

ICNIRP's draft HF guidelines

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Work in progress!!

No final decisions made.

Numbers preliminary.

Scope

- Limit exposure to high-frequency EMFs (100 kHz – 300 GHz)
- Provide protection against adverse health effects to humans
- Consider occupational and general public exposure
- Consider direct and indirect exposure (but only contact with charged objects)
- Not included:
 - Electromagnetic interference
 - Exposure for medical purposes
 - Compliance issues (e.g. measurement)

Principles

- Identification of scientific data on effects of exposure on biological systems
- Determination of effects considered both
 - adverse to humans and
 - scientifically substantiated (independent replication, sufficient quality, scientifically explicable generally)
- Identification of 'health effect threshold' (needs sufficient data)
- Alternatively set 'operational threshold' (based on exposure-effect relation)
- Provide a criterion for a reasonable level of protection

Principles (cont.)

- Application of reduction factors to thresholds
 - account for scientific uncertainty, relative importance of the health effect, variation across the population
 - reduction factors may differ based on these parameters
- **ICNIRP applies conservatism at a number of stages of the guideline setting process.**
All restrictions are considered conservative estimates that will remain protective unless they are exceeded by a substantial margin.

Scientific basis

- Available major EMF reviews + original papers not included in the reviews
 - there is an extensive body of relevant literature, ranging from cellular research to cancer epidemiology
 - research has only found evidence of potentially harmful effects from:
 - electrostimulation
 - electroporation
 - microwave hearing (thermal effect)
 - temperature elevations above thresholds

Scientific basis (cont.)

- No evidence that HF-EMF causes such diseases as cancer
- No evidence that HF-EMF impairs health beyond effects that are due to established mechanisms of interaction
- In addition the thermo-biology literature was considered

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Interaction mechanisms (temperature elevation)

- Temperature increases taken to represent health effects, and restrictions set to avoid these
- Health effects primarily related to T
- T is dependent on many factors that are independent of EMF, such as environmental temperature and work rate
- Therefore: ΔT indicative of health effects assuming thermonormal baseline state

Body core temperature

- Mean body core temperature (approximately 37 °C) typically varies over the day by 0.5 °C
 - thermoregulatory functions (e.g. vasodilation, sweating) to keep body core temperature in thermonormal range
 - most health effects induced by hyperthermia (> 38°C) resolve readily with no lasting effects, but risk of accident and heat stroke increases
- $\Delta T > 1$ °C in body core is defined as potentially harmful
- RF modelling predicts:
 - 3-4 W kg⁻¹ WBA SAR over 2 hours induce $\Delta T \approx 0.5$ °C
 - 6-7 W kg⁻¹ WBA SAR may results in $\Delta T \approx 1$ °C (consistent with the limited human measurement research)
- **ICNIRP suggests an operational threshold of 4 W kg⁻¹ (6 min avg.)**

Local temperature

- Excessive localized heat can cause pain and damage cells. There is a substantial body of literature showing that tissue damage can occur at temperatures $> 41-43$ °C (time dependent)
- Thermonormal brain and abdomen temperature is typically < 38 °C, and that of the extremities (including skin and pinna) < 36 °C
- Local temperatures > 40 °C should be avoided
- $\Delta T > 2$ °C in the head, torso, testes, eyes considered potentially harmful
- $\Delta T > 4$ °C in the extremities (limbs, skin, pinna) considered potentially harmful

Local temperature (cont.)

- Modelling/extrapolation suggests:
 - ≤ 6 GHz a SAR_{10g} of 10 W kg^{-1} results in $\Delta T \leq 2 \text{ }^\circ\text{C}$ ($20 \text{ W kg}^{-1} / \leq 4^\circ\text{C}$)
 - at 6 GHz, 400 W m^{-2} results in $\Delta T \approx 4 \text{ }^\circ\text{C}$
- **ICNIRP suggests:**
 - **up to 6 GHz:**
 - **operational threshold 10 W kg^{-1} for head, torso, testes, eyes**
 - **20 W kg^{-1} for extremities**
 - **above 6 GHz:**
 - **400 W m^{-2}**

Electrostimulation

- Electrostimulation effects described in ICNIRP ELF Guidelines (2010); not considered here

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Electroporation

- Intense electric field pulses of short duration: may cause reversible or permanent dielectric breakdown of cell membranes
- From laboratory conditions (t_p = pulse duration):
- **ICNIRP:**
 - operational threshold 10 kV m^{-1} ($t_p > 0.1 \text{ }\mu\text{s}$)
 - $10 t_p / 0.1 \text{ kV m}^{-1}$ ($t_p < 0.1 \text{ }\mu\text{s}$)

Microwave hearing

- Microwave hearing can occur from brief HF pulses (300 MHz-10 GHz)
- **ICNIRP:**
 - **threshold: 4 mJ kg⁻¹ (0.1 sec avg.)**

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Averaging

- Averaging mass
 - under discussion (smaller mass for short exposure durations?)
 - Shape: under discussion
 - keep as it is, include multiple tissue types
 - use compact shape (e.g. a flexible cube)
 - Limit surface to volume ratio
- Averaging time
 - 6 minutes up to ~6 GHz; above decrease for PD

Reference levels

- Will be derived using numerical dosimetry
 - far field exposure
 - such that, under normal conditions, all basic restrictions are kept

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Next steps

- Will be discussed again in meeting end September
- Need to resolve number of details (e.g. reference levels)
- Next meeting early December
- Hopefully: draft for public consultation ready by end December

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Thanks for your attention and your patience!