

Recommendations for static and ELF fields

Rüdiger Matthes
Federal Office for Radiation Protection
Germany



Outline

- General aspects and concepts
- Static field guidelines
- ELF guidelines
- Prospect



6th International NIR Workshop
October 14th to 17th, 2008, Rio de Janeiro, Brazil



General aspects and concepts



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Bundesamt für Strahlenschutz

ICNIRP guidelines

Current guidelines

- | | |
|--|------|
| ➤ 50 Hz electric and magnetic fields (interim) | 1990 |
| ➤ Static magnetic fields | 1994 |
| ➤ Time-varying EMF > 0 Hz -300 GHz | 1998 |

Under revision

- Static magnetic fields
- Time varying electric and magnetic fields up to 100 kHz

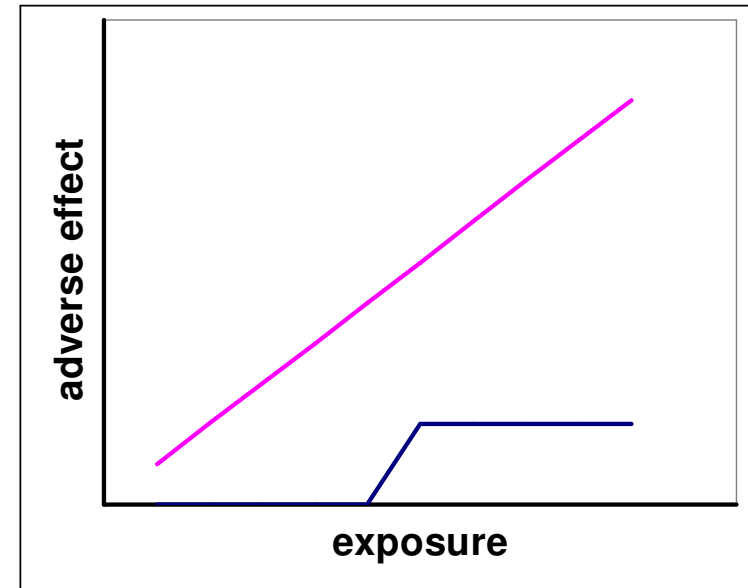


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ICNIRP guidelines

- Protection from known health hazards
- Based on scientific evidence
 - Result from a careful analysis of the literature that considers direct and indirect, acute and chronic effects
- Quantitative relationship between exposure and adverse effect
- Safety (reduction) factors to consider uncertainties in the database and biological variability



- * All known adverse effects in this context are characterised by a threshold

Guideline basis

- Adverse effect with lowest threshold
- Uncertainties considered
 - often no rigorous basis
 - expert judgment
- Exposure conditions considered (e.g. occupational, medical)



Guideline concept

- **Basic restrictions**
in terms of biologically effective quantities
- **Reference levels**
in terms of external field quantities
Exposure below reference levels ensures compliance with basic restrictions, since the relations between them have been developed under worst-case conditions.
- **Two tiers**
general public
occupational

* No guideline for medical exposure but advice through statements



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Biologically effective quantities

static magnetic field	Magnetic flux density	T
up to 100 kHz (10 MHz)	In situ current density	mA m ⁻²
	In situ electric field	V m ⁻¹

Static field guidelines

* Guidelines on limits of exposure to static magnetic fields, Health Physics, vol. 66, 1994



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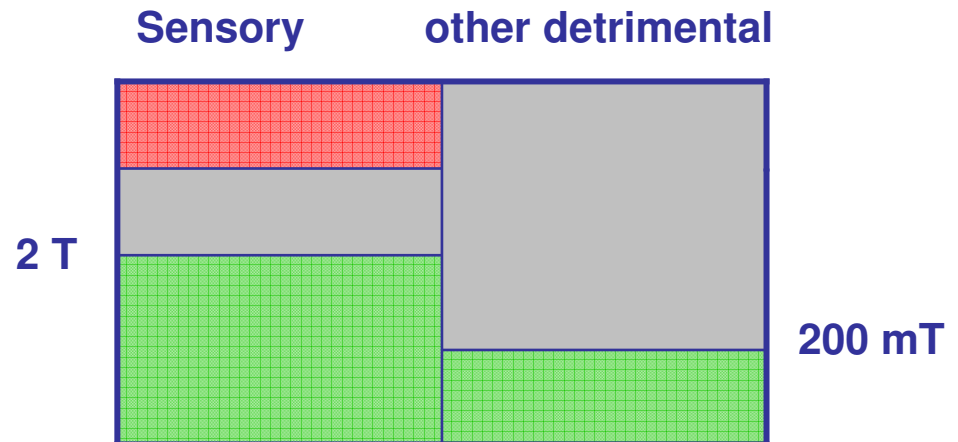
Adverse effects of static fields

➤ Electric fields

- Insufficient evidence
- Spark discharges
- Contact currents

➤ Magnetic fields

- Annoyance (vertigo, nausea, phosphenes) due to movement in the field
- No detrimental effects on developmental, behavioral and physiological parameters up to 2 T
- Lack of knowledge re long-term exposure, but from established mechanisms 200 mT were assumed safe
- Interference with electronic implants and ferromagnetic objects



Exposure limits for static magnetic fields

Occupational

- Whole body, continuous, averaged per workday 200 mT
- Ceiling value 2 T
- Limbs 5 T

General public

- Continuous 40 mT
- Occasionally, appropriately controlled up to occupational limits

* Limits for homogeneous fields, otherwise average over 100 cm²

** No reference levels



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Additional considerations for static magnetic fields

- Cardiac pacemaker interference (0,5 mT)
- Other electronic implants (?)
- Ferromagnetic implants (few mT)
- Hazard from flying metallic objects (precaution above 3 mT)
- Analog watches, credit cards, computer discs (above 1 mT)

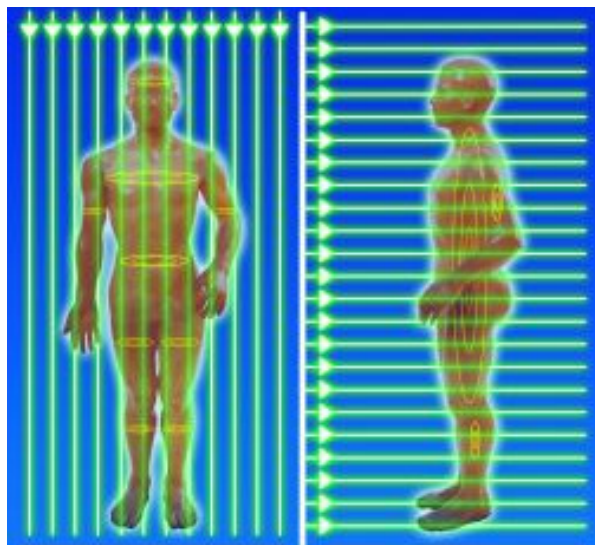
ELF guidelines

* Guidelines for limiting exposure to time-varying electric, magnetic, and electromagnetic fields (up to 300 GHz), Health Physics, Volume 74, Number 4, 1998



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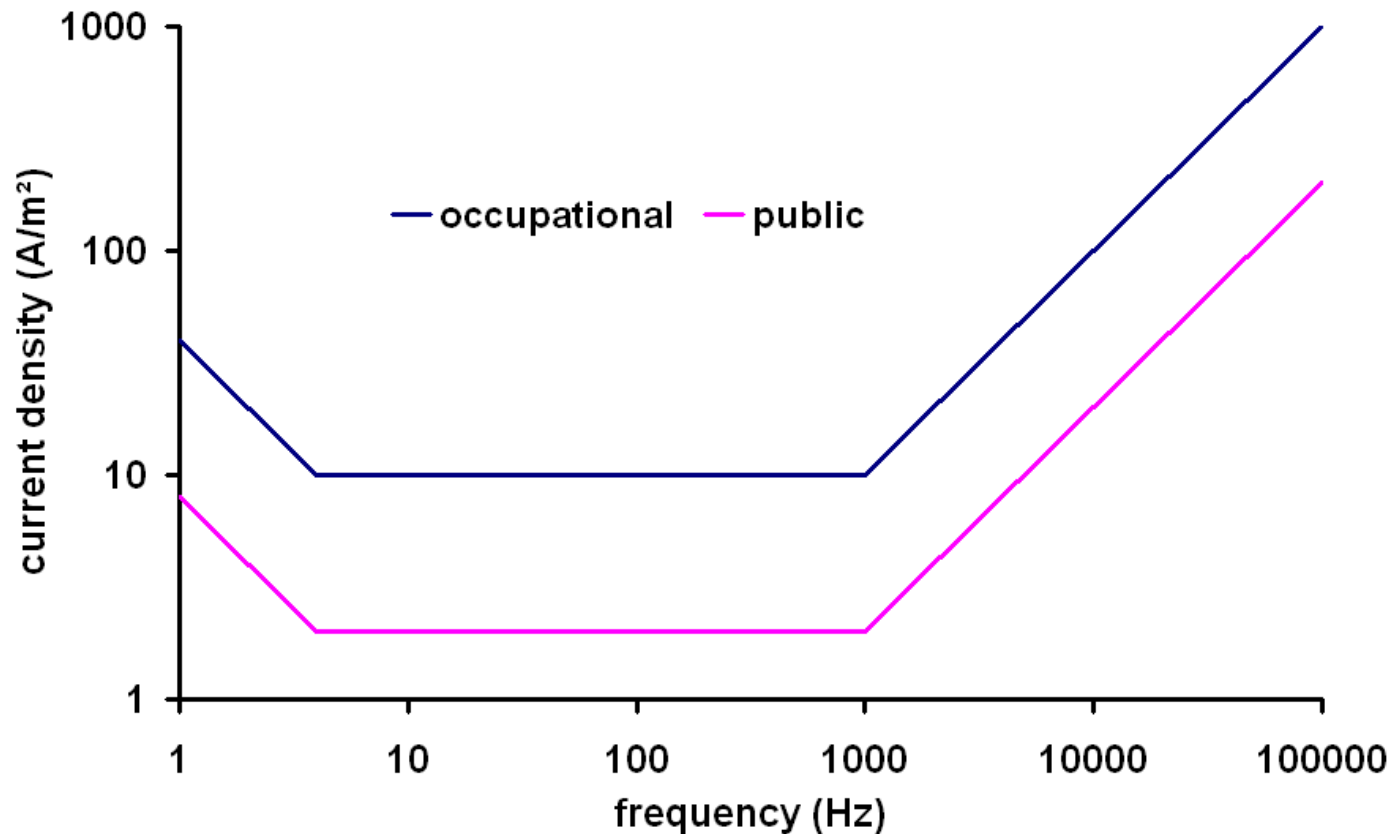
Effects of ELF fields

- Induction of internal electric fields and currents
- Acute changes in central nervous system excitability and other acute effects such as reversal of the visually evoked potential
- The effects are related to the internal electric field (V m^{-1}) or the internal current density (A m^{-2})

I_{ind} (mA m^{-2})	Effects
< 1	none established
1 – 10	minor biological
10 -100	phosphenes, nervous system
100 – 1000	CNS excitability, stimulation threshold, possible health hazards
> 1000	extra systoles, ventricular fibrillation, definite health hazards

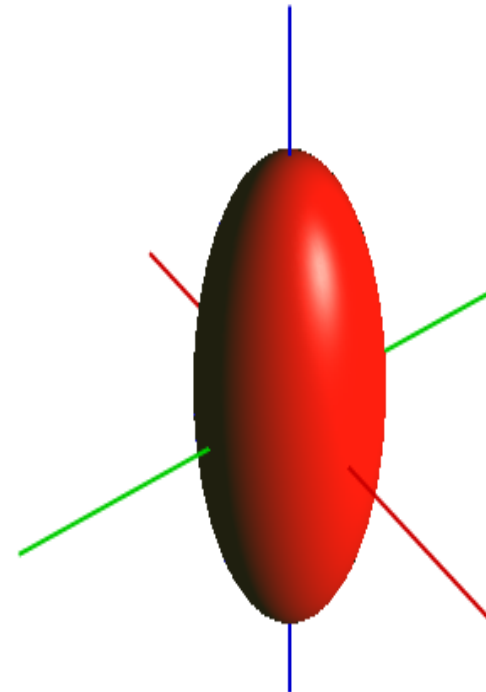
* WHO EHC 69, frequency range 3 – 300 Hz

Basic restrictions for ELF fields



Dosimetry for ELF fields

- Reference levels derived by modelling
- Simplification
 - distribution of conductivity
 - anisotropy
- Simple circular models
- Faraday's law of induction
$$J = \pi R f \sigma B$$
- First refined anatomical models



Reference levels for ELF

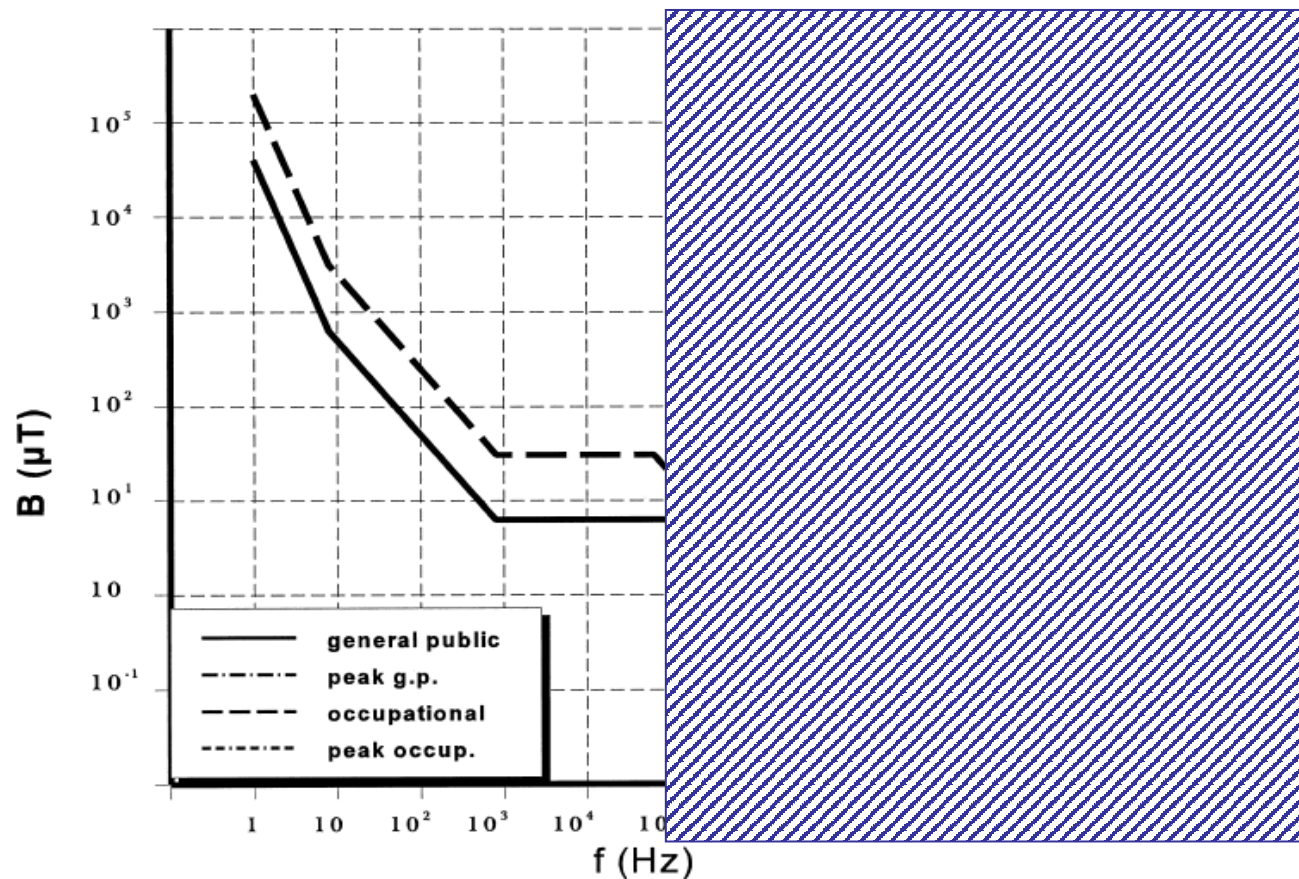


Fig. 2. Reference levels for exposure to time varying magnetic fields (compare Tables 6 and 7).

Basic restrictions and reference levels for ELF

Occupational

- **Basic restriction (4 Hz – 1 kHz)**
 - Induced current density 10 mA m⁻²
- **Reference levels (50 Hz)**
 - Electric field 10 kV m⁻¹
 - Magnetic flux density 500 μT

General public

- **Basic restriction (4 Hz – 1 kHz)**
 - Induced current density 2 mA m⁻²
- **Reference levels (50 Hz)**
 - Electric field 5 kV m⁻¹
 - Magnetic flux density 100 μT

Reference levels for ELF contact currents

Exposure characteristics	Frequency range	Maximum contact current (mA)
Occupational exposure	Up to 2,5 kHz	1,0
	2,5 – 100 kHz	0,4 f
	100 kHz – 110 MHz	40
General public exposure	Up to 2,5 kHz	0,5
	2,5 – 100 kHz	0,2 f
	100 kHz – 110 MHz	20

Multiple frequency fields

$$\sum_{i=1 \text{ Hz}}^{10 \text{ MHz}} \frac{J_i}{J_{L,i}} \leq 1. \quad (5)$$

Basic restriction

$$\sum_{i=1 \text{ Hz}}^{1 \text{ MHz}} \frac{E_i}{E_{L,i}} + \sum_{i>1 \text{ MHz}}^{10 \text{ MHz}} \frac{E_i}{a} \leq 1, \quad (7)$$

and

$$\sum_{j=1 \text{ Hz}}^{65 \text{ kHz}} \frac{H_j}{H_{L,j}} + \sum_{j>65 \text{ kHz}}^{10 \text{ MHz}} \frac{H_j}{b} \leq 1, \quad (8)$$

Reference values

Prospect



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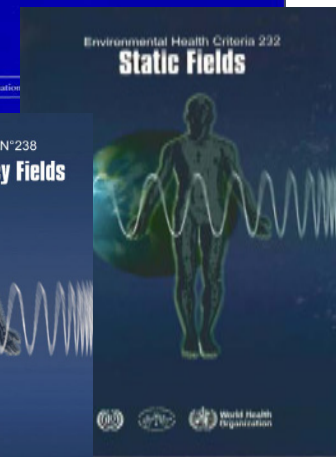
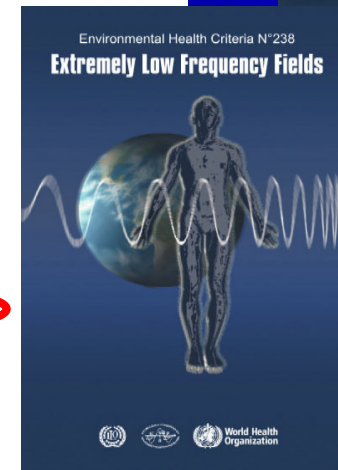
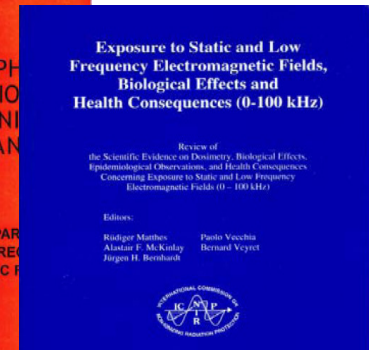
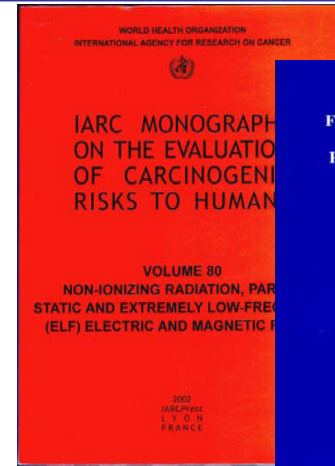
Revision of the static and ELF guidelines

New scientific evidence

Steps

- Identification of gaps
- Evaluation of carcinogenicity
- Review of overall knowledge
- Health risk assessment
- Revision of standards

WHO
IARC
ICNIRP
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Revision of the static and ELF guidelines

Status

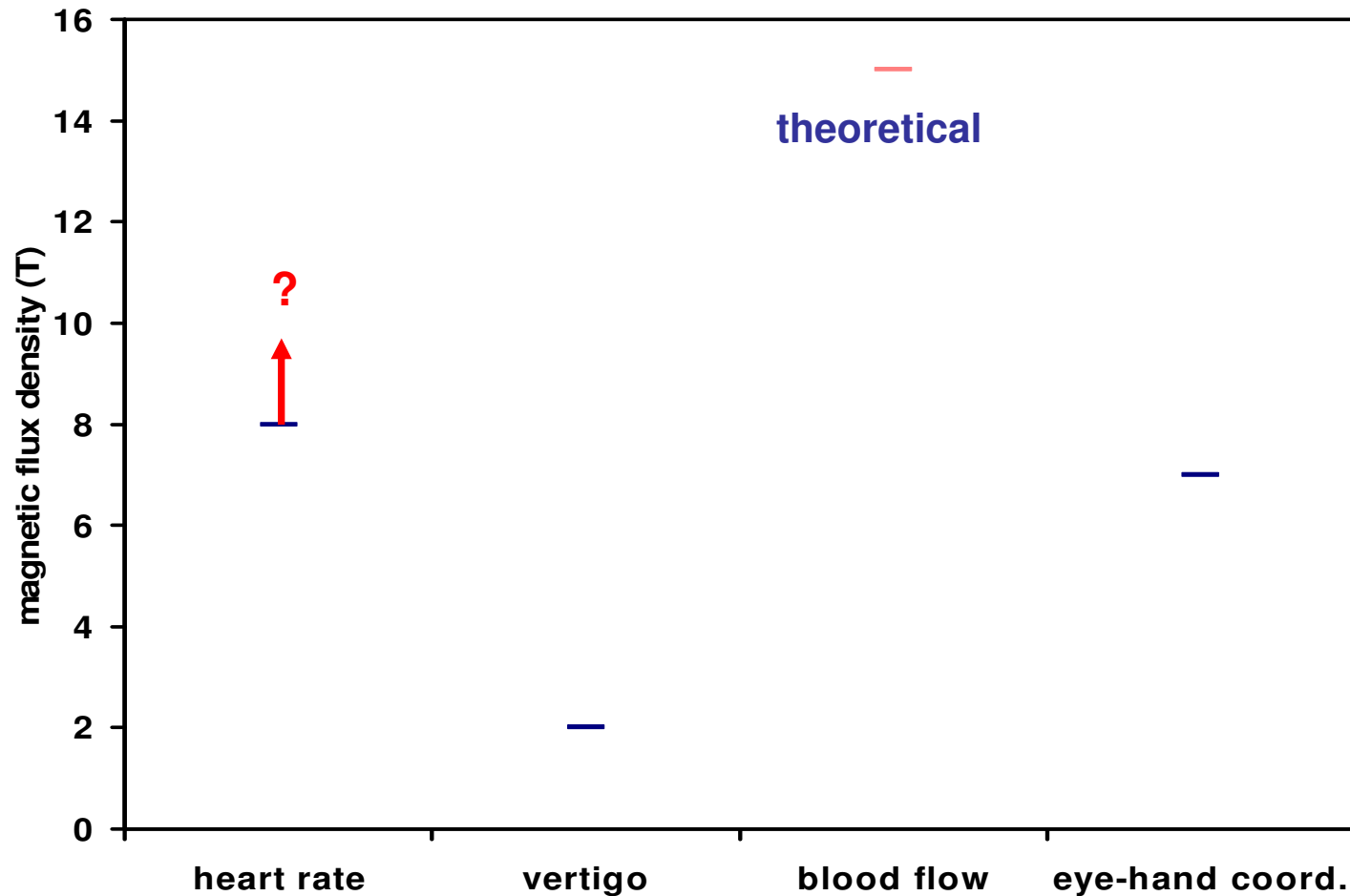
➤ Static magnetic fields

- ☒ Revision drafted
- ☒ Expert consultation
- ☐ Publication (expected in 2009)

➤ ELF electric and magnetic fields

- ☒ Revision drafted
- ☒ Harmonization with static guidelines
- ☐ Internal approval
- ☐ Consultation
- ☐ Publication (optimistically 2009)

Revision of the static guidelines



Exposure limits for static magnetic fields

Occupational

- ~~Whole body, continuous, averaged per workday~~ ~~200 mT~~
- Head and trunk 2 T
- Limbs ~~5 T~~ 8 T

General public

- Continuous ~~40 mT~~ 400 mT
- ~~Occasionally, appropriately controlled up to occupational limits~~

* spatial peak exposure limits

** For specific work applications, exposure up to 8T can be justified



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Exposure limits for static magnetic fields

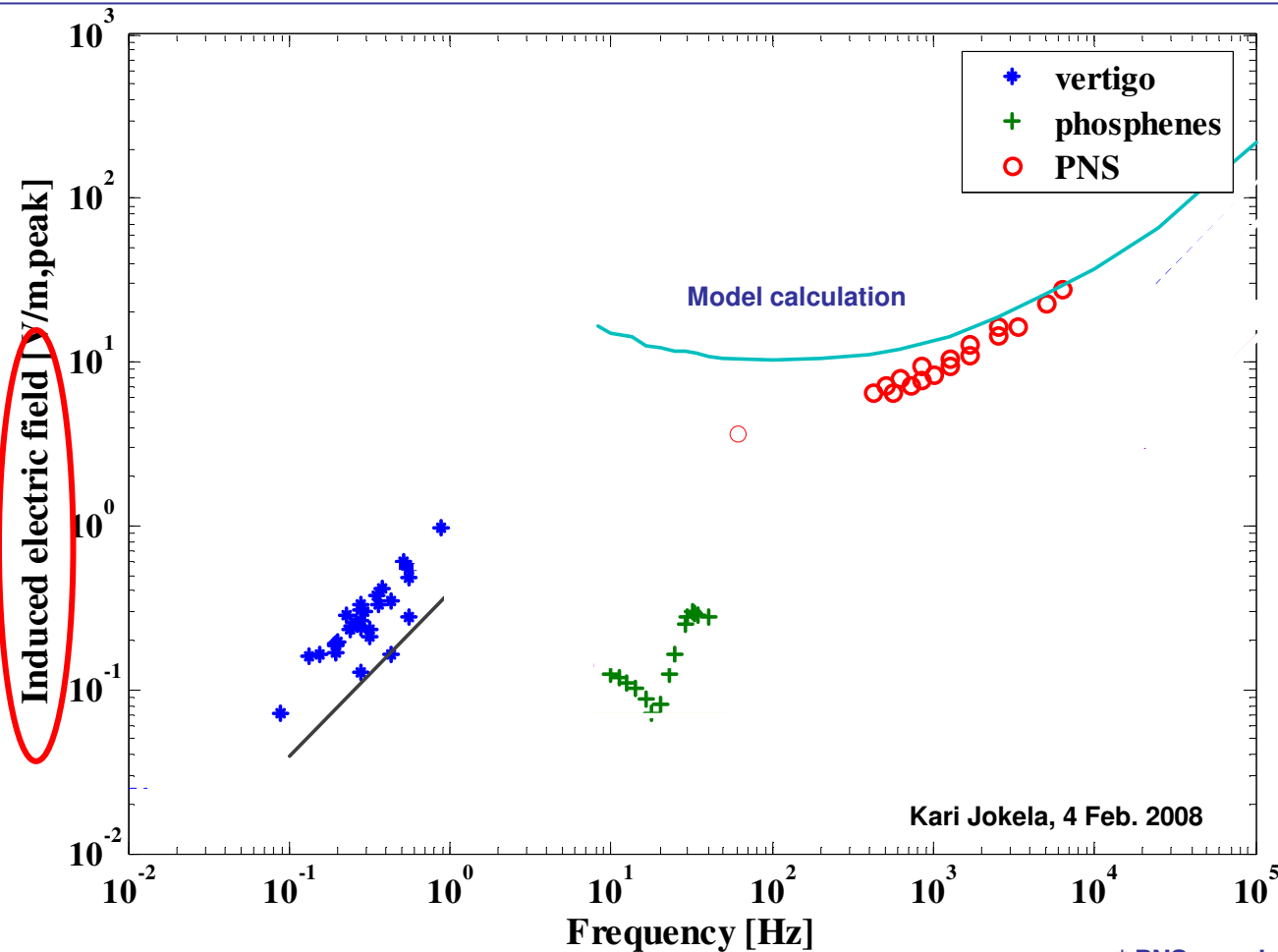
***** Because of potential indirect adverse effects, ICNIRP recognizes that practical policies need to be implemented to prevent inadvertent harmful exposure of persons with implanted electronic medical devices and implants containing ferromagnetic material, and dangers from flying objects, which can lead to much lower restriction levels such as 0.5 mT**



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Revision of the ELF guidelines



* PNS = peripheral nerve stimulation

An aerial photograph of Rio de Janeiro, Brazil, showing a dense urban landscape with numerous high-rise apartment buildings. The city is nestled between steep, green mountains. In the background, the iconic peaks of Sugarloaf Mountain (Pão de Açúcar) and Corcovado Mountain are visible under a hazy sky. The foreground shows a green, tree-covered hillside with a yellow and green fence line.

**Many thanks
for your attention !!!**