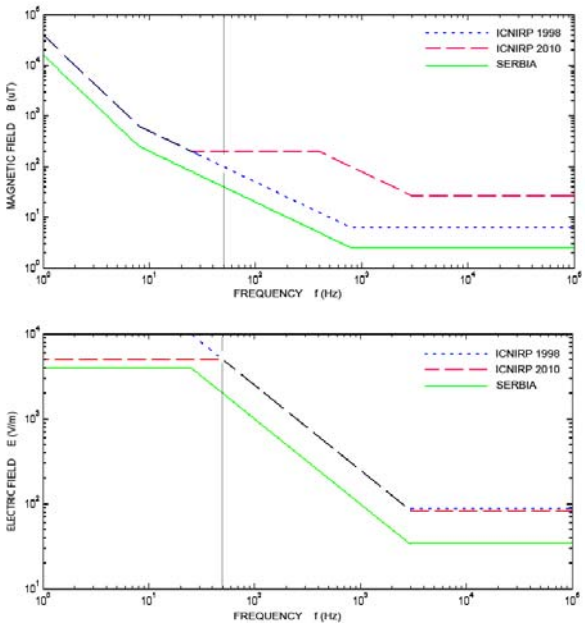

Figure 1. *Serbian vs. ICNIRP reference levels for public exposure on low frequency electric and magnetic fields*

The Serbian regulations are stricter, and allow only 40% of the reference levels provided by ICNIRP [2]. However, these regulations are only applicable for general public exposure of non-ionizing radiation.

Croatia

On 9 July, 2010, the Croatian parliament adopted the "Law for non-ionizing radiation" (Official Gazette of Croatia No.91/10) [8]. On the basis of article 8 paragraph 2 of this law, the Ministry of Health issued the "Rulebook on Protection from Electromagnetic Fields" (Official Gazette of Croatia No.98/11) [9]. This rulebook prescribes the basic threshold and reference levels on public and occupational exposure to electromagnetic fields from 1 Hz to 300 GHz. The reference levels for public exposure are the same as in Serbia (provided in Table 1), and the reference levels for occupational exposure are provided in Table 2.

Table 2. *Reference levels for occupational exposure on low frequency electric and magnetic fields in Croatia*

Frequency	Electric field strength E [V/m]	Magnetic flux density B [uT]
< 1 Hz	14 000	40 000
1-8 Hz	10 000	$40\,000/f^2$
8-25 Hz	10 000	5 000/f
0,025-0,8 kHz	250/f	5/f
0,8-3 kHz	250/f	6,25
3-100 kHz	87	6,25

The comparison of the reference levels in Croatia, provided in [9] and those provided by ICNIRP [2],[3] for occupational exposure, is illustrated in Fig. 2.

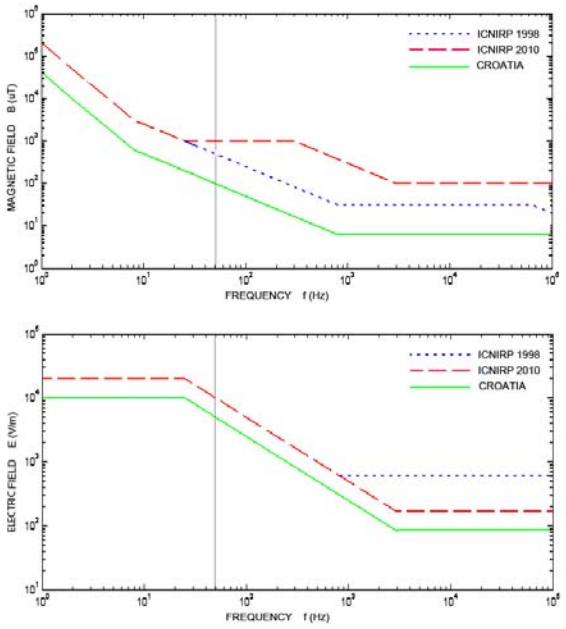

Figure 2. *Croatian vs. ICNIRP reference levels for occupational exposure on LF electric and magnetic fields*

The reference levels in Croatia for general public and occupational exposure to low frequency electric and magnetic fields are stricter than the reference levels provided in [2] and [3].

Greece

In 2002, Greece implemented measures for protection of the general public from low frequency electric and magnetic fields exposure, by putting into force the legislative act "Protection measures for the exposure of the general public to all low frequency electric and magnetic fields emitting devices" (GG No.512, Vol. B 25-4-2002) [10]. This legislative act implements the basic restrictions and reference levels recommended by the Council of the European Union for frequencies from 0 Hz to 300 GHz (1999/519/EC) [4].

For the low frequency electric and magnetic fields, the

reference levels provided in the ICNIRP guidelines [2] are applied. For the EMF from antenna systems, the limits are set to 80% and 60% from the limits given in the ICNIRP guidelines [2] if the antennas are located less than 300m from schools, kinder gardens or hospitals.

However, there is no national legislation with binding limits for professional exposure to low frequency and radiofrequency EMF in Greece.

Bulgaria

In the Bulgarian legislation, national standards for non-ionizing radiation have been implemented. They define limiting levels for: occupational exposure to electric and magnetic fields at low frequencies (Ordinance No. 7, Gov. News No. 88/1999) [11] and public and occupational exposure in the radio frequency and microwave range (Ordinance No. 9, Gov. News No.35/1991) [12]. The reference levels for occupational exposure to low frequencies are provided in Table 3.

Table 3 *Reference levels for occupational exposure on low frequency electric and magnetic fields in Bulgaria*

Frequency	Electric field strength E [V/m]	Magnetic flux density B [mT]
0 - 100 Hz	25 000	60/f *
100 Hz - 4 kHz	$2.5 \cdot 10^6$ /f	60/f
4 - 60 kHz	625	60/f

* Maximum 60T for static magnetic fields

The comparison illustrated in Fig. 3 indicates that the reference levels for occupational exposure to electric fields, provided by [11], are more lenient than those provided by ICNIRP [2] and [3], while the reference levels for magnetic fields are stricter or more lenient depending on the frequency.

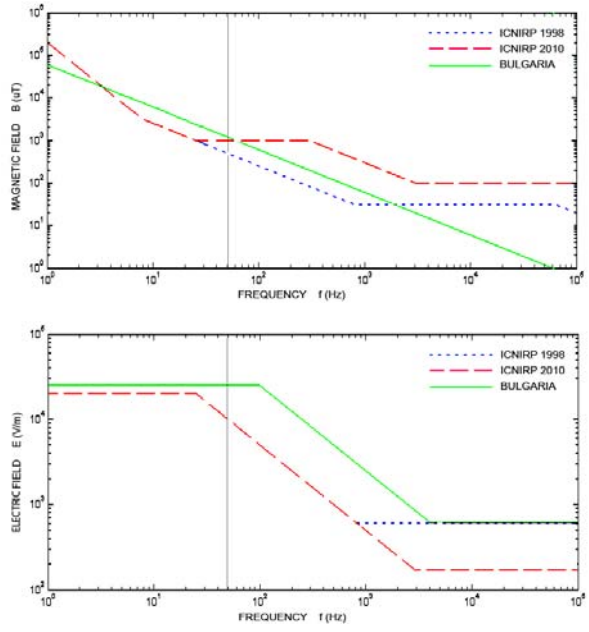

Figure 3. *Bulgarian vs. ICNIRP reference levels for occupational exposure on LF electric and magnetic fields*

The maximum duration of occupational exposure to intense electric fields in the vicinity of high-voltage equipment at power frequency (50 Hz) is defined in the Bulgarian national standard BNS 12.1.002-78 [13]. The exposure durations defined by this standard are provided in Table 4.

Table 4. *Maximum duration of occupational exposure on intense electric fields, defined by BNS 12.1.002-7*

Electric field strength E [kV/m]	Permissible duration of exposure t [minutes/day]
< 5	No limit
5 - 10	< 180
10 - 15	< 90
15 - 20	< 10
20 - 25	< 5
> 25	Access only with equipment for personal or collective protection

The Bulgarian legislation has not implemented limiting values for general public exposure to low frequency electric and magnetic fields.

Macedonia

In Macedonia there is no legislation that regulates the reference levels for public and occupational exposure to electric and magnetic fields at low frequencies. The "Rulebook for maximum permissible levels of human exposure on non-ionizing radiation" (Official Gazette of SFRY No. 50/90) is applicable for public and occupational exposure at frequencies from 300 kHz to 300 GHz. Therefore the European regulations for low frequencies are implemented as non-binding. The law for non-ionizing radiation has been in preparation for several years, and it has not been stated when it will be implemented.

CONCLUSION

In this paper, the authors have provided an overview of the level of implementation of the regulations concerning public and occupational exposure to low frequency electric and magnetic fields in the Southeast European countries. The above data indicate that in these countries, some regulations have been partially implemented or completely absent from their national legislation. The same trend has been observed in other countries worldwide.

Although measurements indicate that the electric and magnetic fields near power equipment are usually compliant with the reference levels, in some cases they can exceed these limits. The absence of legislation that should establish the limits and standards for protection from non-ionizing radiation is yet another obstacle in providing legal protection of the people whose safety is potentially compromised.

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BIOGRAPHY

Blagoja Markovski was born in Skopje, Macedonia in 1985.
He received the Degree in electrical engineering from the Ss. Cyril and Methodius University, Skopje, in 2009.
Currently, he is a teaching assistant within the Faculty of Electrical Engineering and Information Technologies at the Ss. Cyril and Methodius University, Skopje.
His fields of interest are EMF exposure assessment, numerical electromagnetic modeling, embedded systems and computer graphics.

PREGLED REFERENTNIH NIVOA ZA NISKOFREKVENTNA ELEKTRIČNA I MAGNETNA POLJA U DRŽAVAMA JUGOISTOČNE EVROPE

Blagoja Markovski, Leonid Grčev, Marija Kacarska

Apstrakt: *U cilju sprečavanja negativnih efekata po zdravlje ljudi od izloženosti niskofrekventnim električnim i magnetnim poljima, objavljeni su brojni nacionalni i međunarodni propisi. Oni regulišu: osnovne granične i referetne nivoe izloženosti, vreme trajanja izloženosti, merne procedure i mere predostrožnosti u slučaju prekoračenja propisanih vrednosti. Dok se u mnogim zemljama ovi propisi već primenjuju, u pojedinim zemljama su samo delimično implementirani ili uopšte ne postoje takvi propisi u njihovom nacionalnom zakonodavstvu.*

Ovaj rad daje pregled primenjenih propisa u zemljama jugoistočne Evrope koji se odnose na javne i profesinalne mere zaštite od izlaganja niskofrekventnim električnim i magnetnim poljima. Cilj ovog rada je utvrđivanje stepena sprovođenja tih propisa u regionu.

Ključne reči: niske učestanosti, električno polje, magnetno polje, profesionalna izloženost, izloženost stanovništva.