ITU Workshop on "Human Exposure to Electromagnetic Fields (EMFs)"

(Quito, Ecuador, 14 August 2013)

SCIENTIFIC BASIS OF THE EMF EXPOSURE STANDARDS

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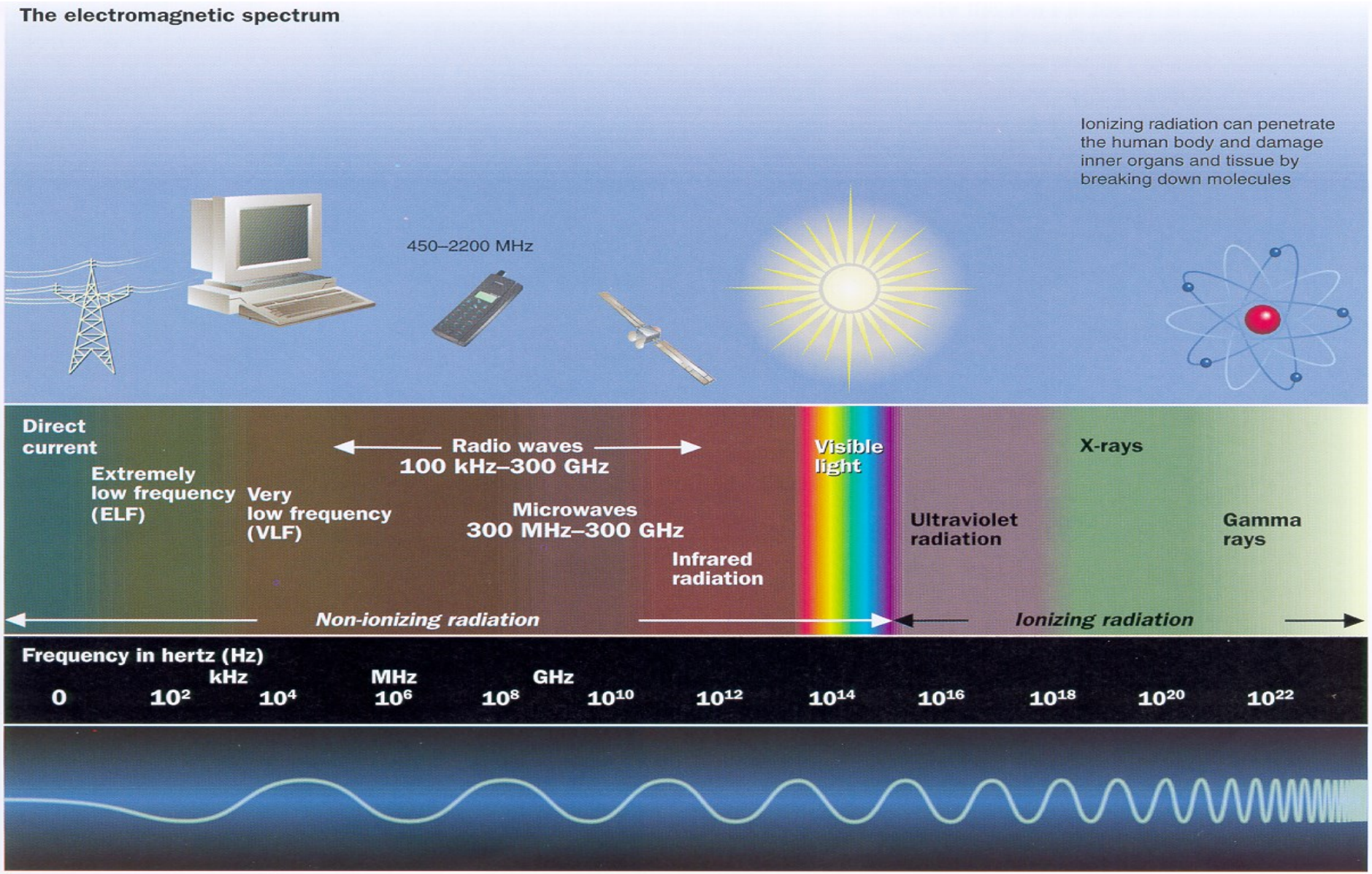
IEC MT1 (IEC 62209-1 & IEC 62209-2)

Outline

- Electromagnetic fields (EMF)
- Ionizing and non-ionizing raditation
- Biological and adverse health effects
- International EMF exposure standards
- ICNIRP & IEEE view on EMF safety guidelines

Electromagnetic fields (EMF)

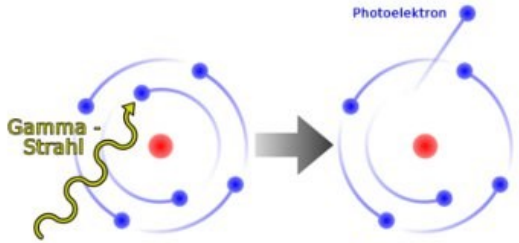
- **Electromagnetic Radiation:** consists of waves of electric and magnetic energy moving together through space.
- All electromagnetic radiation can be classified by frequency from the extremely low to extremely high frequencies.

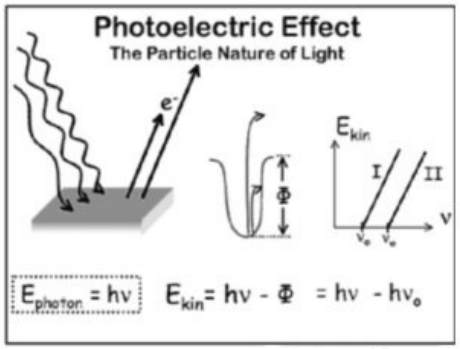

The electromagnetic spectrum
Ionizing radiation can penetrate the human body and damage inner organs and tissue by breaking down molecules
450–2200 MHz
Direct current
Extremely low frequency (ELF)
Very low frequency (VLF)
Radio waves
100 kHz–300 GHz
Microwaves
300 MHz–300 GHz
Infrared radiation
Visible light
Ultraviolet radiation
X-rays
Gamma rays
Non-ionizing radiation
Ionizing radiation
Frequency in hertz (Hz)
kHz
MHz
GHz
0
10²
10⁴
10⁶
10⁸
10¹⁰
10¹²
10¹⁴
10¹⁶
10¹⁸
10²⁰
10²²

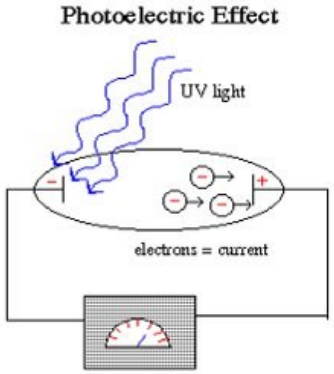
Ionizing and non-ionizing radiation

- Extremely high frequency radiation such as Ultraviolet (UV) and X-rays is called "Ionizing Radiation" because it is powerful enough to effect changes in the atoms of matter it strikes, by breaking chemical bonds (ionization) , thus altering their chemical and biological nature .
- Electromagnetic radiation at those frequencies below the UV band are generally classified as "Non-Ionizing Radiation" because they typically lack the energy to effect changes in atomic structure.
- Photoelectric effect:

E10 Photoelectric Effect

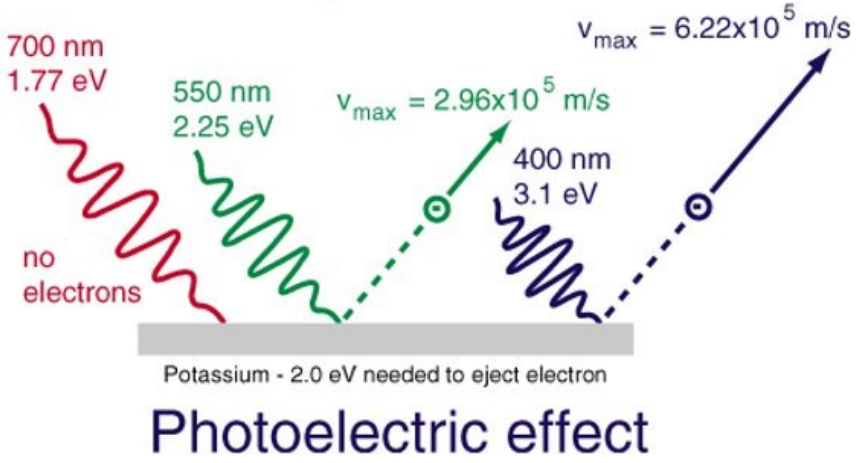




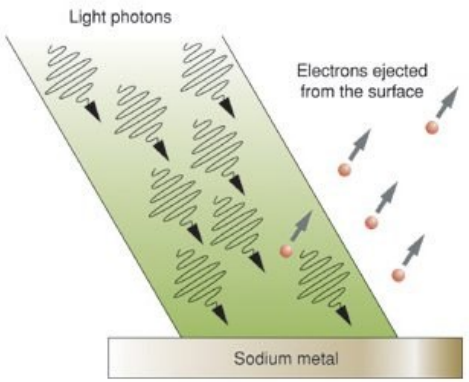


$E_{photon} = h\nu$

photon = wave particle of light



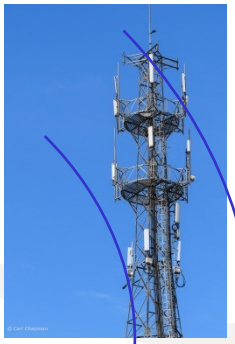
Photoelectric effect

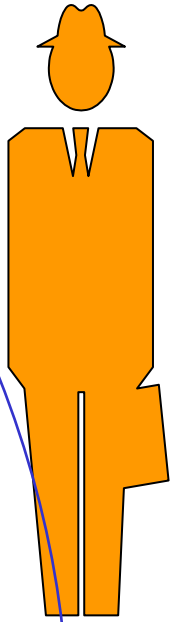


Biological and Health Effects, What's the difference?

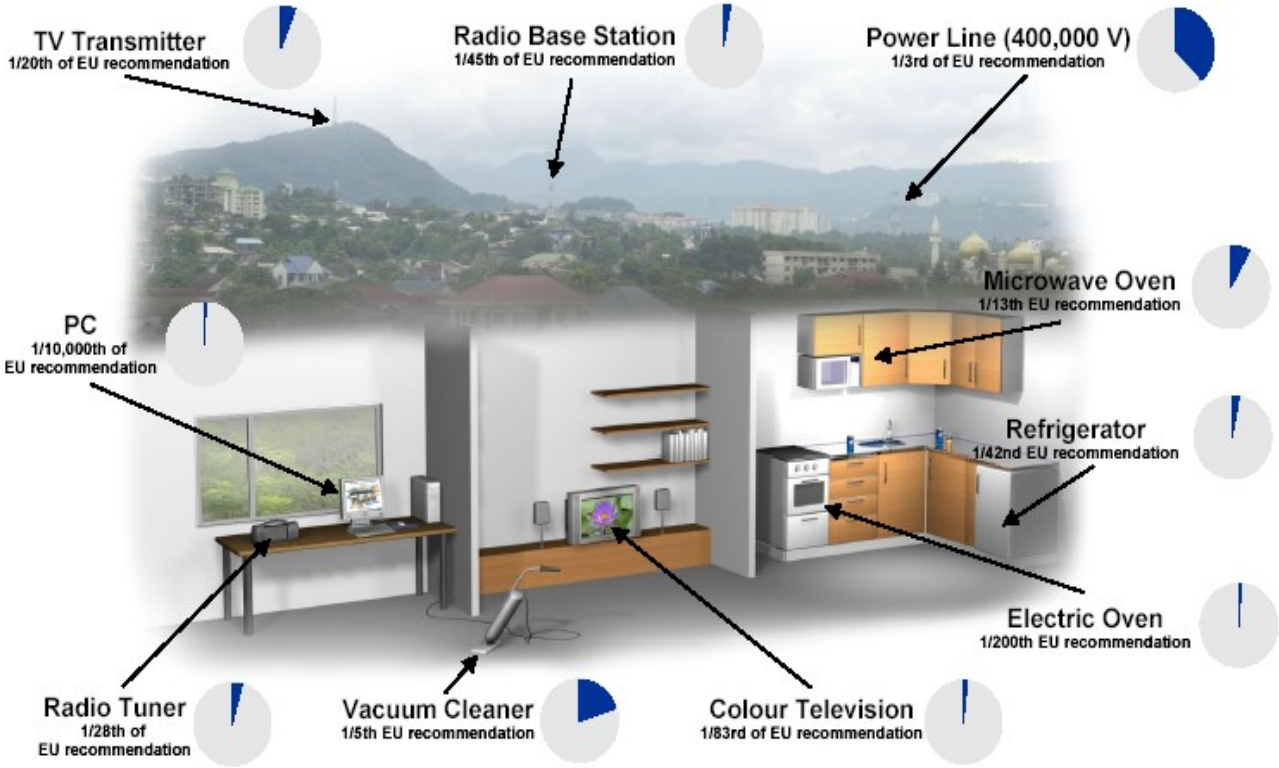
- A biological effect is any measurable physiological response to EMF exposure ….not necessarily hazardous…
- An adverse health effect is a biological effect outside the body's normal range of physiological compensation that is detrimental to health or well-being

Most common wireless technology
RF Sources





Exposure level of some common EMF sources



Quality of Science (Established vs. Possible)

Increasing validity

A	Confirmed and Established Science	
B	Unconfirmed report (could be useful)	?
C	Unconfirmed report contradicts A	?
D	Unconfirmed report with clear flaws and artifacts	?
E	Junk report in peer-reviewed literature	?
F	Junk report in non-peer-reviewed literature	?

Adapted from Osepchuk [2004]

"Good science is never outdated." -- Herman P. Schwan

Statistical meaning of single findings

- What does a single positive or negative finding mean?
  - Statistically significant criteria <0.05 means that 1/20 positive/negative findings are wrong positive/negative findings.
  - This means that scientific publications are full of wrong positive/negative findings
  - This is why the repeatability of the results is fundamental principle in science.
  - This the reason why the concept of weight of evidence also is used in evaluation of EMF scientific literature.

International EMF Exposure standards

- International Commission on Non-Ionizing Radiation Protection (ICNIRP)*
  - independent group of experts
  - emanated from IRPA/INIRC in May 1992
  - members are not affiliated with commercial or industrial enterprises
  - Multidisciplinary

* **Most of the ICNIRP related slides are taken from Ruediger Matthes's May 2013 presentation**

International RF Exposure Standards

- **ICNIRP (1998):** *"this publication is to establish guidelines for limiting EMF exposure that will provide protection against known adverse health effects"*.

  *ICNIRP reconfirmed its guidelines in 2009.

- **IEEE ICES C95.1-2005:** *"The purpose of this standard is to provide exposure limits to protect against established adverse effects to human health induced by exposure to RF electric, magnetic and electromagnetic fields over the frequency range of 3 kHz to 300 GHz."*

ICNIRP…

- balanced in terms of geography and gender
- formally recognized cooperation with WHO
- registered not-for-profit
- Science based exposure limits
- endorsed by WHO

ICNIRP…

Commission 2012-2016

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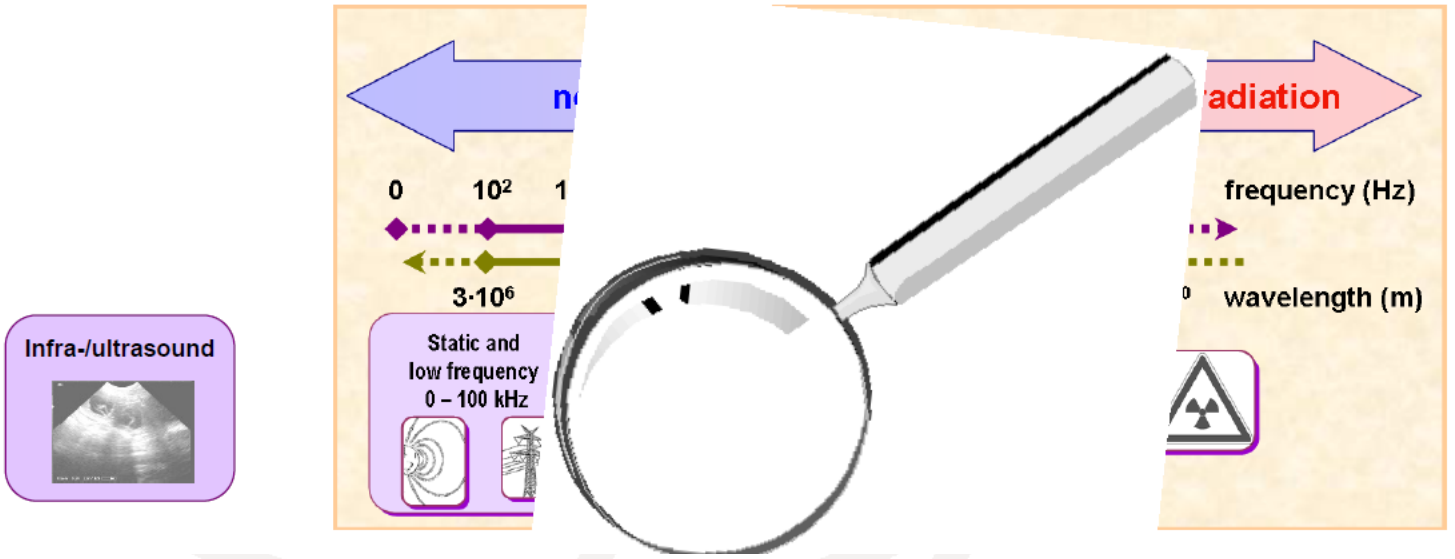
ICNIRP…

ICNIRP objectives

- advance non-ionizing radiation protection
- provide scientific guidance and recommendations
- focus on people and the environment
  - general public, workers, patients

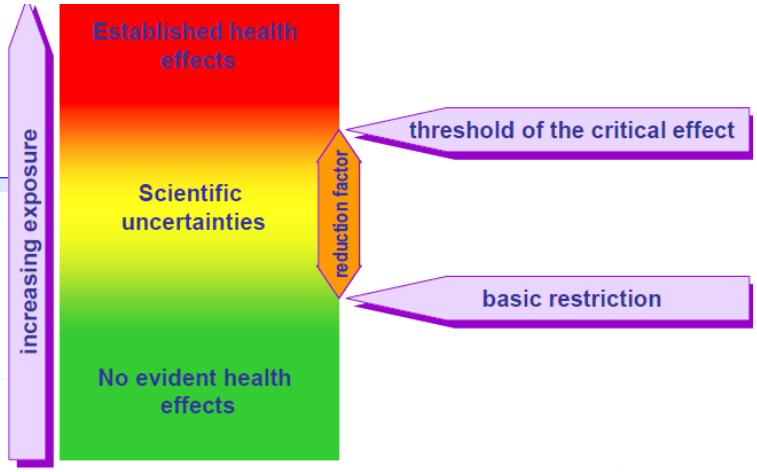


Scientific basis of exposure guidelines

ICNIRP´s approach

- protection from established health hazards
  - detectable impairment of the health
- result from a careful analysis of the literature
  - rationale considers direct and indirect, acute and chronic effects
- risk assessment based on sound scientific evidence
  - studies that meet quality criteria
  - totality of science
- reduction (safety) factors to consider quantitative uncertainties in the database and biological variability
- two tier system
  - worker / general public

Scientific basis of exposure guidelines…



Reduction factor

uncertainties in the data base
- biological variability
- uncertainties and variability in dosimetry
- threshold definition (often extrapolation)

impact of environmental conditions
- high temperature
- high activity levels

overall no rigorous scientific basis for reduction factors
- conservative expert judgement

ICNIRP limits

Basic restrictions (SAR)

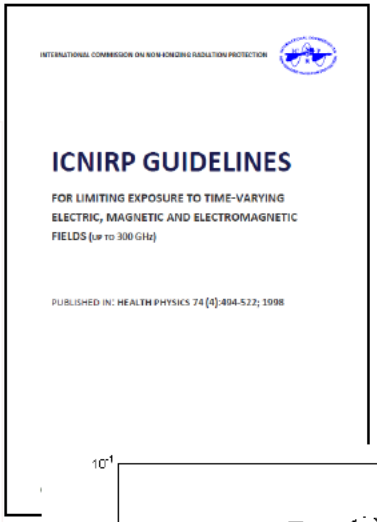
Workers

Whole body exposure	0.4 W/kg
Local exposure – head and trunk	10 W/kg
Local exposure – limbs	20 W/kg

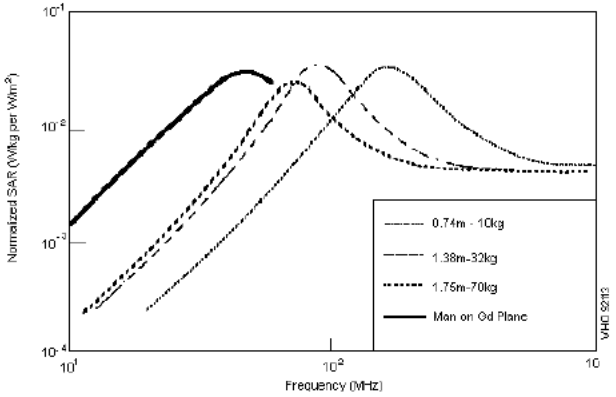
General public

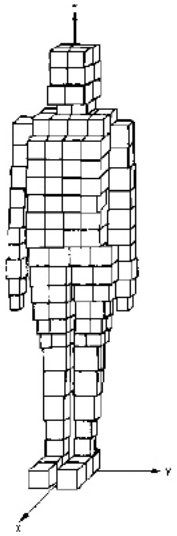
Whole body exposure	0.08 W/kg
Local exposure – head and trunk	2 W/kg
Local exposure – limbs	4 W/kg

All values averaged over 6 minutes
All local exposure is to be averaged over 10 g



Reference values





IEEE-ICES

- large committee open to anyone with a material interest
- about 130 members from 26 countries
- Open consensus process
- The same scietific rationale as ICNIRP.

2006: IEEE C95.1-2005 published on April 19, 2006 (comprehensive revision, 250 pages, 1143 ref.)

http://standards.ieee.org/about/get/index.html

Conclusions and Recommendations

- No adverse health effects have been confirmed below the current international RF safety guidelines or exposure standards (ICNIRP, IEEE).
- Adopt/Harmonize your RF limits with WHO's endorsed RF exposure limits of ICNIRP!