ICNIRP
INTERNATIONAL COMMISSION ON
NON-IONIZING RADIATION PROTECTION

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The new ICNIRP radiofrequency guidelines

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Current status

- Submitted to Health Physics, publication December 2019
  - Guidelines (exposure limits & rationale)
  - Technical appendix (dosimetry issues, background reference levels)
  - Biological appendix (overview health effects)

- Public consultation, finished 9 October 2018
  - ~120 contributions, >1000 individual comments

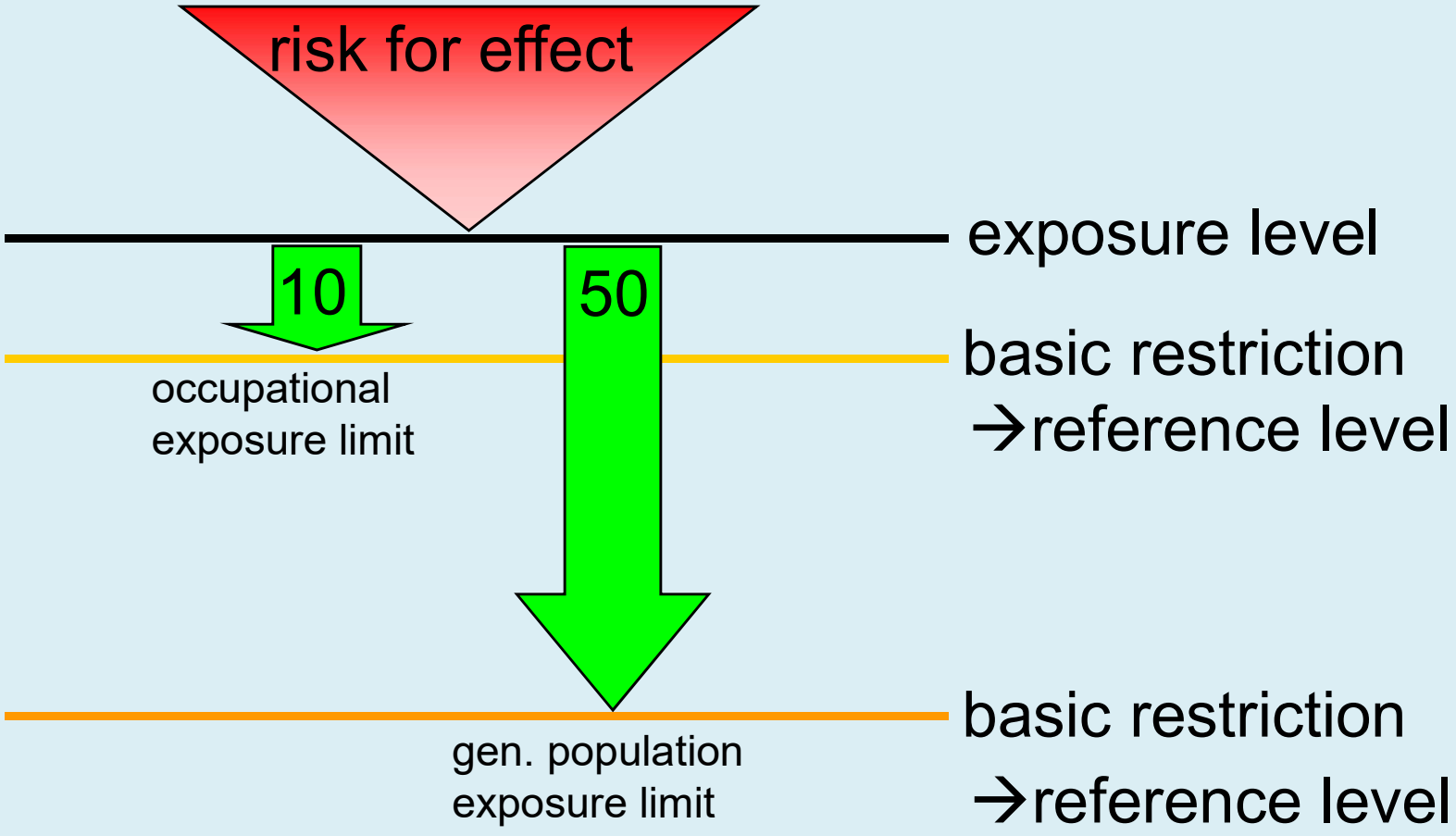
Steps in the process

1. Identification of scientific data on effects of exposure on biological systems
2. Determination of effects considered both
   - adverse to humans and
   - scientifically substantiated (independent replication, sufficient quality, scientifically explicable generally)
3. Identification of adverse health effect threshold
   - minimum RF EMF exposure level shown to produce harm, or
   - where there is insufficient RF research:
     - minimum exposure predicted to cause harm from non-RF literature, e.g. heating from other factors
     - = *operational* adverse health effect threshold

Next steps

- Derivation of exposure limits (basic restrictions)
  - Application of reduction factors to health effect thresholds
  - Higher for general public (often: 50) than for occupational (often:10)
- Derivation of reference levels
  - Field strength values derived from basic restrictions
    - Provide practical method to determine compliance with basic restrictions
    - Conservative for all *realistic* exposure conditions, not all *possible* exposure conditions

Reduction factors



Scientific basis

- Draft WHO review on RF (2014), SCENHIR report (2015), SSM reports (2016-2018) + original papers not included
- No evidence that RF EMF causes adverse health effects other then through heating
  - No evidence for cancer
  - No adverse non-thermal adverse health effects
  - Some evidence for some biological effects, but these are not adverse
- Thermal biology literature also considered

Interaction mechanisms (temperature elevation)

- Temperature increases taken to represent health effects, and restrictions set to avoid these
- Distinction between steady-state and brief exposures (no dissipation of heat)
- Whole-body exposure: increase >1 °C in body core temperature potentially harmful (=operational standard)
  - for comparison: ACGIH heat stress at work standard aims at protecting against >1 °C core body temperature increase
- Local exposure: temperature >41 °C

SAR and frequency

- Previous:
  - SAR up to 10 GHz, power density at higher frequencies
- Now:
  - *whole-body* SAR up to 300 GHz
  - *local* SAR up to 6 GHz
  - 6-300 GHz: *absorbed* (=incident - reflected) power density

SAR and body core temperature

- RF modelling predicts:
  - ~6 W/kg WBA SAR, 1 h, ambient temperature of 28 °C: core body temperature increase ~1 °C (consistent with the limited human measurement research)
  - WBA SAR for same effect higher in children (more efficient heat dissipation)
- ICNIRP: adverse health effect threshold:
  WBA SAR of 4 W/kg averaged over 30 min (=time to ~ reach steady state)
- Very conservative !
- Generation energy in human adult: ~1 W/kg at rest, ~2 W/kg standing, ~12 W/kg running

Local exposure: tissues

- Tissue damage can occur at local temperatures >41-43 °C (time-dependent)
- ICNIRP: adverse health effect threshold:
  Local temperature >41 °C
- Type-1 tissues (normal temperature < 33-36 °C): 5 °C increase allowed
  - upper arm, forearm, hand, thigh, leg, foot, pinna, cornea, anterior chamber and iris of the eye, epidermal, dermal, fat, muscle and bone tissue
- Type-2 tissues (normal temperature < 38.5 °C): 2 °C increase allowed
  - all tissues in the head, eye, abdomen, back, thorax and pelvis, excluding those defined as Type-1 tissue

Local exposure: adverse health effect levels

- Modelling/extrapolation suggests:
  - ≤ 6 GHz: SAR_{10g} of 20 W/kg: temperature increase max. 2 °C
  - >6 GHz: absorbed power density (S_{ab}) of 200 W/m^2: temperature increase max. ~5 °C in superficial, less in deeper tissue
- ICNIRP: adverse health effect levels:
  - 100 kHz - 6 GHz:
    - Head & Torso: local SAR_{10g} 20 W/kg (averaged over 6 min)
    - Limbs: local SAR_{10g} 40 W/kg (averaged over 6 min)
  - >6 - 300 GHz: S_{ab} 200 W/m^2 (averaged over 6 min and 4 cm^2)
  - Narrow beam exposure: >30-300 GHz: S_{ab} 400 W/m^2 (averaged over 6 min and 1 cm^2)
- Also (complex) limits for short (pulsed) exposures

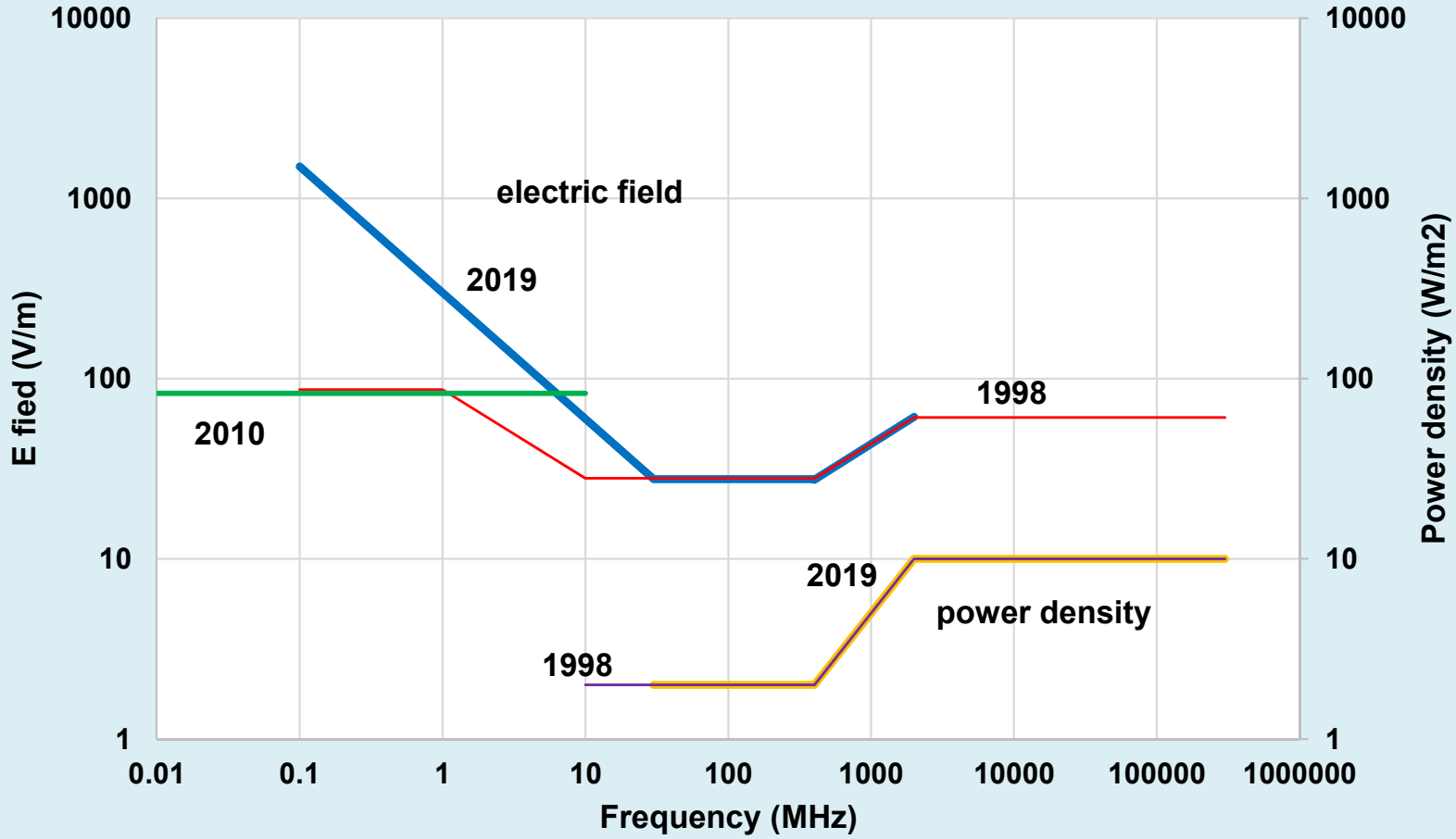
Basic restrictions and differences with 1998 values

Parameter	Freq. range	ΔT	Spatial	Aver. time	Health effect level	Red. fact.	Occup.	Red. fact.	General public
Core ΔT	100 kHz-300 GHz	1°C	WBA	30 min 6 min	4 W/kg	10	0.4 W/kg	50	0.08 W/kg
Local ΔT (Head & Torso)	100 kHz-6 GHz	2°C	10 g	6 min	20 W/kg	2	10 W/kg	10	2 W/kg
Local ΔT (Limbs)	100 kHz-6 GHz	5°C	10 g	6 min	40 W/kg	2	20 W/kg	10	4 W/kg
Local ΔT (Head, Torso, Limbs)	>6-300 GHz 30-300 GHz 10-300 GHz	5°C	4 cm^2 1 cm^2 20 cm^2	6 min 6 min $68/f^{1.05}$	200 W/m^2 400 W/m^2	2	100 W/m^2 200 W/m^2 50 W/m^2	10	20 W/m^2 40 W/m^2 10 W/m^2

Reference levels

- Dependent on:
  - Workers / general public
  - Far field / radiative near field / reactive near field
  - Whole-body / local
    - Local, exposure ≥ 6 minutes
    - Local, exposure < 6 minutes

Reference levels general public, whole-body ≥6 min



Conclusion 2019 vs 1998 (& 2010) guidelines

- Better biological rationale
- Better dosimetry
- More details
- More complex
- More accurate

Thank you for your attention