ATTACHMENT 5

# RF EXPOSURE AND COMPLIANCE STANDARDS

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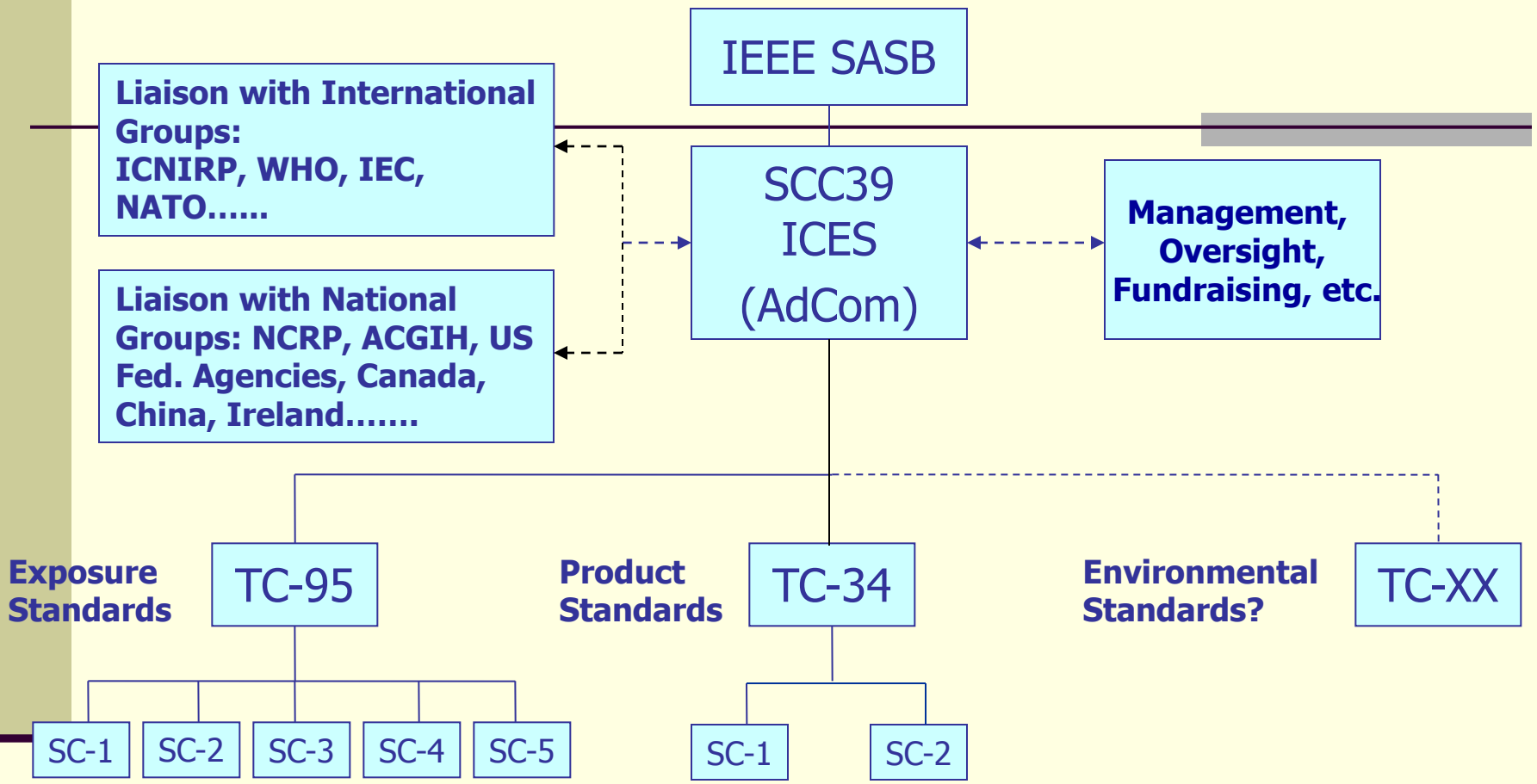
# ICES as the Focal Point in the Global Program for EME Safety Standards




**SC-1: Measurements & Calculations**
**SC-2: Warning Signs/Hazard Comm**
**SC-3: 0-3 kHz**
**SC-4: 3 kHz - 300 GHz**
**SC-5: EEDs**

**SC-1: SAR Evaluation – Measurement Techniques**
**SC-2: SAR Evaluation – Computational Techniques**

# IEEE Safety Standards History

1960: USASI C95 Radiation Hazards Project and Committee chartered

1966: USAS C95.1-1966

- 10 mW/cm$^2$ (10 MHz to 100 GHz)
- based on simple thermal model

1974: ANSI C95.1-1974 (limits for $E^2$ and $H^2$)

1982: ANSI C95.1-1982 (incorporates dosimetry)

1991: IEEE C95.1-1991 (two tiers – reaffirmed 1997)

2002: IEEE C95.6-2002 (0-3 kHz)

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

# C95.1-2005 definitions

- **biological effect:** A biological effect is an established effect caused by, or in response to, exposure to a biological, chemical or physical agent, including electromagnetic energy. Biological effects are alterations of the structure, metabolism, or functions of a whole organism, its organs, tissues, and cells. Biological effects can occur without harming health and can be beneficial. Biological effects also can include sensation phenomena and adaptive responses.
- **adverse health effect:** A biological effect characterized by a harmful change in health.

Recommendations are made to protect against established adverse health effects in human beings associated with exposure to electric, magnetic and electromagnetic fields in the frequency range of 3 kHz to 300 GHz.

# ANSI C95.1-1982 standard

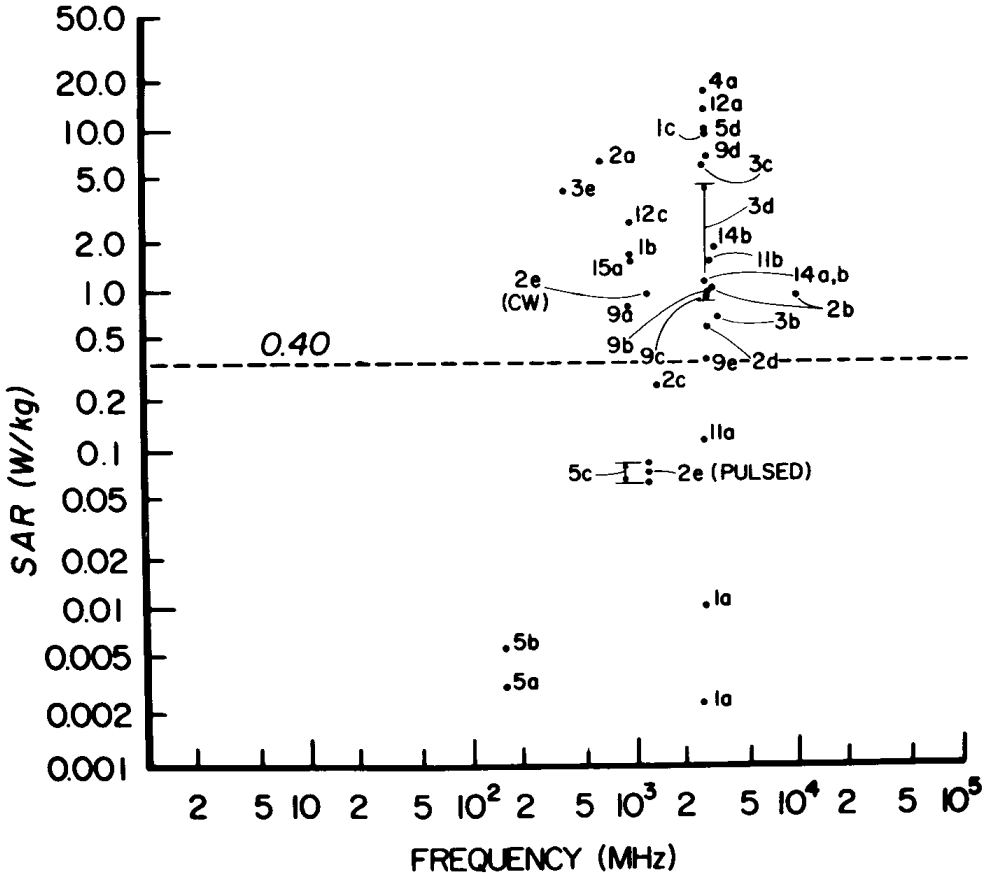


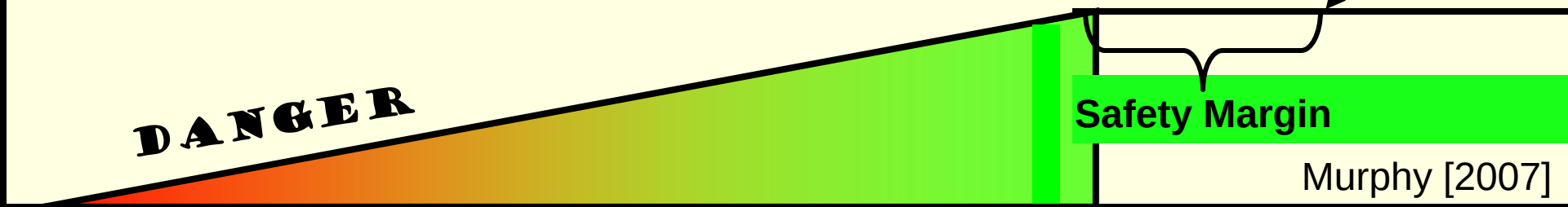

**Fig A3**
**Whole-Body-Averaged SAR**
**Corresponding to Biological Effects Reported in**
**Various References of Appendix**

# Safety factors

- ANSI C95.1-1982
  - A factor of 10 for one tier standard
    - Whole body SAR 0.4 W/kg
  - Based on man model and animal data, peak to whole body SAR ratio 20X
    - Peak SAR 8 W/kg averaged over 1 g
- NCRP 1986
  - Occupational 10X
  - General public 50X
- IEEE C95.1-1991
  - Controlled Environment 10X
    - Whole body 0.4 W/kg, Peak 8 W/kg per 1 g
  - Uncontrolled Environment 50X
    - Whole body 0.08 W/kg, peak 1.6 W/kg per 1 g
- IEEE C95.1-2005 (based on database before December 31, 2003)
  - Controlled environment 10X
    - Whole body 0.4 W/kg, Peak 10 W/kg per 10 g
  - Action level 50X
    - Whole body 0.08 W/kg, Peak SAR 2 W/kg per 10 g

# An exposure limit is NOT like the edge of a cliff, with immediate danger when it is exceeded.


**Limit values are conservatively set some distance from the start of a slope, down which the possibility of danger gradually increases.**




Murphy [2007]

# Nature of Standards

- **Exposure standards** – based on science, with large safety margins, conservative, protective, realistic

- **Compliance standards** – precision, repeatability, conservative, can be implemented, easy to regulate

Need trade offs, when a standard is good enough, and agreed by >75% voting members.

Standards are living documents, and can be improved based on the best scientific information at the time.

Charlie Backof: “Good engineers know how to solve a problem. Great engineers know when to stop.”

# Benefits of Harmonization

Supports WHO harmonization efforts

- **Consumers** gain the protection of an internationally recognized safety standard, and have equal access to products and services that are available to consumers elsewhere in the world
- **Regulators** can have a consistent approach to regulation consistent with the recommendations of the WHO, the ITU and the WTO
- **Industry** gains by developing and manufacturing products to a widely accepted international standard and, once tested for compliance, can make those products available around the world in a consistent and timely manner

# Conclusions

- Exposure standards have large safety margins.
- Compliance standards should be practical and realistic.
- We should not be in a position where we can’t see the forest for the trees.
- Harmonization is the key issue for exposure and measurement standards.