COMMISSION OF THE EUROPEAN COMMUNITIES

Brussels, 27.05.1999
COM(1999)247 final

98/0166(COD)

AMENDED PROPOSAL FOR A RECOMMENDATION OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL

ON THE LIMITATION OF EXPOSURE OF THE GENERAL PUBLIC TO ELECTROMAGNETIC FIELDS 0 HZ-300 GHZ

(presented by the Commission pursuant to Article 250(2)
of the EC Treaty)

Explanatory Memorandum

In June 1998, the Commission presented to Council a Proposal for a Recommendation of the European Parliament and of the Council on the limitation of exposure of the general public to electromagnetic fields 0Hz-300GHz (COM(98)268 final).

The Council decided on 3 July 1998 to consult the European Parliament on that proposal, given the interest expressed by that institution on the subject. The President of the Parliament referred the proposal to the Committee on the Environment, Public Health and Consumer Protection, which nominated Mr TAMINO as rapporteur. On 28 November 1998, the Committee considered the Commission proposal and the rapporteur's draft report. The report was adopted by the Committee at its meeting of 18 February 1999.

On 10 March 1999, the European Parliament approved the Commission proposal as amended and adopted the legislative resolution.

The Commission has accepted fully or in part 9 of the Parliament's amendments, out of a total of 17.

Position regarding each of the amendments adopted by the European Parliament

Amendment 1: Opinion of the Commission: partially accepted.
Recital 1(a) (new).
This amendment refers to provisions in the Treaty which concern the protection from exposure to electromagnetic fields of workers; these are dealt with elsewhere than in the Recommendation.

Amendment 2: Opinion of the Commission: rejected.
Recital 1(b) (new).
This amendment covers principles falling outside the scope of Article 152(4) of the Treaty in so far as they refer to Community policy on the environment, which is not the subject matter of this Recommendation.

Amendment 3: Opinion of the Commission: accepted.
Recital 2.
The reference to "legislative" measures is not accurate. The Commission considers however that the amendment can be accepted because the Recommendation in question is itself a legislative measure, proposed under Article 152 of the Treaty. The amendment would regrettably seem to exclude non-legislative measures which may be taken, such as studies, reports or information campaigns.

Amendment 17: Opinion of the Commission: rejected.
Recital 4
The reference to "potentially harmful long-term effects" is imprecise. It is not clear how such effects could be identified. In any case, the set of basic restrictions and reference levels proposed by the Commission, include safety margins based on best available scientific advice.

Amendment 4: Opinion of the Commission: partially acceptable.
Recital 7.
The objective of protection of the health of citizens by means of Recommendations is fully in accordance with the provisions of Article 152(4). The use of the term "uniform" may however be over-restrictive.

Amendment 5: Opinion of the Commission: partially accepted.
Recital 8.
The references to scientific documentation, stringent basic restrictions and review are considered acceptable. The reference to the precautionary principle is not considered appropriate and the reference to "any possible public health hazard" is considered inapplicable.

Amendment 6: Opinion of the Commission: rejected
Recital 12a (new).
The reference to product compliance standards is inappropriate in a text based on Article

152(4) of the Treaty. This should be addressed in the context of Internal Market legislation.

Amendment 7: Opinion of the Commission: partially acceptable.
Recital 16.
The Commission could accept part of this amendment, retaining the reference to the review process, and making the reference to the International Commission on non-ionising radiation a particular part of this process.

Amendment 8: Opinion of the Commission: partially acceptable.
Recommendation II(b)
The first part of the amendment "according to the above framework", is acceptable as it clarifies the presentation of the text.

The second part of the amendment is vague in that it refers to "where the public live and spend significant time", which is not defined: the point concerning on-going research is covered by recommendation V, and the invitation to the Commission to keep the matters covered in the Recommendation under review.

Amendment 15 and 14: Opinion of the Commission: rejected.
Recommendation III and III(ba) new
These amendments recommend that Member States establish "minimum safety distances". In the Commission's view, Member States should be able to adopt a variety of measures, which may or may not involve safe distancing, as is appropriate in a given case. The Commission has already proposed for this purpose a set of basic restrictions and reference levels, based on the best available scientific data. The validity of the methodology proposed in these amendments remains unclear.

Amendment 10: Opinion of the Commission: accepted.
Recommendation V
The reference to the widest range of research sources is considered appropriate.

Amendment 11: Opinion of the Commission: partially accepted.
Recommendation V, 2nd subparagraph (new).
The reference to non-civil research has been included as part of the review process.

Amendment 12, 20 and 21: Opinion of the Commission: rejected.
"Invites"
The amendment goes beyond the areas covered in Article 152(4), which specifically exclude harmonisation of laws. Product safety rules are also excluded from the scope of this Recommendation.

Amendment 13: Opinion of the Commission: partially acceptable.
Annex II, 6th paragraph
The basic restrictions, based on recommendations of the International Commission on non-ionising radiation protection, already incorporate added safety factors. It may be useful to mention this.

INITIAL PROPOSAL **for a Council Recommendation on the limitation of exposure of the general public to electromagnetic fields 0Hz-300GHz** COM(1998)268final 98/0166 (CNS)	AMENDED PROPOSAL **for a Recommendation of the European Parliament and of the Council on the limitation of exposure of the general public to electromagnetic fields 0Hz-300GHz**
THE COUNCIL OF THE EUROPEAN UNION Having regard to the treaty establishing the European Community, and in particular Article 129 thereof;	THE EUROPEAN PARLIAMENT AND THE COUNCIL OF THE EUROPEAN UNION, Having regard to the Treaty establishing the European Community and in particular Article 152(4) thereof ;
Having regard to the proposal from of the Commission[1]	
Having regard to the opinion of the European Parliament[2]	
1. Whereas in accordance with point (o) of Article 3 of the Treaty, Community action must include a contribution towards the attainment of a high level of health protection;	1. Whereas in accordance with point (p) of Article 3 of the Treaty, Community action must include a contribution towards the attainment of a high level of health protection; Whereas the Treaty also makes provision for protecting the health of workers and of

[1] O.J. xxx, amended proposal O.J. xxx

[2] O.J. xxx

	consumers;
2. Whereas the European Parliament in its resolution on combating the harmful effects of non-ionising radiation[3] called on the Commission to propose measures seeking to limit the exposure of workers and the public to non-ionising electromagnetic radiation;	2. Whereas the European Parliament in its resolution on combating the harmful effects of non-ionising radiation[3] called on the Commission to propose legislative measures seeking to limit the exposure of workers and the public to non-ionising electromagnetic radiation;
3. Whereas Community minimum requirements for the protection of health and safety of workers in relation to electromagnetic fields exist for work with display screen equipment[4]; whereas Community measures were introduced to encourage improvements in the safety and health at work of pregnant workers and workers who have recently given birth or are breastfeeding[5] which oblige , *inter alia*, employers to assess activities which involve a specific risk of exposure to non-ionising	

[3] O.J. n° C 205, 25.7.94, p. 439

[3] O.J. n° C 205, 25.7.94, p. 439

[4] O.J. n° L 156, 21.6.90, p. 14-18

[5] O.J. n° L348, 28.11.92, p. 1-8

radiation; whereas minimum requirements have been proposed for the protection of workers from physical agents[6] which include measures against non-ionising radiation;	
4.Whereas it is imperative to protect members of the general public in the Community against established adverse health effects that may result as a consequence of exposure to electromagnetic fields;	
5. Whereas measures with regard to electromagnetic fields should afford all Community citizens a high level of protection; whereas provisions by Member States in this area should be based on a commonly agreed framework, so as to ensure consistency of protection throughout the Community;	
6. Whereas in accordance with the principle of subsidiarity, any new measure taken in an area which does not fall within the exclusive competence of the Community, such as non-ionising radiation protection of the public, may be taken up by the Community only if, by reasons of the scale or effects of the proposed action, the objectives proposed can be better achieved by the Community that by member States.	
7. Whereas there is a need to establish a Community framework for the protection of the public with regard to electromagnetic fields by means of recommendations to Member States;	7: Whereas there is a need to establish a Community framework with regard to exposure to electromagnetic fields, with the objective of protection of the public by means of recommendations to Member States;

[6] O.J. n° C 77, 18.3.93, p. 12 and O.J. n° C 230, 19.8.94, p. 3-29

8.Whereas this framework must be based on the best available scientific data and advice in this area and should comprise basic restrictions and reference levels on exposure to electromagnetic fields; whereas advice on this matter has been given by the International Commission on Non-Ionising radiation Protection (ICNIRP) and has been endorsed by the Commission's Scientific Steering Committee.	8: Whereas this framework which can draw on the large body of scientific documentation which already exists, must be based on the best available scientific data and advice in this area and should comprise basic restrictions and reference levels on exposure to electromagnetic fields; whereas advice on this matter has been given by the International Commission on Non-Ionising radiation Protection (ICNIRP) and has been endorsed by the Commission's Scientific Steering Committee and has to be regularly reviewed and reassessed in the light of new knowledge and developments in technology and applications of sources and practices giving rise to exposure to electromagnetic fields;
9. Whereas such basic restrictions and reference levels should apply to all radiation emitted by electromagnetic fields with the exception of optical radiation and ionising radiation; whereas for the former relevant scientific data and advice still requires additional consideration, and whereas for the latter Community provisions already exist;	
10. Whereas adherence to the recommended restrictions and reference levels should provide a high level of protection in respect of established health effects that may result from exposure to electromagnetic fields, but may not necessarily avoid interference problems with, or effects on the functioning of, medical devices such as metallic prostheses, cardiac pacemakers and defibrillators, and cochlear implants; whereas	

interference problems with pacemakers may occur at levels below the recommended reference levels and should be the object of appropriate precautions which, however, are not within the scope of this recommendation;	
11. Whereas, in accordance with the principle of proportionality, this recommendation must set general principles and methods of protection for members of the public while leaving it to the Member States to provide for detailed rules for sources and practices giving rise to exposure to electromagnetic fields and the classification of conditions of exposure of individuals as work-related or not, account taken of and in accordance with, Community provisions concerning the safety and health protection of workers;	
12. Whereas Member States may provide for a higher level of health protection than that reflected in these recommendations;	
13. Whereas measures by the Member States in this area, whether binding or non-binding and the way they have taken into account these recommendations should be the object of reports at national and Community level;	
14. Whereas in order to increase awareness of risks and measures of protection against electromagnetic fields the Member States should promote the dissemination of information, and rules of practice in this field, in particular with regard to the design, installation and use of equipment, so as to aim to obtain that levels of exposure will not exceed the recommended restrictions;	

15. Whereas attention should be paid to appropriate understanding and communication on risk related to electromagnetic fields taking into account public perceptions of such risks;	
16. Whereas the Member States should take note of progress made in scientific knowledge and technology with respect to non-ionising radiation protection; whereas these recommendations should be reviewed in particular in the light of guidance by competent international organisations such as the International Commission on Non-Ionising Radiation Protection;	16: Whereas the Member States should take note of progress made in scientific knowledge and technology with respect to non-ionising radiation protection and provide for regular scrutiny and review with assessment made regularly in the light of guidance by competent international organisations such as the International Commission on Non-Ionising Radiation Protection
HEREBY RECOMMENDS THAT	
I. Member States assign for the purpose of this Recommendation to the physical quantities listed in Annex I.A. the meaning given to them therein;	
II. Member States, in order to provide for a high level of health protection against exposure to electromagnetic fields: a) adopt framework of basic restrictions and reference levels using as a basis that given in Annex I.B.;	
b) implement measures in respect of sources or practices giving rise to exposure of the general public to electromagnetic fields on the basis of such a framework;	b) implement measures according to the above-mentioned framework, in respect of sources or practices giving rise to electromagnetic exposure of the general public with the exception of exposure for medical purposes where the risks and benefits of

	exposure, above the basic restrictions, must be properly weighed;
c) aim to achieve respect of the basic restrictions given to Annex II for public exposure;	
III. Member States, in order to facilitate and promote respect of the basic restrictions given in Annex II;	
a) use the reference levels given in Annex III for exposure assessment purposes to determine whether the basic restrictions are likely to be exceeded;	
b) evaluate situations involving sources of more than one frequency in accordance with the formulas set up in Annex IV, both in terms of basic restrictions and reference levels;	
IV. Member States, in order to increase understanding of risks and protection against exposure to electromagnetic fields:	
Provide in an appropriate format information to the public on the health impact of electromagnetic fields and the measures taken to address them;	
V. Member States, in order to enhance knowledge about the health effects of electromagnetic fields	
Promote and review research relevant to EMF and human health in the context of their national research programmes, taking into account Community and international research recommendations and efforts;	Promote and review research relevant to EMF and human health in the context of their national research programmes, taking into account Community and international research recommendations and efforts, from the widest possible range of sources;

VI. Member States, in order to contribute to the establishment of a consistent system of protection against risks of exposure to electromagnetic fields;	
Prepare reports on the adoption and implementation of measures that they take in the field covered by this Recommendation, and inform the Commission thereof after a period of three years following the adoption of this Recommendation, indicating how the latter has been taken into account in these measures;	
INVITES	
The Commission to prepare a report for the Community as a whole taking into account the reports of the Member States, and keep the matters covered in this recommendation under review, with a view to its revision and up dating.	
Done at Brussels, for the Council The PRESIDENT	Done at Brussels, for the European Parliament and the Council The President
ANNEX I **DEFINITIONS**	

In the context of this recommendation, the term electromagnetic fields include static fields, extremely low frequency (ELF) fields and radio-frequency (RF) fields, including microwaves, encompassing the frequency range of 0 Hz to 300 GHz.	
A. Physical Quantities In the context of EMF exposure, eight physical quantities are commonly used:	
1. *Contact current* (I_C) between a person and an object is expressed in amperes (A). A conductive object in an electric field can be charged by the field.	
2. *Current density* (J) is defined as the current flowing through a unit cross section perpendicular to its direction in a volume conductor such as the human body or part of it, expressed in amperes per square metre (A/m^2).	
3. *Electric field strength* is a vector quantity (E) that corresponds to the force exerted on a charged particle regardless of its motion in space. It is expressed in volts per metre (V/m).	
4. *Magnetic field strength* is a vector quantity (H), which, together with the magnetic flux density, specifies a magnetic field at any point in space. It is expressed in amperes per metre (A/m).	
5. *Magnetic flux density* is a vector quantity (B), resulting in a force that acts on moving charges, it is expressed in teslas (T). In free space and in biological materials, magnetic flux density and magnetic field strength can be interchanged using the equivalence 1 A $m^{-1} = 4\pi$ 10^{-7} T.	

6. *Power density* (S) is the appropriate quantity used for very high frequencies, where the depth of penetration in the body is low. It is the radiant power incident perpendicular to a surface, divided by the area of the surface and is expressed in watts per square metre (W/m^2).	
7. *Specific energy absorption* (SA) is defined as the energy absorbed per unit mass of biological tissue, expressed in joules per kilogram (J/kg). In these recommendations it is used for limiting non-thermal effects from pulsed microwave radiation.	
8. *Specific energy absorption rate* (SAR) averaged over the whole body or over parts of the body, is defined as the rate at which energy is absorbed per unit mass of the body tissue and is expressed in watts per kilogram (W/kg). Whole body SAR is a widely accepted measure for relating adverse thermal effects to RF exposure. Besides the whole body average SAR, local SAR values are necessary to evaluate and limit excessive energy deposition in small parts of the body resulting from special exposure conditions. Examples of such conditions are: a grounded individual exposed to RF in the low MHz range and individuals exposed in the near field of an antenna. Of these quantities, magnetic flux density, contact current, electric and magnetic field strengths and power density can be measured directly.	
B. Basic restrictions and reference levels	
For the application of restrictions based on the assessment of possible health effects of electromagnetic fields, differentiation should be made between basic restrictions and reference levels.	
– *Basic restrictions.* Restrictions on exposure to time-varying electric,	

magnetic, and electromagnetic fields that are based directly on established health effects and biological considerations are termed "basic restrictions". Depending upon the frequency of the field, the physical quantities used to specify these restrictions are magnetic flux density (B), current density (J), specific energy absorption rate (SAR), and power density (S). Magnetic flux density and power density can be readily measured in exposed individuals.	
– *Reference levels.* These levels are provided for practical exposure assessment purposes to determine if the basic restrictions are likely to be exceeded. Some reference levels are derived from relevant basic restrictions using measurements and/or computational techniques and some address perception and adverse indirect effects of exposure to EMFs. The derived quantities are electric field strength (E), magnetic field strength (H), magnetic flux density (B), power density (S), and limb current (I_L). Quantities that address perception and other indirect effects are (contact) current (I_C) and, for pulsed fields, specific energy absorption (SA). In any particular exposure situation, measured or calculated values of any of these quantities can be compared with the appropriate reference level. Respect of the reference level will ensure respect of the relevant basic restriction. If the measured value exceeds the reference level, it does not necessarily follow that the basic restriction will be exceeded. Under such circumstances, however, there is a need to establish whether there is respect of the basic restriction.	
Quantitative restrictions on static electric fields are not given in these recommendations. However, it is recommended that annoying perception of surface electric charges and spark discharges causing	

stress or annoyance should be avoided. Some quantities such as the magnetic flux density (B) and the power density (S) serve both as basic restrictions and reference levels, at certain frequencies (see Annex II and III).	
ANNEX II **BASIC RESTRICTIONS**	
Depending on frequency, the following physical quantities (dosimetric / exposimetric quantities) are used to specify the basic restrictions on electromagnetic fields: Between 0 and 1 Hz basic restrictions are provided for magnetic flux density for static magnetic fields (0 Hz) and current density for time varying fields up to 1 Hz, in order to prevent effects on the cardiovascular and central nervous system. Between 1 Hz and 10 MHz basic restrictions are provided for current density to prevent effects on nervous system functions. Between 100 kHz and 10 GHz basic restrictions on SAR are provided to prevent whole-body heat stress and excessive localised heating of tissues. In the range 100 kHz to 10 MHz, restrictions on both current density and SAR are provided. Between 10 GHz and 300 GHz basic restrictions on power density are	

provided to prevent heating in tissue at or near the body surface. The basic restrictions, given in Table 1, are set so as to account for uncertainties related to individual sensitivities, environmental conditions, and for the fact that the age and health status of members of the public vary.	The basic restrictions, given in Table 1, include appropriate safety factors in respect of established health effects; they are set so as to account for uncertainties related to individual sensitivities, environmental conditions, and for the fact that the age and health status of members of the public vary.
Table 1: Basic restrictions for electric, magnetic and electromagnetic fields (0 Hz - 300 GHz).	

Frequency range	Magnetic flux density (mT)	Current density (mA/m^2) (rms)	Whole body average SAR (W/kg)	Localised SAR (head and trunk) (W/kg)	Localised SAR (limbs) (W/kg)	Power density, S (W/m^2)
0 Hz	40	–	–	–	–	–
>0-1 Hz	–	8	–	–	–	–
1-4 Hz	–	8/f	–	–	–	–
4 - 1000 Hz	–	2	–	–	–	–
1000 Hz -100 kHz	–	f/500	–	–	–	–
100 kHz - 10 MHz	–	f/500	0.08	2	4	–
10 MHz - 10 GHz	–	–	0.08	2	4	–
10 - 300GHz	–	–	–	–	–	10

Notes

1. f is the frequency in Hz.
2. The basic restriction on the current density is intended to protect against acute exposure effects on central nervous system tissues in

the head and trunk of the body and includes a safety factor 3. Because of electrical inhomogeneity of the body, current densities should be averaged over a cross section of 1 cm^2 perpendicular to the current direction. 4. For frequencies up to 100 kHz, peak current density values can be obtained by multiplying the rms value by $\sqrt{2}$ (~1.414). For pulses of duration t_p the equivalent frequency to apply in the basic restrictions should be calculated as $f = 1/(2t_p)$. 5. For frequencies up to 100 kHz and for pulsed magnetic fields, the maximum current density associated with the pulses can be calculated from the rise/fall times and the maximum rate of change of magnetic flux density. The induced current density can then be compared with the appropriate basic restriction. 6. All SAR values are to be averaged over any 6-minute period. 7. Localised SAR averaging mass is any 10 g of contiguous tissue; the maximum SAR so obtained should be the value used for the estimation of exposure. 8. For pulses of duration t_p the equivalent frequency to apply in the basic restrictions should be calculated as $f = 1/(2t_p)$. Additionally, for pulsed exposures, in the frequency range 0.3 to 10 GHz and for localised exposure of the head, in order to limit and avoid auditory effects caused by thermo-elastic expansion, an additional basic restriction is recommended. This is that the SA should not exceed 2mJ kg^{-1} averaged over 10 g of tissue.	

ANNEX III **Reference Levels**	
Reference levels of exposure are provided for the purpose of comparison with values of measured quantities. Respect of all recommended reference levels will ensure respect of basic restrictions. If the quantities of measured values are greater than the reference levels , it does not necessarily follow that the basic restrictions have been exceeded. In this case, an assessment should be made as to whether exposure levels are below the basic restrictions.	
The reference levels for limiting exposure are obtained from the basic restrictions for the condition of maximum coupling of the field to the exposed individual, thereby providing maximum protection. A summary of the reference levels is given in Tables 2 and 3. The reference levels are generally intended to be spatially averaged values over the dimension of the body of the exposed individual, but with the important proviso that the localised basic restrictions on exposure are not exceeded. In certain situations where the exposure is highly localised, such as with hand-held telephones and the human head, the use of reference levels is not appropriate. In such cases respect of the localised basic restriction should be assessed directly.	
Field levels Table 2: Reference levels for electric, magnetic and	

electromagnetic fields (0 Hz - 300 GHz, unperturbed rms values).	

Frequency range	E-field strength (V/m)	H-field strength (A/m)	B-field (μT)	Equivalent plane wave power density (W/m^2) S_{eq}
0-1 Hz	-	3.2×10^4	$4x10^4$	-
1-8 Hz	10,000	$3.2x10^4/f^2$	$4x10^4/f^2$	-
8 – 25 Hz	10,000	4,000/f	5,000/f	-
0.025 - 0.8 kHz	250/f	4/f	5/f	-
0.8 – 3 kHz	250/f	5	6.25	-
3 – 150 kHz	87	5	6.25	-
0.15 - 1 MHz	87	0.73/f	0.92/f	-
1-10 MHz	$87/f^{1/2}$	0.73/f	0.92/f	-
10 – 400 MHz	28	0.073	0.092	2
400 - 2000 MHz	$1.375\ f^{1/2}$	$0.0037\ f^{1/2}$	$0.0046\ f^{1/2}$	f/200
2 – 300 GHz	61	0.16	0.20	10

Notes: 1. f as indicated in the frequency range column. 2. For frequencies between 100 kHz and 10 GHz, S_{eq}, E^2, H^2, and B^2 are to averaged over any 6-minute period. 3. For frequencies exceeding 10 GHz, S_{eq}, E^2 , H^2, and B^2 are to be averaged over any $68/f^{1.05}$-minute period (f in GHz). 4. No E-field value is provided for frequencies <1 Hz, which are effectively static electric fields. For most people the annoying perception of surface electric charges will not occur at field strengths less than 25 kV/m. Spark discharges causing stress or annoyance should be avoided.	
For peak values, the following reference levels apply to the E-field strength (V/m), H-field strength (A/m) and the B-field (μT):	
– For frequencies up to 100 kHz, peak reference values are obtained by multiplying the corresponding rms values by $\sqrt{2}$ (~1.414). For pulses of duration t_p the equivalent frequency to apply should be calculated as $f = 1/(2t_p)$. – For frequencies between 100 kHz and 10 MHz peak reference values are obtained by multiplying the corresponding rms values by 10^{α} , where $\alpha = (0.665 \log(f/10^5)+0.176)$, f in kHz. -For frequencies between 10 MHz and 300 GHz peak reference values	

are obtained by multiplying the corresponding rms values by 32	
Although little information is available on the relation between biological effects and peak values of pulsed fields, it is suggested that, for frequencies exceeding 10 MHz, S_{eq} as averaged over the pulse width should not exceed 1000 times the reference levels or that field strengths should not exceed 32 times the fields strength reference levels. For frequencies between about 0.3 GHz and several GHz and for localised exposure of the head, in order to limit or avoid auditory effects caused by thermo-elastic expansion, the specific absorption from pulses must be limited. In this frequency range, the threshold SA of 4-16 mJ kg^{-1} for producing this effect corresponds, for 30-μs pulses, to peak SAR values of 130-520 W kg^{-1} in the brain. Between 100 kHz and 10 MHz, peak values for the fields strengths are obtained by interpolation from the 1.5-fold peak at 100 kHz to the 32-fold peak at 10 MHz.	
Contact currents and limb currents For frequencies up to 110 MHz additional reference levels are recommended to avoid hazards due to contact currents. The contact current reference levels are presented in Table 3. The reference levels on contact current were set to account for the fact that the threshold contact currents that elicit biological responses in adult women and children are approximately two-thirds and one-half, respectively, of those for adult men. Table 3: Reference levels for contact currents from conductive objects (f in kHz)	

Frequency range	Maximum contact current (mA)
0 Hz - 2.5 kHz	0.5
2.5 kHz - 100 kHz	0.2 f
100 kHz - 110 MHz	20

For the frequency range 10 MHz to 110 MHz, a reference level of 45 mA in terms of current through any limb is recommended. This is intended to limit the localised SAR over any 6-minute period	
ANNEX IV **Exposure from sources with multiple frequencies**	
In situations where simultaneous exposure to fields of different frequencies occurs, the possibility that these exposures will be additive in their effects must be considered. Calculations based on such additivity should be performed separately for each effect; thus separate evaluations should be made for thermal and electrical stimulation effects on the body.	
Basic restrictions In the case of simultaneous exposure to fields of different frequencies, the following criteria should be satisfied in terms of the basic restrictions.	
For electric stimulation, relevant for frequencies from 1 Hz up to 10 MHz, the induced current densities should be added according to: $\sum_{i=1Hz}^{10MHz} \frac{J_i}{J_{L,i}} \leq 1$	

For thermal effects, relevant from 100 kHz, specific energy absorption rates and power densities should be added according to: $$\sum_{i=100kHz}^{10GHz} \frac{SAR_i}{SAR_L} + \sum_{i>10GHz}^{300GHz} \frac{S_i}{S_L} \leq 1$$	
where J_i is the current density at frequency i; $J_{L,i}$ is the current density basic restriction at frequency i as given in Table 1; SAR_i is the SAR caused by exposure at frequency i; SAR_L is the SAR basic restriction given in Table 1; S_i is the power density at frequency i; S_L is the power density basic restriction given in Table 1.	
Reference levels For application of the basic restrictions, the following criteria regarding reference levels of field strengths should be applied.	
For induced current densities and electrical stimulation effects, relevant up to 10 MHz, the following two requirements should be applied to the field levels:	

$$\sum_{i=1Hz}^{1MHz} \frac{E_i}{E_{L,i}} + \sum_{i>1MHz}^{10MHz} \frac{E_i}{a} \leq 1$$ and $$\sum_{j=1Hz}^{150kHz} \frac{H_j}{H_{L,j}} + \sum_{j>150kHz}^{10MHz} \frac{H_j}{b} \leq 1$$	
where E_i is the electric field strength at frequency i; $E_{L,i}$ is the electric field strength reference level from Table 2; H_j is the magnetic field strength at frequency j; $H_{L,j}$ is the magnetic field strength reference level from Table 2; a is 87 V/m and b is 5 A/m (6.25 μT).	
Compared to the ICNIRP guidelines[1] which deal with both occupational and general public exposure, cut-off points in the summations correspond to exposure conditions for members of the public.	

[1] **International Commission on Non-Ionizing Radiation Protection. Guidelines for Limiting Exposure to Time-Varying Electric, Magnetic, and Electromagnetic Fields (up to 300 GHz). Health Phys.; in press**

The use of the constant values (a and b) above 1 MHz for the electric field and above 150 kHz for the magnetic field is due to the fact that the summation is based on induced current densities, and should not be mixed with thermal effect circumstances. The latter forms the basis for $E_{L,i}$ and $H_{L,j}$ above 1 MHz and 150 kHz respectively, found in Table 2.	
For thermal effect circumstances, relevant from 100 kHz, the following two requirements should be applied to the field levels: $$\sum_{i=100kHz}^{1MHz} \left(\frac{E_i}{c}\right)^2 + \sum_{i>1MHz}^{300GHz} \left(\frac{E_i}{E_{L,i}}\right)^2 \leq 1$$ and where $$\sum_{j=100kHz}^{150kHz} \left(\frac{H_j}{d}\right)^2 + \sum_{j>150kHz}^{300GHz} \left(\frac{H_j}{H_{L,j}}\right)^2 \leq 1$$	
E_i is the electric field strength at frequency i; $E_{L,i}$ is the electric field reference level from Table 2; H_j is the magnetic field strength at frequency j;	

$H_{L,j}$ is the magnetic field reference level derived from Tables 2; c is $87/f^{1/2}$ V/m and d 0.73/f A/m.	
Again, compared to the ICNIRP guidelines some cut off points have been adjusted for public exposure only. For limb current and contact current, respectively, the following requirements should be applied:	
$\sum_{k=10MHz}^{110MHz}\left(\frac{I_k}{I_{L,k}}\right)^2 \le 1 \qquad \sum_{n=1Hz}^{110MHz}\frac{I_n}{I_{C,n}} \le 1$ where I_k is the limb current component at frequency k; $I_{L,k}$ is the reference level for limb current, 45 mA; I_n is the contact current component at frequency n; $I_{C,n}$ is the reference level for contact current at frequency n (see Table 3).	
The above summation formulae assume worst-case phase conditions among the fields from the multiple sources. As a result, typical exposure situations may in practice result in less restrictive exposure levels than indicated by the above formulae for the reference levels.	

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