International Amateur Radio Union Region 1

Europe, Middle East, Africa and Northern Asia Founded 1950

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Subject	**Report from ICNIRP Workshop**		
Society	EMC Chair	**Country:**	Germany
Committee:	**EMC**	**Paper number:**	**C7-11**
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Report from ICNIRP Workshop held in Istanbul 26-28 May 2015

Thilo Kootz, DL9KCE

Scope

In view of updating the guidance on limiting exposure to high frequency (HF) fields, ICNIRP reviewed the current scientific knowledge on the thresholds of thermal damage. The current workshop revisited the ICNIRP 1998 concept, namely that the health relevant increase of body core temperature is approximately 1° C and a whole-body exposure with an average SAR of 4 W/kg result in a core temperature increase of less than 1°C within 30 min. Details of this concept as well as thresholds for partial/local body exposures are subjects to review.

Scope

Amongst others, the following topics and questions were addressed:

Definition/Specification of the threshold for thermal damage:

a) with respect to - the whole body, - parts of the body (limbs, trunk, head), - different organs (i.e. brain, eye, testis, skin etc.) - different tissues (muscle, fat, nerve, connective tissue) b) regarding frequency dependence

c) with respect to external conditions (cold and hot environment, humidity, clothing)

d) with respect to internal/individual conditions (interindividual variations, age-dependence, health status, metabolic status, medication, compromised thermoregulation, pregnancy,…)

Definition/Specification of the health relevant quantity (SAR, power flux density, temperature, thermal dose/CEM43°C, Arrhenius thermal dose rate)

Is our thermoregulation (evolved to respond to physical work and hot environments) effective in responding to local (internal) HF-induced heating?

Is the averaging time of 6 min and the averaging mass of 10g of contiguous tissue appropriate?

Has exposure duration to be taken into account (even at low exposure levels)?

Speeches

- Andreas Flouris, University of Thessaly, Greece
  - functional architecture of the thermoregulatory system
- Thomas Voets, University of Leuven, Belgium
  - Thermosensation - Ion channels as molecular thermosensors
- Heidi Danker-Hopfe, Charité, Berlin, Germany
  - Thermoregulation, sleep and ageing
- Eugene A. Kiyatkin, NIDAIRP Baltimore, US
  - On the temperature sensitivity of the brain
- Andreas Flouris, University of Thessaly, Greece
  - Heat load limitations under normal and stress conditions
- Masami Kojima, Kanazawa Medical University, Japan
  - Ocular thermal injury
- Roger Mieusset, CHU Toulouse, France
  - Genital heat stress and semen quality
- Ken Foster, University of Pennsylvania, Philadelphia, US
  - (Thermal) mechanisms of interaction between HF and biological systems

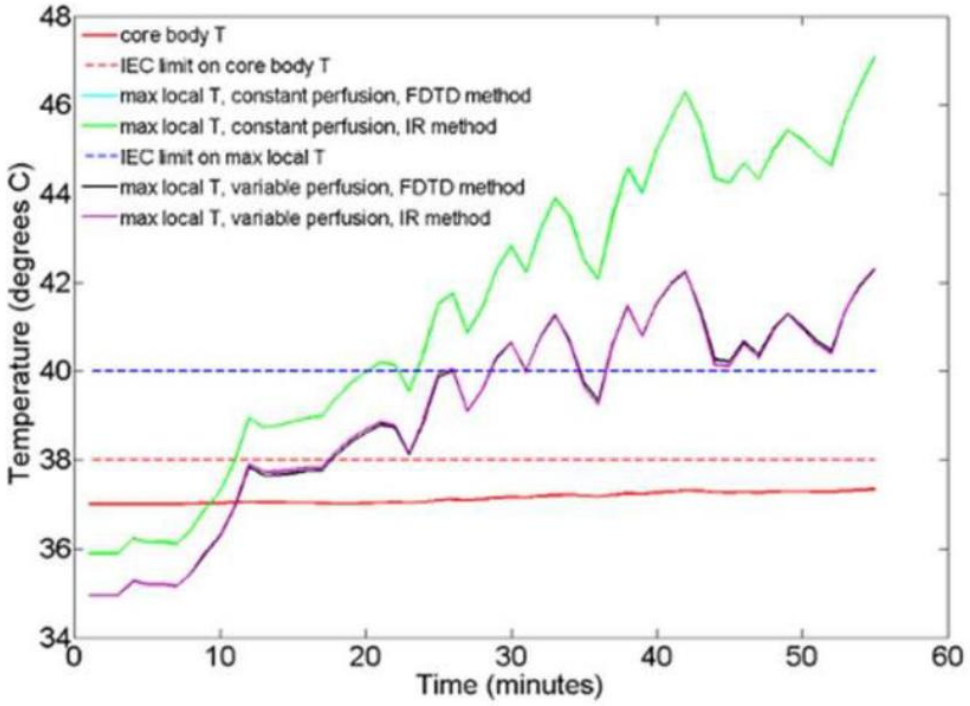
Speeches

- Akimasa Hirata, Nagoya Insitute of Technology, Japan
  - Computational age dependence of heating, heating of the eye, relationship between SAR and temperature
- Marvin Ziskin, Temple University Medical School, Philadelphia, US
  - Frequency dependence of heating, thermal threshold for teratogenicity, reproduction and development
- Christopher M Collins, New York University School of Medicine, US
  - RF pulse sequence and temperature elevation
- Gerard van Rhoon, Erasmus MC Cancer Institute, Rotterdam, Netherlands
  - Mild hyperthermia in cancer therapy
- Elizabeth Repasky, Roswell Park Cancer Institute, Buffalo, US
  - The role of temperature in cancer immunology
- Theodoros Samaras, Aristotle University of Thessaloniki, Greece
  - CEM43°C thermal dose thresholds for MRI
- Manuel Murbach, IT´IS, ETH Zurich, Switzerland
  - Tissue heating during MR examination as function of RF exposure and local thermoregulation, consequences for the MR safety standard IEC 60601-2-33
- Johan van den Brink, Philips Healthcare, Best, Netherlands
  - Evaluation of estimated CEM43 values attained for realistic use cases under (local) SAR constraints imposed by IEC60601-2-33
- Niels Kuster, IT'IS, Zurich, Switzerland
  - Temperature rise due to medical implants

Christopher Collins

Series of Pulse Sequence and Temperature (in realistic MRI exam)

- SAR levels and SAR distribution can change on the order of minutes through an MRI exam



Christopher Collins

Conclusions

- Temperature depends on RF heating distribution as well as rate of perfusion by blood, etc.
  - It is difficult to heat brain compared to most other tissues
- Limits of temperature and thermal dose can alleviate dependence on time average necessary for SAR limits and need for averaging mass for (10g) local SAR limits, as well as improve relevance of what we regulate
- For pulse sequences relevant to MRI and communications, there is no need to consider SAR timecourse down to the level of milliseconds
- Heating timecourse on the order of minutes (series of MRI pulse sequences in an exam, positioning and use – or not – of cell phone through time) can result in temperature changes on the order of 1°C

Niels Kuster

Summary

- the hypothesis that “a significant portion of the population (people w/ passive or active medical implants) is not protected from serious health hazards below 100 MHz (e.g., MRI, wireless power transfer)” is true.
- revision of limits or statement in standard “people w/ implant are not protected” needed
- the hypothesis that “spatial averaging mass of 10g is too large for localized exposure” is true for implant safety consideration.
- reduced averaging mass needed for conservative ΔT estimation
- restriction to contiguous tissue is important
- most elongated implants in MR are not intrinsically safe
- risk-benefit considerations for implants in MRI are needed

Manuel Murbach

Conclusions

- enforcement of ICNIRP localized SAR limits would be too conservative
- strict enforcement of the current temperature limits (39°/40°) may be very restrictive and overly conservative regarding the history of safe use
- risk-benefit analysis and the well controlled environment (exposure/environment) justify a more progressive safety concept
- governing limitations should be based on thermal dose (CEM43) rather than temperature or local SAR

Marvin C. Ziskin, M.D.

Temperature Rise From Whole Body SAR

SAR	Temp Rise	Comment
15 W/kg	4.0 ^{0}C	Abnormality
4 W/kg	1.0 ^{0}C	No Harm
1.5 W/kg	0.4 ^{0}C	Safe Level
0.4 W/kg	0.1 ^{0}C	RF Standard

Note: Diurnal Variation = ± 0.5 ^{0}C

Mieusset Roger

3. Is the 6-minute average currently used by ICNIRP for setting limits sensible in terms of the defined threshold?

For each posture for at least 45-60 min, a steady-state is achieved after 30 to 40 min.

Some authors used the mean values of the recordings for the first and the last 10 min to evaluate the thermal impact on scrotal temperature of a given factor (e.g. type of underwear) in a given posture.

(Jung et al. 2004, 2008)

Kenneth Foster

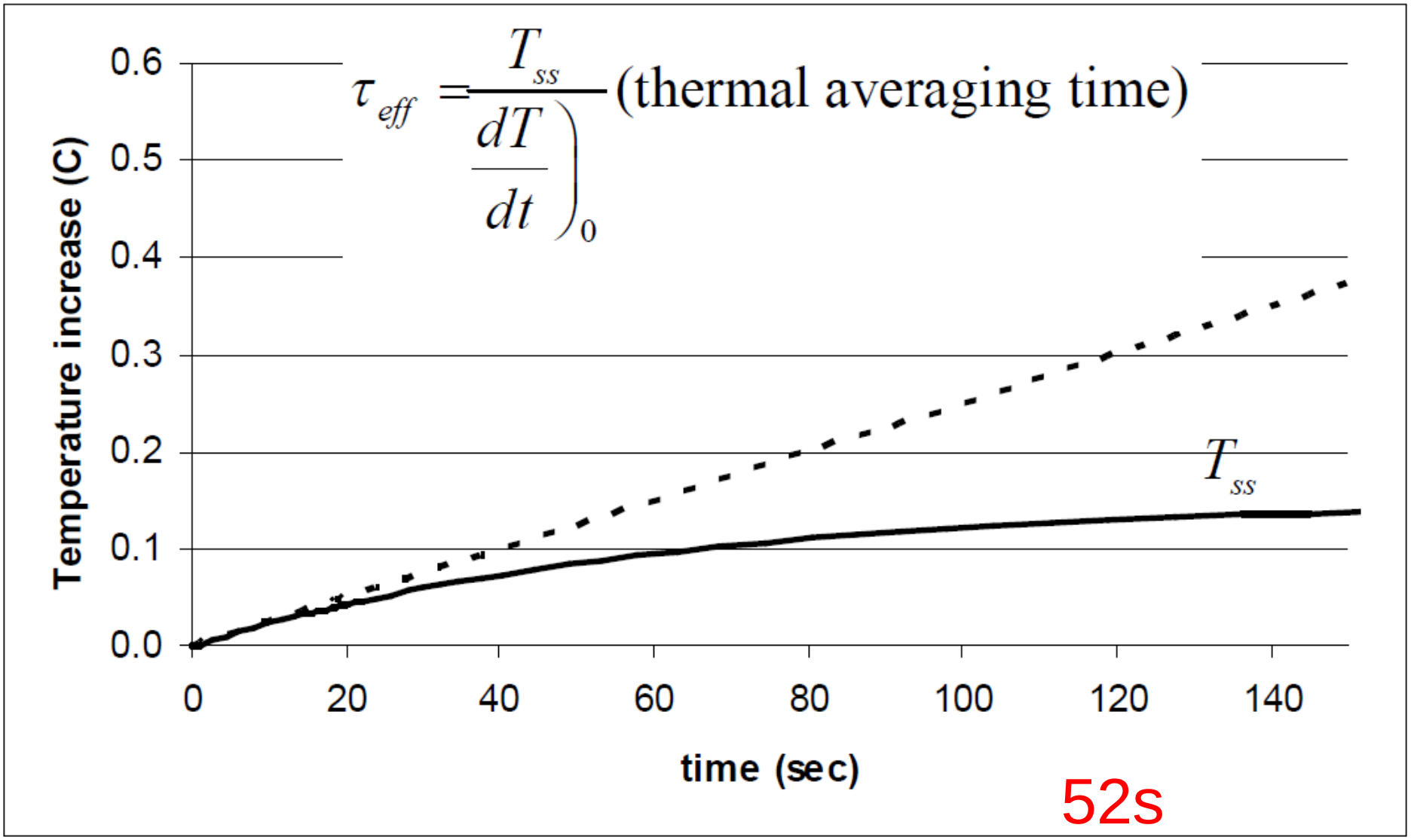
Thermal and Spatial Averaging

WHENCE 6 MINUTES?

"Our early C-95.4 Committee needed to recommend a time constant. My suggestion was 0.1 h. I was trying to come up with a number with as few significant figures as I could, considering the precision of what we were dealing with. A minute was too short — an hour was too long. But, alas, 0.1 h turned into 6 min, and 6 min implies an accuracy beyond the art…"

Tom Ely (1998) quoted in Foster et al, Bioelectromgnetics 19:420 – 428 (1998)

Kenneth Foster



Conclusion

- Scientific work is in a very early stage
- Not very much enthusiasm currently
- General tendency: Current limit are conservative
- For true involvement of IARU, a lot more is necessary
- Will future ICNIRP publications be used for EU policy?
- Process will cost at least 10 years until policy is changed

“Amateurs Radio is just a hobby, no limits in Turkey”