

Are Safety Limits Valid?



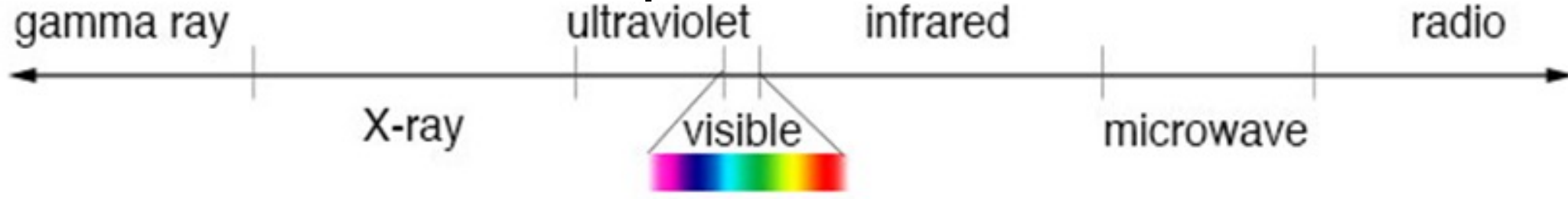
The Royal Society of Medicine: 1 Wimpole Street W1G 0AE, London, England

A CRITIQUE OF RF EXPOSURE LIMITS AND RECOMMENDATIONS FOR THE BETTER PROTECTION OF WORKERS AND THE PUBLIC

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IONIZING RADIATION

NONIONIZING RADIATION



shorter wavelength
higher frequency
higher energy



longer wavelength
lower frequency
lower energy



THE ELECTROMAGNETIC SPECTRUM

Health Effects Microwave and RF Radiation

- Subject of Scientific Research for 70 Years
- Safety Guidelines Promulgated for 50+ Years
- *Deja Vu ... Been There, Done That!*
- “Where’s the Beef?”
- Why Are We Still Discussing Exposure Limits, Guidelines and Standards?

The Public Health Issue is ...

Are There Health Hazards?

- **Yes, with High Degree of Agreement**
 - Acute, High Intensity, High Absorption Rates Can Produce Adverse Thermal Effects in Tissue
- **Controversy Arises From**
 - Repeated or Long-Term Exposures (> 6 or 30 min)
 - Possible Delayed Health Effects at Low Levels, e.g., Cancer

Review of Exposure Limit Development

- 1966:** Initially setting **10 mW/cm²** (100 W/m²) in ~ **0.1 hr** to limit excessive tissue heating (ANSI)
- 1982:** Minor amendment to replace 0.1 hour by **6 min**
- 1986:** Inauguration of **SAR** in W/kg as basic restriction by NCRP (**vs.** incident power density)
- 1992:** Introduction of **1-g SAR** of **1.6 W/kg** in IEEE Standards (Recognized by ANSI)
- 1996:** US **FCC** implemented **rules** for permissible exposure based on SAR of 1.6 W/kg in 1-g tissue
- 1998:** ICNIRP published (with same database as IEEE & NCRP) but set **10-g SAR** of **2.0 W/kg** as Guidelines.

Review of Exposure Limits (cont.)

2001: International Committee on Electromagnetic Safety (**ICES**) approved to replace IEEE C95.1

2005: ICES revised its standard and *adopted* ICNIRP's **2.0 W/kg SAR** over **10-g** tissue — **harmonization?**

2019: ICES updated its standards and introduced skin power density restrictions for **mm-Wave** and **5G**

2019: **FCC** reaffirmed 1996 RF exposure limits, as applicable to **5G**

2020: **ICNIRP** revised its guidelines with emphasis on **heating effects** and minimized **pulse effects**

2022: ICBE-EMF (as **New international Commission**)

Current Guidelines/Standards Based on Thermal Effect for “Safe” Human Exposure to RF Radiation (ICES 2019; ICNIRP 2020).

Frequency Range	Tissue Type	ΔT	Ave. Schem e	Ave Time	Health Effect	Factor	Public Level	Factor	Worker Level
100kHz-6 GHz	Head-Torso	2 °C	10 g	6 min	20 W/kg	10	2 W/kg	2	10 W/kg
	Local Limb	2 °C	10 g	6 min	40 W/kg	10	4 W/kg	2	20 W/kg
> 6 GHz-300 GHz	Head-Torso	5 °C	4 cm ²	6 min	200 W/m ²	10	20 W/m ²	2	100 W/m ²
30 GHz - 300 GHz	Local Limb	5 °C	1 cm ²	6 min	400 W/m ²	10	40 W/m ²	2	200 W/m ²
100 kHz-300 GHz	Body Core	1 °C	WBA	30 min	4 W/kg	50	0.08 W/kg	10	0.4 W/kg

Anomalies and Inconsistencies (1)

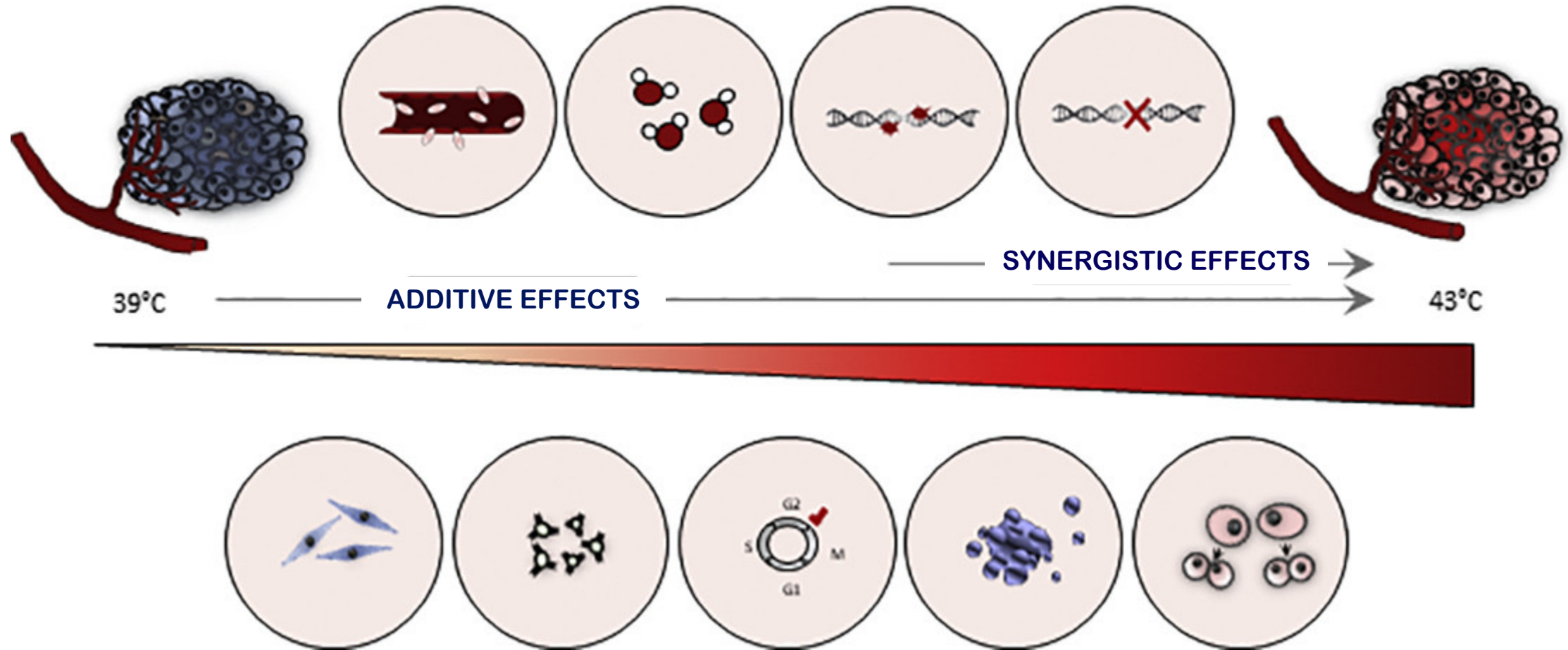
- ICNIRP deleted its 1998 **restriction of pulse exposure limit** — Contrary to recent 5G and persistent concerns
- ICES and ICNIRP exposure limits are **revised to emphasize strong conviction for RF heating**
- Standards based on:
 - Whole-body temperature increase of **1°C**
 - Local tissue temperatures of **2°C to 5°C**
 - For **short-term exposures of 6 to 30 min**

Anomalies and Inconsistencies (2)

- Aside from lack of mm-wave data, New criteria of **(5°C)** for 5G (6 GHz to 300 GHz) is concerning
- Local tissue temperature of 5°C would induce tissue temperature to increase from a nominal 37 °C to a hyperthermic 42 °C
- **Hyperthermic tissue temperature of 42 °C is cytotoxic** — well-known exponential cell kills
- It's the medical foundation for treatment of malignant tumors in hyperthermia therapy for cancer

At both molecular and physiological levels there are different working mechanisms responsible for the additive and synergistic interactions of hyperthermia [Oei et al 2020].

Hyperthermia as Radiosensitizer and Chemosensitizer



Anomalies and Inconsistencies (3)

- **2011**, IARC classified RF radiation as “**a possible carcinogen** in humans” based on epidemiological reports but only partial data from animal experiments
- **2018**, US NTP reported **clear evidence** of RF exposure causing development of **malignant tumor in rats** (schwannoma) at 6 W/kg (1 °C body temp rise) following 2-year exposures
- **Animal data** IARC **sought** were provided by NTP study and by Ramazzini Institute in **2018**
- NTP and Ramazzini **animal cancer reports** logically and scientifically **supplement IARC’s classification**
- Curiously, the **revised** of safety limits regard IARC classification and animal results — **as not applicable**

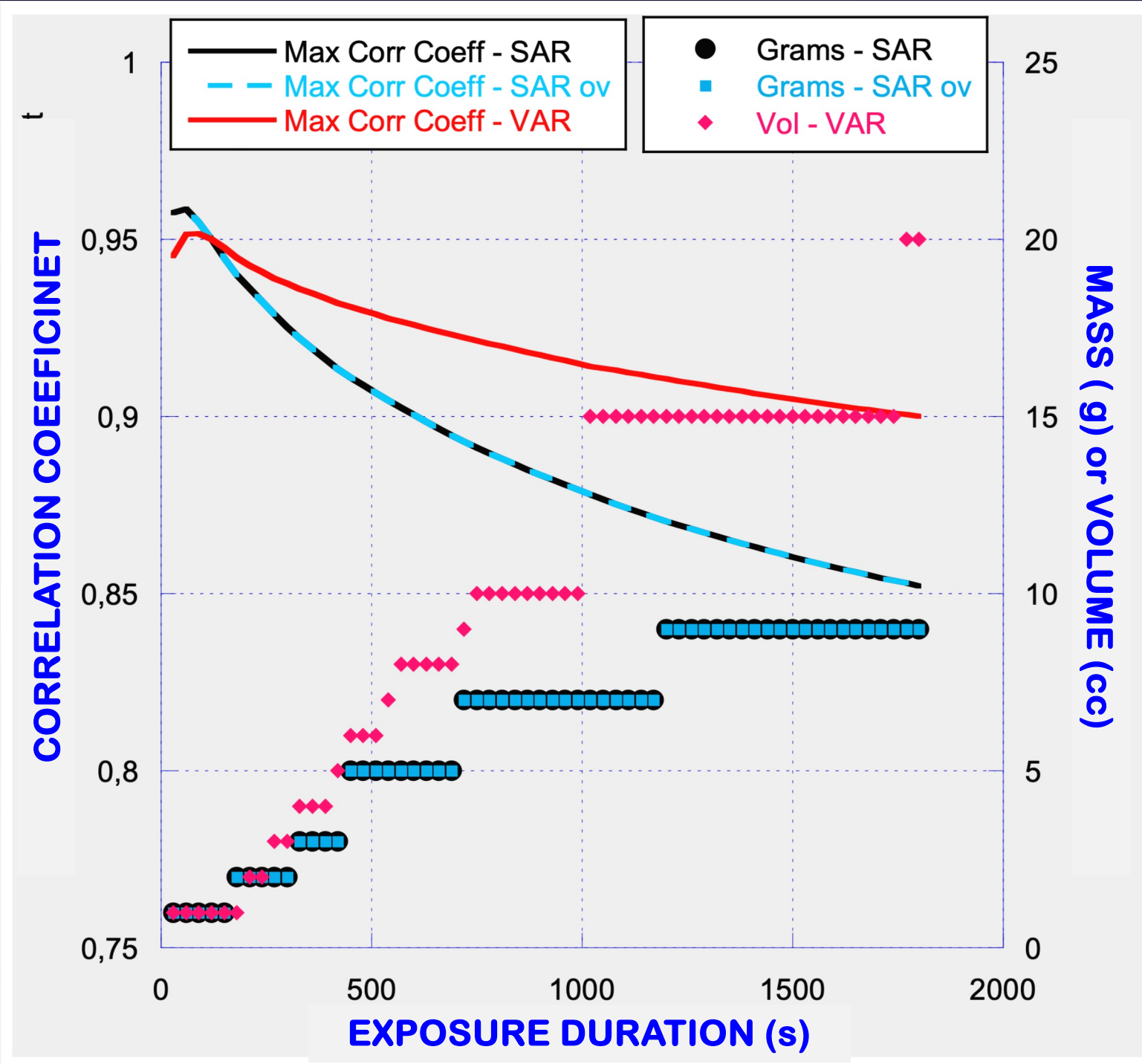
Anomalies and Inconsistencies (4)

- The revisions objected with **putative “chance differences”** from experimental treatments or resulting body temp rise of 1 °C in rats
- Overlooked **serious error in declaring** a 1 °C body temp rise as cancer causing
- Decision totally **ignored the independent variable** for the animal experiments — **RF exposure**

Anomalies and Inconsistencies (5)

- Other issues such as:
- Revised limits do not provide any adjustments for effects due to **long-term** human exposures (> 6 or 30 min).
- Total **lack of appreciation** of scientific knowledge on **chronic toxicology, genotoxicity, and carcinogenicity** regarding RF exposures below the basic restrictions promulgated by the exposure limits
- **Outdated characterization of SAR**, by not accounting for averaging mass and exposure duration dependences.

Correlations among exposure duration, SAR, and temperature elevation for 800 MHz plane wave in anatomic human models



Conclusions

- **Mobile phone** and wireless technologies have **demonstrated benefit to persons** in modern society
- For **impact on health and safety** of humans who are unnecessarily subjected to high levels of RF exposure over prolonged durations or even over lifetimes, **the jury is IN.**
- **Epidemiological** studies and **animal** investigations are **consistent** in indicating **RF exposure as probably carcinogenic to humans.**
- The **principle of ALARA**—as low as reasonably achievable—ought to be adopted **as a strategy for RF health and safety protection.**



THANK YOU !

Some of My Related Recent Publications

1. “RF Health Safety Limits and Recommendations,” *IEEE Microwave Magazine*, Vol. 24/6, pp 18-22(77), June 2023
2. “Incongruities in recently revised radiofrequency exposure guidelines and standards.” *Environmental Research*, 222, April 2023
3. “Carcinogenesis from chronic exposure to radio-frequency radiation.” *Front. Public Health*, 10: 1042478, Oct 2022
4. “Health Safety Guidelines and 5G Wireless Radiation,” *IEEE Microwave Magazine*, Vol. 23/1, pp 10-13, Jan 2022
5. “Science, Politics, and Groupthink.” *IEEE Microwave Magazine*, Vol. 22/5, pp 24-26, May 2021
6. “FCC Announces Its Existing RF Exposure Limits Apply to 5G.” *IEEE Microwave Magazine*, Vol. 21/4, pp 15-17, April 2020

Correlation coefficients of linear fitting for different averaging schemes after 30 min (steady state) RF exposure of anatomic model

