A Global Survey and Comparison of Different Regulatory Approaches to Non-Ionizing RADHAZ and Spurious Emissions

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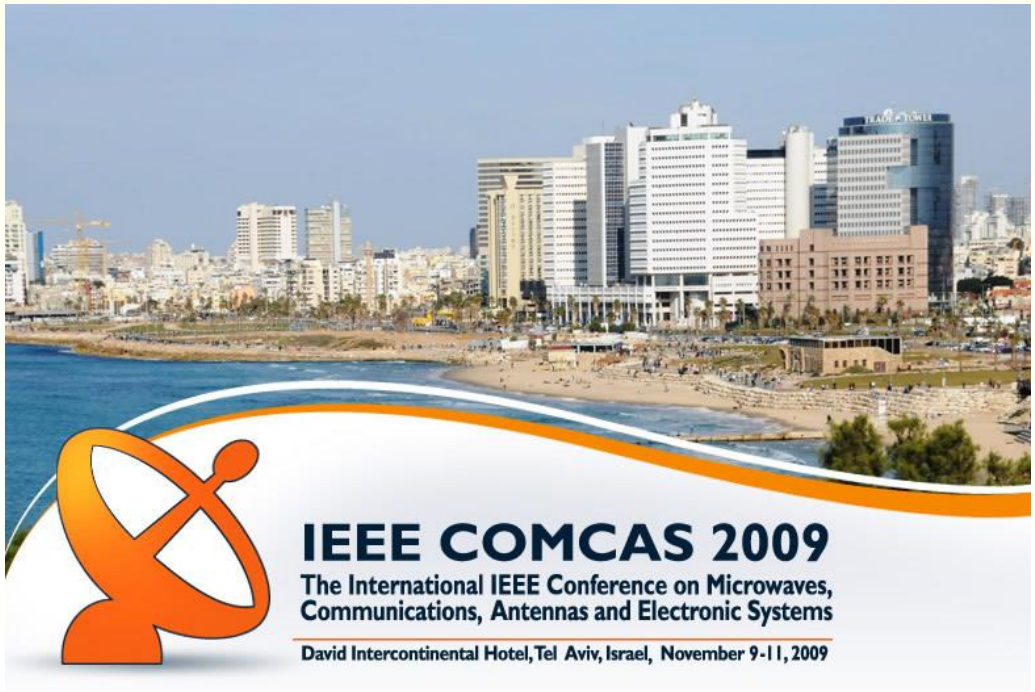

Purpose / Motivation

- Why are there so many different thresholds worldwide for Radiation Hazards (RADHAZ)?
- The topic is of great public interest
- 1996 Santa Rosa ITU-R (International Telecommunications Union) Study Group 1 meeting on Spurious Emissions has triggered my personal interest
- A worldwide survey of regulations and standards in 235 countries (PhD research)

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Outline

- The different approaches in applying **RADHAZ** limits worldwide for Cellular Base Stations and Utility Power Lines
- The different approaches in applying **Spurious Emission** limits worldwide
- A survey of the differences
  - What are they? - Comparison tables
  - Why? - culture and geography

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RADHAZ: Quantities and Units

Quantity	Symbol	Unit	Unit-Symbol
Frequency	f	Hertz	Hz
Magnetic flux density*	B	Tesla	T
		Gauss	G
Specific Absorption Rate	SAR	Watt per kilogram or milliWatt per gram	W/kg or mW/g
Power density or power flux density	S	Watt per square metre	W/m^2
		mWatt per square cm	mW/cm^2

*** to convert from microtesla (μT) to milligauss (mG), multiply by 10.**
1 μT = 10 mG; 0.1 μT = 1 mG.

An error in this conversion resulted in the delay of 3 years in populating an administrative building in Jerusalem.

ICNIRP and EC Levels for RADHAZ

Frequency range	Equivalent plane wave power density S_{eq} (**W/m^2**)	Magnetic Flux Density (μT), B
25-800 Hz	-	**5,000/f**
400-2000 MHz	**f/200**	0.0046 f ^{½}
2-300 GHz	10	0.2

Same formula adopted in Europe and North America:
100μT for 50Hz Europe, and 83.3μT for 60Hz North America.

Differences ICNIRP versus USA (FCC)

Power Density Limits (W/m^2)

Frequency range	ICNIRP	ANSI (USA)
	General Public	Uncontrolled
400 - 1,550 MHz	f /200	f /150
1,550 - 2,000 MHz	f /200	f /150

- **IEEE C95.1-2005 exposures at 400-2,000 MHz is now 4/3 more stringent (new f/200 W/m^2) relative to IEEE 1991 (f/1500 mW/cm^2 = f/150 W/m^2)**
- **The updated IEEE value (2005) is identical (not to FCC nor ANSI present levels) to the ICNIRP level (f/200 W/m^2)**

Tolerability to EM Risk, relative to ICNIRP1998

- **US, Canada and Japan** are more tolerant of risk - 133% ICNIRP
- Countries **less** tolerant of risk, with more stringent thresholds:

Country	*Power Density Relative to ICNIRP*
Switzerland	1%
Italy	2%- 20%
Poland	2%
Luxembourg	5%
China	8%
Israel	10%
Bulgaria	12%
Russia	20%
Belgium	25%
Greece	80%

See WTO http://www.who.int/docstore/peh-emf/EMFStandards/who-0102/Worldmap.htm

Tolerability to Magnetic Risk, relative to ICNIRP1998

Countries Less Tolerant to Magnetic Risk

Country	*Magnetic Flux Density Relative to ICNIRP*
Switzerland	1%
Italy	3% (daily mean, for more than 4 hours); 10% (for 'designed lines')
Slovenia	10% (for new installations)
Israel	10% (proposed in 'occupational' area)
Russia	10% (indoor); 50% (outdoor)
Poland	75%
Greece	80%

Considerations in Setting Thresholds

- Tradeoff - **cellular coverage and electricity infrastructure** vs. human hazards
- Scandinavian economy; Northern population is more tranquil and restrained; essentiality of wireless communications
- Levels in Switzerland and Slovenia were influenced by Italy due to geographical (and linguistic) vicinity
- Italian instability, topography and FM pirates
- Trusting styles may lead to less precaution; less precaution is typical to the 'innocent until proven guilty' way of thinking: there are no hazards to humans until the risks are scientifically proven
- Common law vs Civil law; Protestantism vs Catholicism (Max Weber: “either eat well or sleep well”); Colonialism; Worldviews
- None of the English-speaking countries applies more restricted limits than ICNIRP levels

RADHAZ Trends

- The allowed exposure levels are reducing with time (UK, Singapore)
- The same countries (Italy, Switzerland and Poland) are intolerant to excessive emissions both from cellular base stations and from utility power lines
- Cultural differences and mentality may explain the different approaches
- A need to manufacture and to circulate the same cellular handsets all over the world; Globalization leads to **harmonization** in SAR limits for handsets

ITU Categories for Spurious Emissions Limits

Category A	Spurious emissions of **ITU Radio Regulations** Appendix 3
Category B	Limits are defined and adopted in **Europe**
Category C	Limits are defined and adopted in the **US and Canada**
Category D	Limits are defined and adopted in **Japan**

Comparison of Spurious Emission Categories

Type of equipment	Category A: All Countries	Category B: Europe	Category C: USA, Canada
Land mobile service	43 +10 log *P*, or 70 dBc, whichever is less stringent *Actually - 43 dBW=* *-13dBm*	mobiles & base stations: –36dBm for 9kHz≤ *f*< 1 GHz –30 dBm for1GHz ≤ *f*<300GHz	150-174 MHz and 421-512 MHz whichever is less stringent 50+10 log *P* or 70 dBc for 12.5 kHz channels
Fixed service		–50 dBm for 30 MHz ≤ *f* < 21.2 GHz –30 dBm for 21.2GHz ≤ *f* <300 GHz	As in Category A

Spurious Emissions (dBm) for Various Systems

Type of equipment	Category A: All Countries	Category B: Europe	Category C: USA, Canada	Category D: Japan
Portable, 465MHz, 1W	-13	-36	-20	-30
Fixed Service, 325MHz, 10W	**-13**	**-50**	**-13**	**-20**
HF Broadcasting, 100 kW	17	17	0	17

Conclusions: Spurious Emissions

- Significant diversity among the different regions
- Tradeoff - **spectral purity** vs. **equipment's cost**
- Europe is stringent in protecting the natural RF resource
- N. America and Japan are more sensitive to market needs (compare also UWB Europe/US/Japan)
- Europe also regulates the spurious emissions of unlicensed SRDs, whereas N. America and Japan do not
- But the US is very keen to protect its exclusive GPS: strict emission limits applied for 1.575GHz

Conclusion (1/2)

Standards and Thresholds: Europe vs. North America

Standard	*Main Power*	*Spurious Emissions & Human Hazards*
Europe	50 Hz	Stringent
North America	60 Hz	Flexible

- US, Canada, and Japan are more tolerant to RF exposure limits from cellular base stations
- These countries are also more lenient with regards to spurious emissions
- “Central planning” EC adopts a precautionary principle in human hazards and protects its congested RF spectrum by enforcing stringent spurious emissions
- N. America prefers *laissez-faire* policy, in order to lower prices of wireless equipment

Conclusion (2/2)

- Universal thresholds (human hazards and spurious emissions) will avoid a Babylon tower of thresholds that confuse suppliers, operators and users
- Variations reflect the societal concerns, social amplification, the acceptance of the precautionary principle, obedience and the national tolerability to risk
- A convergence to 2 hemispheres: Europe regulated by CEPT and EU; American standards, led by the US (and Canada)
- Book covering the topic and correlating the differences in tolerability to risk in Europe and the US with distinctive legal origin (Civil Law vs. Common Law) and religion (Catholicism vs. Protestantism):

"An Analysis of Regulatory Frameworks for Wireless Communications, Societal Concerns and Risk" / Dr. Haim Mazar

http://www.moc.gov.il/new/documents/frequences/MazarThesisOct08.pdf

http://www.universal-publishers.com/book.php?method=ISBN&book=1599427109

Backup: Comparison Cellular Handsets, SAR (W/kg)

10 MHz–10 GHz Portables; General Population

ICNIRP	European Community	FCC- USA
2.0; averaged over 10 g tissue		1.6; averaged over 1g tissue

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