

**THE EUROPEAN PRE-STANDARD ENV 50166
"HUMAN EXPOSURE TO ELECTROMAGNETIC FIELDS"**

B. Kunsch

Austrian Research Centre Seibersdorf, Seibersdorf, A 2444

SCOPE AND CONCEPT

The CENELEC Prestandard ENV 50166 (1) deals with the prevention of adverse effects of human exposure to electromagnetic fields within the frequency range 0 Hz-300 GHz. It is based on the well-established short term effects, the stimulation of nerves and muscle tissue at low and heating at high frequencies. Reports on long term effects such as the induction or promotion of cancer have been scrutinised and it was found that the current available evidence had not established a connection. Basic restrictions, which must not be exceeded, are given for biologically relevant quantities and complemented by reference levels which are more readily measurable thus facilitating the checking of compliance. The Prestandard does not apply to the deliberate exposure of persons during medical research, diagnosis or treatment. Furthermore, safety hazards associated with the ignition of flammable materials or the triggering of explosive devices are not covered, and the interference of permissible fields with implants cannot be excluded.

LOW FREQUENCIES (0-10 kHz)

At low frequencies there are basic restrictions in terms of induced current density, contact current, electric field strength and static magnetic flux density. The ENV sets 10 mA/m² as the basic restriction for workers within the frequency range 4 Hz-1000 Hz. The current density restriction is set inversely proportional to the frequency below 4 Hz and directly proportional to the frequency above 1000 Hz. This accounts for the specific stimulation characteristics of excitable cells. For the general population a precautionary factor of 2.5 was chosen. Harmful indirect effects are prevented by limiting the contact current, to 3.5 mA over the entire low frequency range for workers and to 1.5 mA for the general population.

High electric fields can make themselves felt through surface effects. To prevent annoyance a basic restriction is set for electric fields at 30 kV/m above 0.1 Hz (42 kV/m at 0 Hz). Similarly, a basic restriction for static magnetic fields at 2 T prevents vertigo and nausea.

Reference levels as limits for the electric and magnetic field strengths are derived from the basic restrictions using worst case assumptions for the geometry and position of the body and the relevant organs, with respect to external fields. Thus compliance with reference levels automatically ensures compliance with the basic restrictions on induced current density. However, reference levels may be exceeded if the basic restrictions are met.

HIGH FREQUENCIES (10 kHz-300 GHz)

The ENV uses the following quantities as basic restrictions in the high frequency range: Induced current density and contact current at frequencies up to 10 MHz and 3 MHz, respectively, the specific absorption rate SAR with different values for whole body, limbs, local heating and the specific absorption SA for pulses of a duration of less than 30 μ s at frequencies above 300 MHz.

The current density is set for workers at $f/100$ mA/m², whereas the precautionary factor of 2.5 is maintained for the general public. Between 10 kHz and 100 kHz the contact current limit increases proportionally to the frequency and, between 100 kHz and 3 MHz, remains constant at 35 mA and 20 mA respectively.

At frequencies of around a few MHz the specific absorption rate SAR takes over from the induced current density to become the significant dosimetric quantity for establishing exposure limits. The threshold for effects which are considered detrimental to health is observed at 4 W/kg, averaged over a 6 min. time interval and over the whole body. This corresponds to a systemic temperature increase of less than 1°C at normal conditions. To derive the basic restriction for workers a safety factor of 10 is applied which gives an SAR of 0.4 W/kg. For the general public 0.08 W/kg was chosen. In the high frequency range both rms and peak values are set for the reference levels. Above 10 MHz, reference levels are also given for the mean power density.

DISCUSSION

Some European countries have already developed national standards or guidelines for the protection of the population from electromagnetic fields (2,3,4). The CENELEC Prestandard is the result of their national electrotechnical committees' harmonization effort. Problems to overcome were the questions whether a one tier

or a two tier structure of the standard should be adopted, and how to define the two levels of protection. For example Great Britain's NRPB guidelines give one set of limits which are valid for everyone whereas Germany's DIN/VDE Standard and Austria's ÖVE Standard distinguish between controlled/uncontrolled areas and workers/general public, respectively.

Beside CENELEC IRPA/ICNIRP and CEU have developed exposure limits at international level. The IRPA/ICNIRP limits are confined to 0 Hz, 50/60 Hz and the frequency range 100 kHz to 300 GHz (5,6,7). The limits of the CEU's draft Directive are related to workers only (8). The draft Directive defines exposure limits as upper limits as well as threshold values below which no adverse health effects are expected. In the region between threshold values and exposure limits there is a set of three action levels. These are not limits but rather field levels, the exceedance of which requires certain countermeasures. At the lowest action level, workers should be informed about their exposure situation, provided with protective gear and training. At the next action level a program for the reduction of exposure has to be developed and areas have to be marked off. Activities at levels higher than the 3rd action level are regarded as hazardous, authorities have to be informed and a systematic health surveillance has to be provided for exposed workers.

This discussion attempts to compare CENELEC's ENV limits with those limits given by IRPA and CEU, being aware that, particularly in the case of field strengths, such a comparison can only be approximate because of differing definitions.

	CENELEC	IRPA	CEU
induced current density , head and trunk [mA/m ²]	10	10	10
electric field strength [kV/m]	10	10	19,6; 12,3; 6.1
magnetic flux density [mT]	1,6	0,5	0,64; 0,4; 0,2
contact current [mA]	3,5		1,5

Table 1: Limit values of CENELEC ENV 50166, IRPA guidelines and CEU draft Directive at 50/60 Hz for exposure of workers over a full working day.

	CENELEC	IRPA	CEU
frequency range [Hz]	1,0.10 ⁴ -3,0.10 ¹¹		1,0.10 ³ -3,0.10 ¹¹
SAR 6 min. [W/kg]			
whole body	0,4	0,4	0,4
extremities	20	20	20
head and trunk	10	10	10
SA [mJ/kg]	10		10
contact current (0,1 - 3 (100) MHz) [mA]	35	(50)	50

Table 2: High frequency limit values of CENELEC ENV 50166, IRPA guidelines and CEU draft Directive for exposure of workers over a full working day.

Generally, the regulations of CENELEC, IRPA/ICNIRP and CEU are based on the same criteria. For workers there is full agreement between the basic restrictions of CENELEC, the basic criteria of IRPA/ICNIRP and the exposure limits of CEU for the induced current density and SAR, which are the starting points for deriving the respective field strengths (e.g. Tab.1 and 2). Differences exist between the contact current limits of CENELEC and CEU, established to control indirect effects.

Figure 1 shows the reference levels of the ENV in comparison with the electric field limits of the IRPA/ICNIRP guidelines and the medium action level of the draft Directive. Figure 2 displays the corresponding magnetic flux density limits. There is a satisfactory agreement between the three regulations. The differences however reveal that there is a need for harmonisation. The same holds true for the exposure limits for the general population as set by CENELEC and IRPA/ICNIRP. For details the reader is referred to the documents in the reference list.

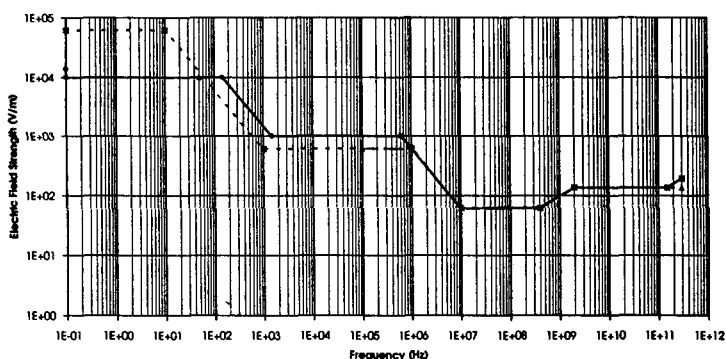


Figure 1: Electric field limits of CENELEC (full line, dots), IRPA/ICNIRP (dashed line, triangles) and CEU (dotted line, squares) for workers exposed over a full working day

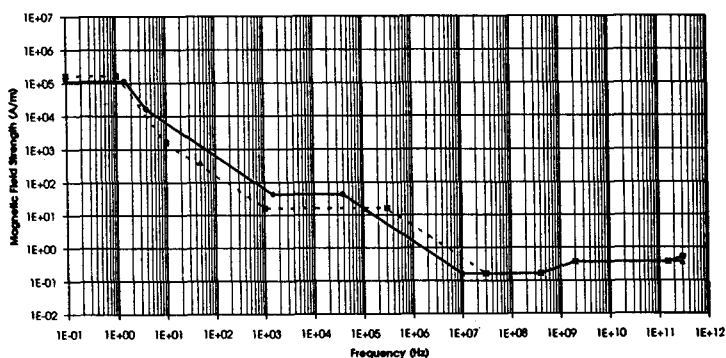


Figure 2: Magnetic field limits of CENELEC (full line, dots), IRPA/ICNIRP (dashed line, triangles) and CEU (dotted line, squares) for workers exposed over a full working day

ACKNOWLEDGEMENT

As chairman of CENELEC's Technical Committee TC 111 which developed ENV 50166 I have the privilege to thank the national committee members and in particular the chairs of the subcommittees Dr. Gabriel and Dr. Maddock as well as the secretaries Dr. Hutzler, D.I. Krause and Dr. Mariutti for their outstanding work.

LITERATURE

1. CENELEC, ENV 50166-1 (low frequencies) and ENV 50166-2 (high frequencies), January 1995
2. DIN/VDE 0848, German Electrotechnical Commission, part 2 (1990) and part 4 (1994)
3. ÖNORM S 1119 and ÖNORM S1120, Austrian Standards Institute, 1994 and 1992, resp.
4. NRPB, Documents, Vol. 4, No.5, 1993
5. ICNIRP, Health Physics 66, 100-106, 1994
6. INIRC, Health Physics 58, 113-122, 1990,
7. IRPA, Health Physics 54, 115-123, 1988
8. Commission of the European Community, Official Journal of EC, 37, 3-29, 19.8.1994