

SAFETY LEVEL WITH RESPECT TO HUMAN EXPOSURE TO RADIOFREQUENCY
ELECTROMAGNETIC FIELDS (300 KHz-100 GHz)*

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Summary: The development of safety guides for human exposure to radiofrequency fields (RFF) must be based principally upon the results of animal experiments since, with the exception of obvious heating effects, there is a paucity of quantitative data relating to the action of these fields on mankind. In using the results of animal experiments, one must be careful to distinguish the difference between exposure fields and the fields in the tissues that produce the biological action. This difference, which varies markedly with frequency, body size, and exposure conditions, must be accounted for in the use of animal data for predicting safe human exposure levels over a broad frequency range. Based on a critical evaluation of the world literature on the subject, it is the consensus of the ANSI Subcommittee C95.4 (charged with developing voluntary safety standards for human exposure to RFF) that fields in the tissues should be restricted to levels that would limit average specific absorption rate (SAR) of the energy to less than 0.4 W/Kg. This led to recommended exposure fields equivalent to 100 mW/cm², for frequencies (f) 0.3 MHz to 3 MHz; $900/f^2$ mW/cm², 3 MHz to 30 MHz; 1 mW/cm², 30 MHz to 300 MHz; $f/300$ mW/cm², 300 MHz to 1500 MHz; 5 mW/cm², 1.5 GHz to 100 GHz.

1. SCOPE OF PURPOSE

Recommendations are made to prevent possible harmful effects in human beings exposed to electromagnetic fields in the frequency range from 300 kHz to 100 GHz. These recommendations are not intended to apply to the purposeful exposure of patients by or under the direction of practitioners of the healing arts.

2. DEFINITIONS

Radiofrequency protection guide (RFPG): The radio-frequency field strength or equivalent power density (mW/cm²) which should not be exceeded without (1) careful consideration of the reasons for doing so, (2) careful estimation of the increased energy deposition in the human body, and (3) careful consideration of the increased risk of unwanted biological effects. Measurements to determine adherence to the recommended protection guides shall be made at distances 5 cm or greater from any object (refer to ANSI C95.3 guide for RF measurements).

3. RECOMMENDATIONS

For human exposure to electromagnetic energy of radiofrequencies from 300 kHz to 100 GHz, the radio-frequency protection guides, in terms of equivalent plane wave free space power density, and in terms of the mean squared electric (E²) and magnetic (H²) field strengths as a function of frequency, are given in Table 1.

For near field exposure, the only applicable radio-frequency protection guides are the mean squared electric and magnetic field strengths given in Table 1, columns (3) and (4). For convenience, these guides may be expressed in equivalent plane wave power density.

For both pulsed and non-pulsed fields, the power density and the squares of the field strengths, as applicable, are averaged over any 0.1 hour period and should not exceed the values given in Table 1.

For mixed or broadband fields consisting of a number of frequencies for which there are different values of radiofrequency protection guide, the fraction of the radiofrequency protection guide incurred within each frequency interval should be determined, and the sum of all such fractions should not exceed unity.

Exclusion: For frequencies between 300 kHz and 1.0 GHz, it is permissible to exceed the protection guides in Table 1 if the averaged rate of energy absorption is less than 7 watts in the human body.

4. EXPLANATION

Exposure to electromagnetic fields in the frequency range under consideration is but one of the several sources of energy input into the body, which requires wide ranges of energy production and dissipation in order to function. For situations involving exposure of the whole body, the radiofrequency protection guide is believed to result in energy deposition averaged over the entire body mass for any 0.1 hour period of about 144 joules per kilogram (J/kg) or less. This is equivalent to a specific absorption rate (SAR) of about 0.40 watts per kilogram (W/kg) spatially and temporally averaged over the entire body mass.

Biological effects data applicable to humans for all possible combinations of frequency and modulation do not exist. The radiofrequency protection guide, therefore, has been based on the best available interpretations of the literature and it is intended to eliminate adverse effects on the functioning of the human body.

The exclusion to the protection guides can be used in relation to fields from low power devices such as hand-held, mobile, and marine radio transceivers. These devices may emit localized fields exceeding the protection guides, but will result in a significantly lower rate of energy absorption than allowed for the whole body. Thus, exposure to fields emitted by devices operating at 1 GHz or less and with less than 7 watts output power would not be restricted. Exposure to fields from devices with greater output power require a case-by-case analysis to determine if the exclusion criterion is applicable.

Where exposure conditions are not precisely known or controlled, exposure reduction should be accomplished by reliable means to values as low as are reasonably achievable. Exposures slightly in excess of the radiofrequency protection guides are not necessarily harmful; however, they are not desirable and should be prevented wherever possible.

*As recommended by ANSI C95 Subcommittee IV. Submitted to the parent committee C95 for consideration April 1980. Vote of acceptance or rejection not known at time of publication.

TABLE 1
RADIOFREQUENCY PROTECTION GUIDES

(1) Frequency Range (MHz)	(2) Power Density (mW/cm ²)	(3) E ² (V ² /m ²)	(4) H ² (A ² /m ²)
0.3 - 3	100	400,000	2.5
3 - 30	900/f ²	4,000 (900/f ²)	0.025 (900/f ²)
30 - 300	1.0	4,000	0.025
300 - 1500	f/300	4,000 (f/300)	0.025 (f/300)
1500 - 100,000	5	20,000	0.125

Note: f is the frequency, in megahertz (MHz)