

NIR PROTECTION STANDARDS: SIMILARITIES AND DIFFERENCES

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PRIMARY AIMS OF ICRP RECOMMENDATIONS

To *contribute to an appropriate level of protection for people and the environment without **unduly** limiting the **desirable human activities** that may be associated with radiation exposure.*

J. Valentin, ICNIRP Workshop, Prague 2008



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WHAT IS NIR?

- **Electromagnetic fields**
 - Static magnetic fields
 - ELF electric and magnetic fields
 - IF electric and magnetic fields
 - RF electromagnetic fields
 - Microwaves
 - THz radiation
- **Optical radiation**
 - Visible light
 - IR radiation
 - UV radiation
 - Laser radiation
- **Ultrasound**
- **Infrasound**



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ICNIRP Statement

GENERAL APPROACH TO PROTECTION AGAINST NON-IONIZING RADIATION

Health Physics 82:540-548 (2002)
www.icnirp.org



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THE PRINCIPLES OF PROTECTION

- **Justification**
- **Optimisation of protection**
- **Application of dose limits**

How are the principles applicable to NIR protection?



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FUNDAMENTALS OF ICNIRP GUIDELINES

- Procedures and criteria are defined a priori
- Restrictions are **based on science**
- No consideration for economic or social issues
- **Only established effects** are considered



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IDENTIFICATION OF EFFECTS

Effects that are:

- **Evident** from peer-reviewed studies
- **Replicated** and/or
- **Consistent** across different studies

are considered as established



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SYSTEMS OF PROTECTION

- **Health threshold based systems**
Adequate for well established, threshold effects
- **Optimization systems**
Adequate for no-threshold known hazards
- **Precautionary measures**
Adequate for suspected, not established hazards



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ESTABLISHED EFFECTS FOR ELF FIELDS

- ↪ Induction of internal electric fields and currents
- ↪ Stimulation of electrically excitable tissues

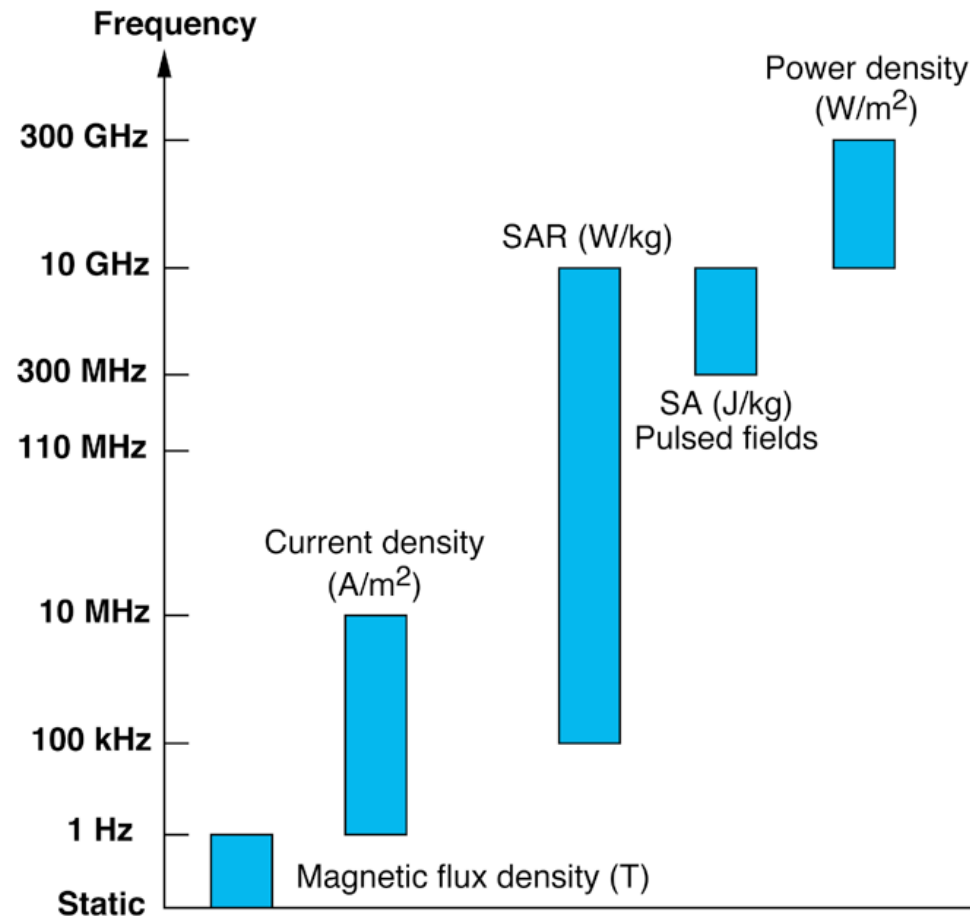
The effects are related to the internal electric field (V/m) or the internal current density (A/m²)

ESTABLISHED EFFECTS FOR RF FIELDS

- Absorption of electromagnetic energy
- Increase of body temperature (general or local)
- Thermal effects

Thermal effects are related to SAR, i.e. to the energy absorbed per unit time and per unit body mass (W/kg)

BIOLOGICALLY EFFECTIVE QUANTITIES ("DOSIMETRIC" QUANTITIES)



“DOSIMETRY” OF EMF

“**Dosimetry**” means the characterization of exposure with relation to relevant parameters of the field, the exposed system, and the environment.

“**Dosimetric**” quantities have been defined (also termed biological effective quantities):

J_{int} , E_{int} , SAR, SA, S

Does a “dose” exist?



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WHAT IS DOSE?

Dose ($\delta\omega\sigma\iota\varsigma$) = What is given

In theory, the concept of dose:

Could be used for some internal (biologically effective) quantities

- SAR, SA

Might be used for some other internal quantities

- J_{int} , E_{int}

Cannot be used for external quantities

- E, B, H, S

THE EMF “DOSE” IN PRACTICE

- **No evidence of effects from cumulative exposure**
- **No equivalence between exposure to different kinds of EMF (e.g. ELF vs RF)**
- **No equivalence between short exposure to low-intensity and long exposure to high-intensity fields**



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THE TWO-LEVEL SYSTEM

- **Basic restrictions**
in terms of biologically effective quantities
- **Reference levels**
in terms of an external exposure metric

Exposure below reference levels ensures compliance with basic restrictions, since the relations between them have been developed under worst-case conditions.

If the reference level is exceeded, the basic restriction is not necessarily exceeded.



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DOSE vs EXPOSURE LEVEL

- **No dose can be defined in the scientific sense**
- **External field strength is often used as a metric for effects (e.g. ELF magnetic fields, RF fields from RBS)**
- **Distinction is generally made between high- and low-level of exposure rather than high- and low-doses**



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HEALTH EFFECTS OF EMF

- **Established acute effects**
Only above given exposure thresholds
Different mechanisms identified for ELF and RF
- **Hypotesized long-term effects**
Well below threshold for acute effects
No mechanism identified



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MECHANISMS AND EFFECTS

- Whichever their nature, the mechanism for long-term effects – if existent – must be **different** from acute effects
- **No extrapolation** from high- to low-level exposure possible

Different protection systems must be adopted



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ICNIRP ON LONG-TERM EFFECTS

ELF

In the absence of support from laboratory studies, the epidemiological studies are **insufficient** to allow an exposure guideline to be established.

RF

Although there are deficiencies in the epidemiological work, [...] the studies have yielded **no convincing evidence** that typical exposure levels lead to adverse reproductive outcomes or an increased cancer risk in exposed individuals.

ICNIRP Guidelines, 1988



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THE EUROPEAN UNION ON LONG-TERM EFFECTS

- **EU Recommendation (1999)**
“Only established effects have been used as the basis for the recommended limitation of exposure”
- **EU Directive (2004)**
“The long-term effects, including possible carcinogenic effects [...] for which there is no conclusive scientific evidence establishing a causal relationship, are not addressed in this Directive”



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IARC AND ELF MAGNETIC FIELDS

In 2001 IARC classified ELF magnetic fields as possibly carcinogenic to humans (Group2B)

What does it means?



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CLASSIFICATION IN GROUP 2B

Condition:

Limited evidence of carcinogenicity in humans

Less than sufficient evidence of carcinogenicity in experimental animals

Limited evidence:

A positive association has been observed; a causal interpretation is considered credible, but chance, bias or confounding cannot be ruled out

Less than sufficient evidence:

At most, a positive association has been observed; a causal interpretation is considered credible, but chance, bias or confounding cannot be ruled out

The agent cannot be considered as an established carcinogen



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EXPOSURE LIMITS AND PRECAUTIONARY MEASURES

- No quantitative exposure limits can be established for long-term effects
- **Precautionary measures** have been envisaged to prevent or reduce long-term effects, although hypothetical
- Measures aimed at the **minimization** of exposure have been claimed, and the **ALARA principle** has been invoked

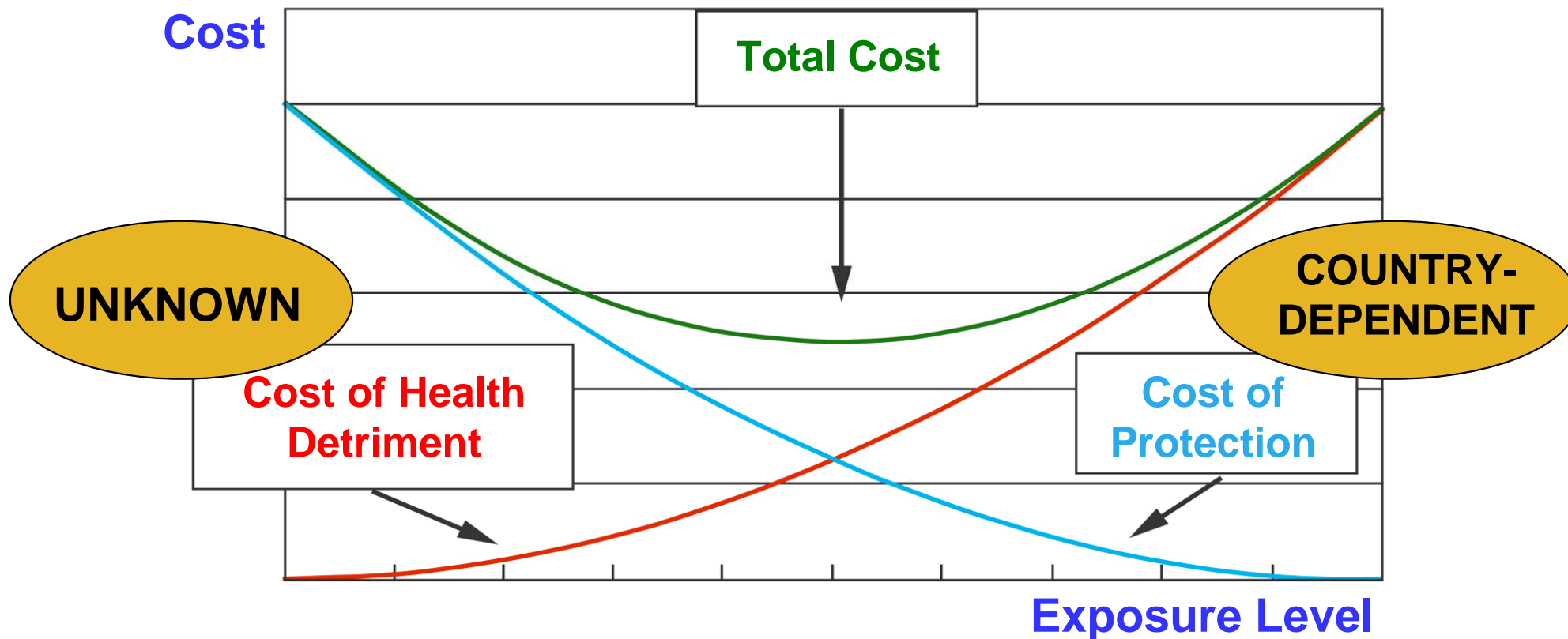


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THE OPTIMIZATION PRINCIPLE (ALARA)



BALANCING RISKS AND BENEFITS

Actions on limiting the exposure of the general public to electromagnetic fields should be balanced with the other **health, safety and security benefits** that devices emitting electromagnetic fields bring to the quality of life, in such areas as telecommunications, energy and public security.

EU Recommendation, 1999



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CONCLUSIONS

- EMF exhibit peculiar characteristics, and no direct parallel can be established with other agents
- High-level exposures can, and should, be regulated through exposure limits
- Low-level exposures must be considered as a separate issue
- There is no scientific basis for quantitative limits to low-level chronic exposures



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CONCLUSIONS

- Separate precautionary measures may be considered, provided they are complementary and not alternative to science-based standards
- Precautionary measures require social and economic considerations that are **outside the remit of ICNIRP**
- **Science** should however be an **essential input** for any precautionary policy, including precautionary measures



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