



**The Swedish Radiation Protection Authority's General Advice
on the Limitation of Exposure of the General Public to Electromagnetic
Fields;**

issued on October 28th 2002.

The Swedish Radiation Protection Authority gives the following general advice.

1. Application

1.1 The purpose of these general advice is to protect members of the general public from acute harmful effects from exposure to electromagnetic fields in the frequency range 0 Hz – 300 GHz.

The general advice are based on recommendations from the Council of the European Union¹. They are intended to serve as guidelines for the application of section 6 of the Radiation Protection Act (1988:220).

1.2 In the general advice basic restrictions as well as reference levels are given.

The basic restrictions ensure that electric and magnetic effects that may occur within the human body do not disturb functions of the central nervous system, nor cause harmful heating of an organ or a tissue. The reference levels are quantities that are measurable outside the human body. They are derived from the basic restrictions and ensure that the basic restrictions are not exceeded.

If measured levels exceed the reference levels, this does not necessarily imply that the basic restrictions are exceeded. In such cases the basic restrictions according to these general advice should apply.

The basic restrictions are in accordance with international recommendations laid down at levels of about 2 percent of the levels where negative health effects are scientifically established.

1.3 These general advice are applicable in areas where members of the general public may be situated in such periods of time giving meaning to the advice.

1.4 The reference levels do not ensure the proper function, nor the lack of disturbance of medical technical devices such as metallic prosthesis, cardiac pacemakers or other implants. Such matters are treated in the legislation on electromagnetic compatibility and medical technical devices.

1.5 These general advice do not apply to occupational exposure to electromagnetic fields. For such exposures regulations from the Swedish Work Environment Authority apply.

¹ Council Recommendation 1999/519/EC, July 12th 1999 on the limitation of exposure of the general public to electromagnetic fields (0 Hz to 300 GHz), (OJ L199, 30/07/1999, p. 59, Celex 399L0519).

2. Basic restrictions

2.1 Electromagnetic fields of a kind that imply that the basic restrictions according to Table 1 are exceeded should not occur at any point where members of the general public may be situated according to clause 1.3.

Table 1 Basic restrictions for electric, magnetic and electromagnetic fields (0 Hz – 300 GHz)

Frequency range	Magnetic flux density (mT)	Current density (effective value) (mA/m ²)	SAR (Whole body (mean value) (W/kg)	Local SAR (head and trunk) (W/kg)	Local SAR (arms and legs) (W/kg)	Power density S (W/m ²)
0 Hz	40	-	-	-	-	-
> 0 Hz - 1 Hz	-	8	-	-	-	-
1 Hz - 4 Hz	-	8/f	-	-	-	-
4 Hz - 1 kHz	-	2	-	-	-	-
1 kHz - 100 kHz	-	f/500	-	-	-	-
100 kHz - 10 MHz	-	f/500	0.08	2	4	-
10 MHz - 10 GHz	-	-	0.08	2	4	-
10 GHz - 300 GHz	-	-	-	-	-	10

f is the frequency expressed in Hz.

Current density is the mean value over 1 cm² perpendicular to the direction of the current.

All SAR-values (Specific Absorption Rate) refer to the mean value in a 6 minute period of time.

Local SAR should be calculated as the mean value over a mass of 10 g contiguous tissue.

3. Reference levels

3.1 The measurable quantities according to Table 2, which are derived from the basic restrictions, should not be exceeded at any point where members of the general public may be situated according to clause 1.3.

3.2 The reference levels according to Table 2 ensure that the basic restrictions in Table 1 are not exceeded.

Table 2 Reference levels for exposure of the general public (0 Hz – 300 GHz)

Frequency range	E-fields (V/m)	H-fields (A/m)	B-fields (μ T)	Equivalent power density for a plane wave S_{eq} (W/m ²)
0 Hz - 1 Hz	-	$3.2 \cdot 10^4$	$4 \cdot 10^4$	-
> 1 Hz - 8 Hz	10000	$3.2 \cdot 10^4 / f^2$	$4 \cdot 10^4 / f^2$	-
8 Hz - 25 Hz	10000	$4000 / f$	$5000 / f$	-
25 Hz - 800 Hz	$2.5 \cdot 10^5 / f$	$4000 / f$	$5000 / f$	-
800 Hz - 3 kHz	$2.5 \cdot 10^5 / f$	5	6.25	-
3 kHz - 150 kHz	87	5	6.25	-
150 kHz - 1 MHz	87	$7.3 \cdot 10^5 / f$	$9.2 \cdot 10^5 / f$	-
1 MHz - 10 MHz	$8.7 \cdot 10^4 / f^{1/2}$	$7.3 \cdot 10^5 / f$	$9.2 \cdot 10^5 / f$	-
10 MHz - 400 MHz *	28	0.073	0.092	2
400 MHz - 2 GHz	$\frac{1.375 \cdot f^{1/2}}{1000}$	$\frac{0.0037 \cdot f^{1/2}}{1000}$	$\frac{0.0046 \cdot f^{1/2}}{1000}$	$f / (2 \cdot 10^8)$
2 GHz - 300 GHz	61	0.16	0.20	10

* In the frequency range 10 MHz – 110 MHz an additional reference level of 45 mA for induced current in each leg or arm should apply.

f is the frequency expressed in Hz.

In the frequency range 100 kHz to 10 GHz, S_{eq} , E^2 , H^2 and B^2 refer to the mean value over a 6 minutes' period of time.

At frequencies higher than 10 GHz, S_{eq} , E^2 , H^2 and B^2 are calculated as the mean values over a period of time that is $68 / (10^9 \cdot f)^{1.05}$ minutes, where f is expressed in Hz.

The mean values for E-fields, H-fields and B-fields are calculated as the square roots of the mean values, during the considered period of time, of the squares of the quantities respectively.

4. Exposure to pulses and short term exposure

4.1 For exposure to pulses, the durations of which are t_p , the frequency $f = 0.5/t_p$ should be used as regards the basic restrictions and the reference levels.

4.2 For exposure of the head to pulse-modulated signals in the frequency range 0.3 GHz to 10 GHz with pulse-durations less than 30 microseconds, an additional basic

restriction should apply so that the absorbed energy per pulse does not exceed 2 millijoule per kilogram evaluated as the mean value over 10 grams contiguous tissue.

4.3 Concerning peak values of E-fields, H-fields and B-fields respectively, the effective value (RMS) according to Table 2 multiplied by a factor according to Table 3 should apply.

Table 3 Factors for the calculation of peak values

Frequency range	Factor
< 100 kHz	$\sqrt{2}$
100 kHz - 10 MHz	10^α where $\alpha = (0.665 \log (f/10^5) + 0.176) *$
10 MHz - 300 GHz	32

* f is expressed in Hz

5. Simultaneous exposure to a variety of frequencies

For exposure to fields consisting of a variety of frequencies simultaneously, the possibility that the fields may add up to give a certain biologic effect should be taken into account. Thus thermal effects in the body and other effects should be considered separately.

Basic restrictions

5.1 Concerning electric stimulation in the frequency range 1 Hz - 10 MHz the induced current densities are summed up according to the equation

$$\sum_{i=1 \text{ Hz}}^{10 \text{ MHz}} \frac{J_i}{J_{Li}} \leq 1$$

5.2 At thermal effects (frequencies higher than 100 kHz) SAR and power densities are summed up according to the equation

$$\sum_{i=100 \text{ kHz}}^{10 \text{ GHz}} \frac{\text{SAR}_i}{\text{SAR}_L} + \sum_{i>10 \text{ GHz}}^{300 \text{ GHz}} \frac{S_i}{S_L} \leq 1$$

where

J_i is the current density at the frequency i ,

J_{Li} is the basic restriction according to Table 1 for the current density at frequency i ,

SAR_i is the SAR-value given by frequency i ,

SAR_L is the basic restriction according to Table 1 for SAR,

S_i is the power density of frequency i and

S_L is the basic restriction according to Table 1 for power density.

Reference levels

5.3 To prevent effects by electric stimulation at frequencies up to 10 MHz the two following equations apply:

$$\sum_{i=1 \text{ Hz}}^{1 \text{ MHz}} \frac{E_i}{E_{Li}} + \sum_{i > 1 \text{ MHz}}^{10 \text{ MHz}} \frac{E_i}{a} \leq 1$$

and

$$\sum_{k=1 \text{ Hz}}^{150 \text{ kHz}} \frac{H_k}{H_{Lk}} + \sum_{k > 150 \text{ kHz}}^{10 \text{ MHz}} \frac{H_k}{b} \leq 1$$

where

E_i is the E-field at frequency i ,

E_{Li} is the reference level according to Table 2 for an E-field at frequency i ,

H_k is the H-field at frequency k ,

H_{Lk} is the reference level according to Table 2 for an H-field at frequency k ,

$a = 87 \text{ V/m}$ and

$b = 5 \text{ A/m}$.

5.4 For thermal effects (frequencies higher than 100 kHz) the two following equations apply:

$$\sum_{i=100 \text{ kHz}}^{1 \text{ MHz}} \frac{E_i^2}{c^2} + \sum_{i > 1 \text{ MHz}}^{300 \text{ GHz}} \frac{E_i^2}{E_{Li}^2} \leq 1$$

and

$$\sum_{k=100 \text{ kHz}}^{150 \text{ kHz}} \frac{H_k^2}{d^2} + \sum_{k > 150 \text{ kHz}}^{300 \text{ GHz}} \frac{H_k^2}{H_{Lk}^2} \leq 1$$

where

E_i is the E-field at frequency i ,

E_{Li} is the reference level according to Table 2 for an E-field at frequency i ,

H_k is the H-field at frequency k ,

H_{Lk} is the reference level according to Table 2 for an H-field at frequency k ,

$c = 8.7 \cdot 10^4 / \sqrt{f} \text{ V/m}$ and

$d = 7.3 \cdot 10^5 / f \text{ A/m}$. In both cases f is expressed in Hz.

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