

# NEW EMF SAFETY LIMITS FOR OCCUPATIONAL AND PUBLIC EXPOSURE IN POLAND

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**Abstract.** On July 23, 2001, new safety limits for occupational exposure to electromagnetic fields (EMF) were introduced in Poland. The limits have been based on the analysis of international recommendations, e.g., ICNIRP (1998), WHO (1998), IEEE standard (1999), drafts of European standards (ENV 1995), and a critical review of the world literature on the biological effects of EMF and health effects of exposure to EMF. Derived from safety limits for occupational exposure, new safety exposure limits for general population were introduced on November 28, 2003. In this paper mandatory procedures for setting limits of exposure to agents harmful to health in the workplace and natural environment are presented. The most essential provisions of two regulations, one issued by the Minister of Labour and Social Policy and the other by the Minister of the Environment, forming the basis of the modern system of EMF exposure control in Poland, are also discussed.

**Key words:**

Electromagnetic field, Safety limits, Occupational exposure, General population exposure, Protective zones

## INTRODUCTION

Guidelines on electromagnetic field (EMF) limits for occupational protection were issued by the Minister of Labour and Social Policy in 2001, whereas guidelines for the EMF limits for public protection were issued by the Minister of the Environment in 2003. Both documents take the form of regulations that have a binding effect in the whole country. In Poland like in several other European countries there is a long tradition of protecting work and natural environments against EMF exposure. The first guidelines on the microwave range were introduced in 1961. They were entirely based on the rules mandatory in the former Soviet Union. From the early 1970s, Poland has successively introduced its own national guidelines (on the microwave range, 1972; on the radiowave range, 1977) to ensure occupational protection. In 1980, first exposure limits for the general public were issued. Apart from radiowave and

microwave ranges (i.e., 0.1 MHz – 300 GHz), the limits for the frequency of 50 Hz were set, taking into account electroenergetic devices (power stations) and power lines. In the work environment, the range of 50 Hz and 1–100 kHz became a standard in the 1990s, but only for the magnetic component. In 1998, hygiene guidelines for the general public were first amended. The frequency range of 0 Hz to 50 Hz, >50 Hz – 1 kHz remained beyond any regulation, and in the frequency range of 50 Hz and 1–100 kHz there were no limits for the electric component. In January 2001, new EMF safety limits for occupational exposure [1–2] and in November 2003, for the general public were introduced in Poland [3].

In the Polish legislative system, the Labour Code [4] harmonized with the European Union standards and its executive provisions form the basis for the protection of workers against agents harmful to health in the work environment.

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The procedure for establishing maximum admissible intensities (MAI) for aforesaid agents is obligatory in Poland.

### PHILOSOPHY OF POLISH STANDARDS

New limits of occupational exposures to EMF in Poland have been adopted on the basis of literature reviews, the criteria adopted in international standards, and our own studies of the EMF effects on the nervous and circulatory systems, which are found to be most sensitive.

For the boundary frequency of 300 GHz, a maximum admissible value has been harmonized with limits recommended for the infrared range.

Safety limits for pulse modulated field in occupational exposure have been designed to protect humans against behavioral effects, and they constitute additional limitation of exposure to such fields.

The new Polish limits for occupational exposure to EMF are an important step towards harmonization of EMF exposure standards. Exposure limits for general population are set forth by the Minister of the Environment. After publication of the new EMF safety limits for occupational exposure in Poland, boundary values for general population were verified.

The philosophy of Polish limits of exposure to electromagnetic fields is based on the idea of protective zones. Three protective zones are distinguished:

- hazardous zone – prohibiting the presence of workers in the zone without personal protective means;
- dangerous zone with a time-limited exposure, and
- intermediate zone with the admissible presence up to 8 h per work-shift.

The area outside the protective zones is termed safety zone without any limits for the presence of people. Boundary value for safety zone was traditionally considered as the maximum admissible level for general public.

### REVIEW OF NEW EMF LIMITS FOR OCCUPATIONAL EXPOSURE

The EMF Safety Limits for Occupational Exposure in Poland are characterized by the following parameters [2]:

- frequency spectrum ( $f$ , [Hz]);
- electric field strength, in the range of 0 Hz – 300 GHz ( $E$ , [V/m]), for the whole body;
- magnetic field strength, in the range of 0 Hz – 3 GHz ( $H$ , [A/m]), for the whole body;
- magnetic field strength, in the range of 0 Hz – 800 kHz ( $H$ , [A/m]) for the limbs (arms to the elbow area and legs to the knee area) that is five times higher than that admissible for the whole body;
- admissible dose of electric and magnetic fields in a dangerous zone: ( $D_E(f)$ , [(E/m)<sup>2</sup> h] and  $D_H(f)$ , [(H/m)<sup>2</sup> h], respectively);
- an additional condition for pulse modulated fields should be met for maximum electric field intensity value in peak pulse;
- exposure indicator,  $W$ .

As follows from the above considerations, admissible values of electric and magnetic field strength depend on the field frequency.

There are three boundary values of electric field strength:  $E_0(f)$ ,  $E_1(f)$  and  $E_2(f)$  and magnetic field strength:  $H_0(f)$ ,  $H_1(f)$  and  $H_2(f)$  of a general influence on a worker's body, according to the protective zones: intermediate, dangerous and hazardous, respectively.

Between the boundary values there exist the following relationships:  $E_0(f) = E_1(f)/3$ ,  $E_2(f) = 10E_1(f)$ ,  $H_0(f) = H_1(f)/3$ ,  $H_2(f) = 10H_1(f)$ .

There is an exception to the aforesaid relationships in the frequency range of 0 Hz <  $f$  < 300 Hz, where the values:  $E_0(f) = E_1(f)/2$ ,  $E_2(f) = 2E_1(f)$ .

For pulse modulated fields in the frequency range of 0.1–300 GHz an additional condition should be fulfilled:

- in the frequency range of 0.1 <  $f$  < 3 GHz:  
 $E_{\max \text{ imp}} < 4.5 \text{ kV/m}$ ;
- in the frequency range of 3 <  $f$  < 10 GHz:  
 $E_{\max \text{ imp}} < 0.43 f + 3.2 \text{ kV/m}$ ;
- in the frequency range of 10 <  $f$  < 300 GHz:  
 $E_{\max \text{ imp}} < 7.5 \text{ kV/m}$

where:  $E_{\max \text{ imp}}$  – maximum electric field strength value in pulse,  $f$  – frequency in GHz.

The safety limits are summarized in Table 1.

**Table 1.** Levels of exposure limits of electric (E) and magnetic (H) fields in occupational exposure in Poland

Frequency range	Electric field strength $E_1(f)$ (V/m)	Admissible dose of exposure $D_E(f)$	Magnetic field strength $H_1(f)$ (A/m)	Admissible dose of exposure $D_H(f)$
$0 \text{ Hz} \leq f \leq 0.5 \text{ Hz}$	20 000	$3200 \text{ (kV/m)}^2\text{h}$	8 000	$512 \text{ (kA/m)}^2\text{h}$
$0.5 \text{ Hz} < f \leq 50 \text{ Hz}$	10 000	$800 \text{ (kV/m)}^2\text{h}$	200	$0.32 \text{ (kA/m)}^2\text{h}$
$0.05 \text{ kHz} < f \leq 0.3 \text{ kHz}$	10 000	$800 \text{ (kV/m)}^2\text{h}$	10/f	$800/f^2 \text{ (A/m)}^2\text{h}$
$0.3 \text{ kHz} < f \leq 1 \text{ kHz}$	100/f	$0,08/f^2 \text{ (kV/m)}^2\text{h}$	10/f	$800/f^2 \text{ (A/m)}^2\text{h}$
$1 \text{ kHz} < f \leq 800 \text{ kHz}$	100	$0,08 \text{ (kV/m)}^2\text{h}$	10	$800 \text{ (A/m)}^2\text{h}$
$0.8 \text{ MHz} < f \leq 3 \text{ MHz}$	100	$0,08 \text{ (kV/m)}^2\text{h}$	8/f	$512/f^2 \text{ (A/m)}^2\text{h}$
$3 \text{ MHz} < f \leq 15 \text{ MHz}$	300/f	$0,72/f^2 \text{ (kV/m)}^2\text{h}$	8/f	$512/f^2 \text{ (A/m)}^2\text{h}$
$15 \text{ MHz} < f \leq 150 \text{ MHz}$	20	$3200 \text{ (V/m)}^2\text{h}$	8/f	$512/f^2 \text{ (A/m)}^2\text{h}$
$0.15 \text{ GHz} < f \leq 3 \text{ GHz}$	20	$3200 \text{ (V/m)}^2\text{h}$	0.053	$0.022 \text{ (A/m)}^2\text{h}$
$3 \text{ GHz} < f \leq 300 \text{ GHz}$	$0.16f + 19.5$	$(f/2 + 55)^2 \text{ (V/m)}^2\text{h}$	—	—

## ASSESSMENT OF EMF EXPOSURE IN THE WORK ENVIRONMENT

It is stated in the Labour Code, and executive provisions to Section X of the Code that employers are obliged to guarantee safe and hygiene working conditions [4]. Electromagnetic fields are subject to mandatory control as potentially harmful physical agents in the work environment. The methods of the measurement and assessment of EMF in the work environment have been described in detail in PN-T-06580-3 – Labour protection in electromagnetic fields and radiation of the frequency range from 0 Hz to 300 GHz, Part 3: Methods of measurement and evaluation of the field on the work stands [5]. EMF assessment in the workplace is carried out on the basis of the measurements and establishment of the range of protective zones around particular EMF sources. Assessment of workers' exposure to EMF is carried out on the basis of the measurements of EMF strength and the time of its occurrence (exposure time). Depending on EMF strength value and exposure time, a four-level scale of worker's exposure assessment has been introduced: negligible, admissible, excessive, and hazardous. Criteria for the above classification have been defined in this standard and PN-T-06580-1 – Labour protection in electromagnetic fields and radiation of the frequency range from 0 Hz up to 300 GHz, Part 1: Terminology [6].

## REVIEW OF NEW EMF EXPOSURE LIMITS FOR GENERAL POPULATION

Guidelines on the protection of the general population and environment from EMF take into account the fact that people are constantly within a certain range of EMF (including children, pregnant women, the elderly, the handicapped and sick people). According to the Ordinance of the Minister of the Environment [3], there are different admissible EMF levels for:

- building areas, and
- areas accessible for general public.

Moreover, the Ordinance defines the methods of control and compliance with admissible EMF levels in the environment in the frequency range of 0 Hz – 300 GHz.

Control measurements of EMF produced by different devices and installations being the source of radiation are performed:

- immediately after the first application of a device,
- every time changes in the device's working conditions occur, and as long as they may bring about variations in the levels of EMF produced by the device itself.

It is the responsibility of the Chief Inspector of Environmental Protection to control the compliance with the rules on the environmental protection as well as to assess the condition of the environment. The Inspector is also

**Table 2.** Admissible EMF levels for building areas

Frequency range	Electric field strength	Magnetic field strength
50 Hz	1 kV/m	60 A/m

**Table 3.** Admissible EMF levels in places accessible to general public

Frequency range	Electric field strength	Magnetic field strength	Power density
0 Hz	10 kV/m	2500 A/m	–
> 0 Hz – 0.5 Hz	–	2500 A/m	–
> 0.5 Hz – 50 Hz	10 kV/m	60 A/m	–
> 0.05 kHz – 1 kHz	–	3/f A/m	–
> 0.001 MHz – 3 MHz	20 V/m	3 A/m	–
> 3 MHz – 300 MHz	7 V/m	–	–
> 0.3 GHz – 300 GHz	7 V/m	–	0.1 W/m <sup>2</sup>

responsible for the organization and coordination of the national environmental monitoring.

Admissible levels of electromagnetic fields are presented in Tables 2 and 3.

Effective values of EMF strength/power density are given exactly to one significant digit.

## CONCLUSION

Intensive research aimed at establishing commonly accepted guidelines on protection against EMF has been carried out in the recent years. Both in the European Union and the World Health Organization (WHO), the research is based on the guidelines of the ICNIRP [7]. The specific absorption rate (SAR) value is a criterion for establishing exposure limits. It is adopted as a measure of well-documented thermal effects resulting from exposure to EMF. Possible non-thermal effects induced by chronic exposure to low-level intensity EMF are not considered here due to the lack of substantial evidence. A probability of such effects has been taken into account in the new safety limits adopted in Poland by introducing the gradation of exposure values in the form of protective zones as well as dose and exposure indicators. In 1996, WHO began an international program concerning “Electromagnetic Fields 0 Hz – 300 GHz”, aimed at assessing the assessment of health and environmental effects of exposure to these fields. It is expected

that the program will result in an international consensus on admissible limits of exposure to EMF. It is also expected that the program will be completed in 2005. In 2001, the Eastern European Regional EMF Meeting and Workshop “Measurements and Criteria for Standard Harmonization in the Field of EMF Exposure” and WHO EMF Standards Harmonization Meeting were held in Varna under the WHO auspices. The participating countries presented the philosophy of establishing EMF exposure limits mandatory in a given country. Apart from Poland, Russia and Bulgaria presented a significant ‘departure’ from the criteria adopted in the ICNIRP guidelines. Countries like Japan, Italy, Sweden, Australia, and Great Britain have introduced additional guidelines based on so called Precautionary Principle for exceptional situations in the human protection encountered in the municipal environment [7].

## REFERENCES

1. *Ordinance of the Ministry of Labour and Social Politics from 2 January 2001 changing the Ordinance as to the question of the maximum admissible intensities and concentrations of factors harmful to health in the workplace.* Journal of Law, 2001, No. 4, item 36.
2. *Ordinance of the Minister of Labour and Social Policy from 29 November 2002 concerning MAC/MAI of agents harmful to health in the work environment.* Journal of Law, 2002, No. 217, item 1833.
3. *Ordinance of the Minister of the Environment from 30 October 2003, on admissible EMF levels in environment, and control methods of compliance with these levels.* Journal of Law, 2003, No. 192, item. 1883.
4. Walczak K, editor. *Labour Code.* Warsaw: Published by C.H. Beck; 2003.
5. PN-T-06580-1: *Labour protection in electromagnetic fields and radiation of the frequency range from 0 Hz up to 300 GHz – Part 1: Terminology.* Warsaw: Polish Committee for Standardization; 2002.
6. *Guidelines for limiting exposure to time-varying electric, magnetic and electromagnetic fields (up to 300 GHz).* International Commission on Non-Ionizing Radiation Protection (ICNIRP). Health Physics 1998; 74: 494–522.
7. *Eastern European Regional EMF Meeting and Workshop “Measurements and Criteria for Standard Harmonization in the Field of EMF Exposure” and WHO EMF Standards Harmonization Meeting [Abstracts, Key Presentations]; 2001 April 28 – May 3; Varna, Bulgaria.* Sofia: National Center of Hygiene; 2001.