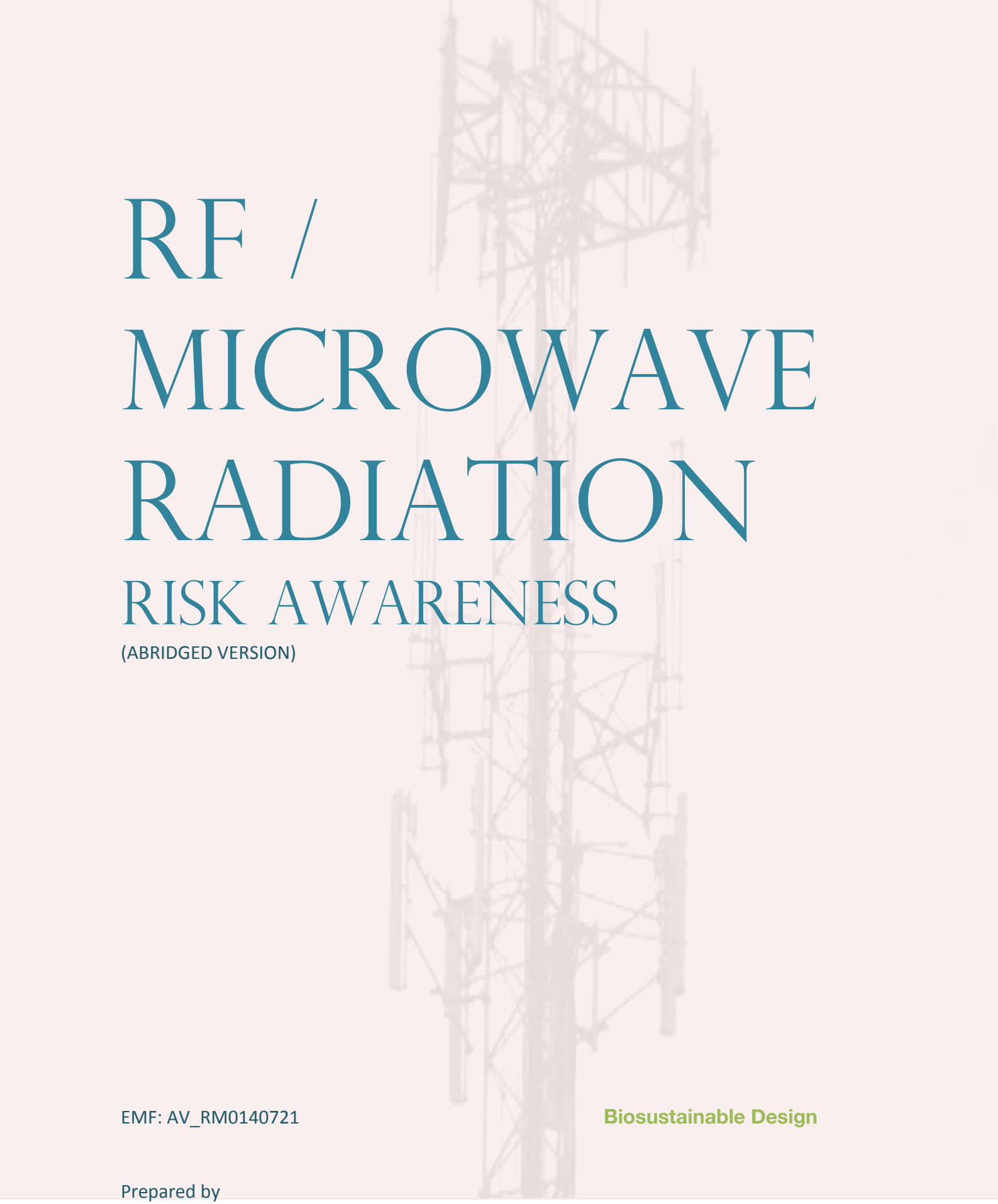

RF / MICROWAVE RADIATION

RISK AWARENESS

(ABRIDGED VERSION)

EMF: AV_RM0140721

Biosustainable Design

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CONTENTS

Introduction

There are numerous scientific studies indicating adverse health effects can arise from even very low levels of RF exposure in the 3 kHz to 300 GHz frequency range (BioInitiative Working Group 2012). It is for such reasons that over 40% of the World's populations have exposure guidelines substantially more rigorous than those provided by ICNIRP (Figure 1).

> *"… the ICNIRP guidelines are neither mandatory prescriptions for safety, the "last word" on the issue nor are they defensive walls for Industry or others"*
>
> Vecchia (2008).

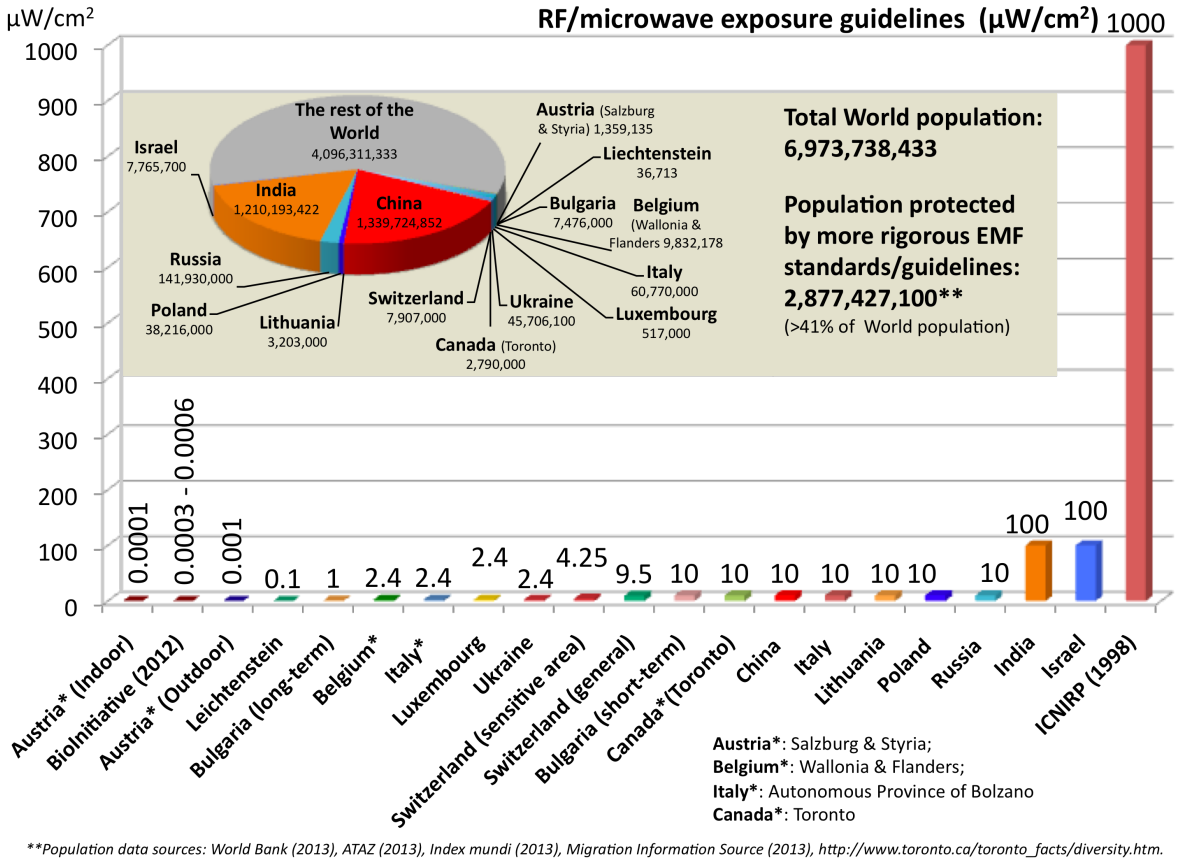

Figure 1: Comparison of RF exposure guidelines and global population.

Austria (Salzburg and Styria)

As there are no explicit regulations by law regarding standards for the health protection of the general population at the federal level (i.e. for the whole Austria), there are non-binding recommendations from different Austrian Ministries, as well as State Parliaments (e.g. Salzburg and Styria), regarding standards for the health protection of the general population.

The Parliament of Styria in Austria has also adopted the Salzburg precautionary value as a recommended limit for electromagnetic radiation in Styria to minimize health risk (Landtag Steiermark 2008) [Information from Jamieson 2013a].

In December 2010, the Austrian Ministry of Health (BMG) published the document "Aspects of the current health assessment of mobile communications - Recommendation of the Supreme Health Council" (BMG 2010). Among its recommendations are the following:

- *"Radio equipment, which leads to a prolonged exposure of people should be set up using a precautionary target value, since long-term effects can not be excluded with sufficient certainty."*
- *"This target value should be set for high-frequency effects at least a factor of 100 below the limit for the power density of the ÖNORM E 8850"* [Oberfeld (2012) notes that ÖNORM E 8850 is similar to ICNIRP 1998].
- *"In addition, legal measures should be taken, that a) in case that various electromagnetic fields acting simultaneously, all relevant frequencies of different emitters are not to exceed the limits and operators are encouraged to minimize exposure from electromagnetic fields well below the limit values during planning and operation"* (BMG 2010).
- The parliament of Salzburg demanded different measures to be taken by the government like to implement a cadaster of all RF/MW antenna sites and publish them in the Salzburg Geographic Information System (SAGIS) as well to the prescribe the special precautionary values for RF/microwave radiation Salzburg (Land Salzburg 2002).

Bulgaria

In Bulgaria, the Health Minister is responsible for the evaluation of the exposure of the general public to EMF and addressing possible adverse effects, *"the limit value for microwaves is 10 µW/cm^2. Compared with the limits recommended by EC (ICNIRP), they are 45 to 100 times more stringent for the frequencies used by the GSM technology"* (Israel 2013).

There are two differentiated exposure categories for the general population:

- **Short-term exposure:** These are for areas where only short-term human stay is possible: hard-to-access areas; and sloping roofs on residential buildings.

  For this type of exposure, the exposure limits proposed in CR 1999/519/EC (ICNIRP) for the frequency range > 0 Hz to 300 GHz are accepted as a basic restriction.

- **Areas where temporary and/or periodical human stay is possible:** agricultural lands; accessible roofs of residential buildings; electric transport; residential areas; and streets.

A precautionary sub zone is also part of the second exposure category, *"... it sets "sensitive" in relation to risk perception regions defined as sites for public purposes: for recreation and leisure, recreation parks, health recreation facilities, facilities for elderly people, rehabilitation and social re-adaptation establishments, children centers, schools, kindergartens, healthcare establishments. This sub zone is defined only for exposure to base stations in the frequency range 850 to 2150 MHz*" (Israel 2013).

For the second category, Bulgaria's strategy is to retain the actual exposure limits it previously used for frequencies between 30 kHz and 30 GHz. In the precautionary sub-zone for the general public the exposure limit is 1 µW/cm^2 [Information from Jamieson 2013a].

People's Republic of China

In the WHO's EMF database for the People's Republic of China there is a review by Cao (2007) documenting the findings of general EMF-related health research in China from 1994 to 2006.

From the total of 383 Chinese papers investigating EMF biological effects in the China National Knowledge Infrastructure (CNKI) databank (this figure excludes papers investigating: EMF medical treatment; EMF prevention; EMF regulation, environmental EMF exposure assessment; and restricted People's Liberation Army research papers on the topic), it is stated that there were 109 epidemiological studies. 108 of these noted biological effects as a result of exposure.

In the epidemiological studies reviewed, 32 were for exposure levels higher than EMF exposure limits for the general public in China. The other 77 were for exposure levels lower than its public exposure limits. Details of those exposure limits are given in Table 1.

Table 1: General Public Exposure Limits to RF/microwave radiation in China (Chiang 2009).

Frequency	1st class exposure limits	2nd class exposure limits
0.1-30 MHz	10 V/m	25 V/m
>30-300 MHz	5 V/m	12 V/m
>0.3-300 GHz	10 μW/cm^2	40 μW/cm^2

1st class exposure limits: Exposures below these levels thought to be safe for permanent exposure and all people (including infants, pregnant mothers, patients, older people, etc.).

2nd class exposure limits: Exposures below these levels acceptable for short-term exposures (factories, parks, recreation spaces, etc.). **Living quarters, hospitals, schools, kindergartens, etc., not allowed to receive such exposures.**

Health effects for the 108 epidemiological studies that reported effects included: abnormal ECG; disorder of immunoglobulin; miscarriage; neurasthenia; poor sleep quality; and sperm dysfunction. Quoting Cao (2007): "*No matter what the exposure level may be, lower or higher than [the Chinese] EMF exposure limits for public, health effects had been reported in these papers. ...*"

Actual exposure levels for the general public in China are well below the rigorous Chinese General Public Exposure Limits. Chiang (2009) remarked that in 3 Chinese cities assessed around 1% of the urban population was exposed to levels >1V/m or 2 μW/cm^2, and that "*Only a very small percentage may be exposed to levels comparable to the [Chinese] limits (in most cases for short time only)*" [Information from Jamieson 2013a].

It would appear prudent for the WHO to obtain translations of the epidemiological studies documented above, so they can be added to the WHO database and properly assessed by those setting guidelines.

India

The adoption of the 'Precautionary Principle' is evident in India with regard to its Government's recent decision to reduce RF/microwave exposure levels to 10% of those presently allowed in ICNIRP guidelines (Government of India 2013).

An example of the findings of the scientific review process that led to such a drastic reduction in exposure levels being made, after a review of all relevant scientific studies utilizing a weight-of-evidence basis is shown in Figure 2.

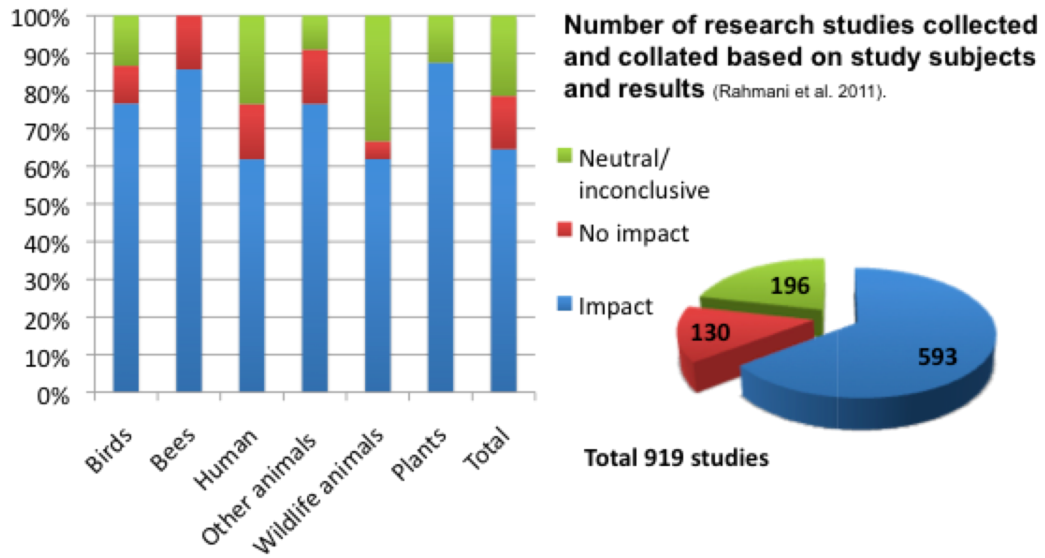

Figure 2: Summary of findings of reviewed EMF research studies on EMFs (Rahmani et al. 2011).
[Information from Jamieson 2013a].

The Russian Federation

> "*The hygienic standards are for the protection of the population, taking into account factors potentially harmful to health, and with the obligation of taking into account typical prevalence of these factors in the general population*" (Grigoriev 2008).

It is recognized by the Russian National Committee on Non-Ionizing Radiation Protection (RNCNIRP) that though individuals are seldom exposed to acute levels of RF/microwave radiation in daily life, most are chronically exposed on a daily basis to low levels of such radiation which can also cause biological effects and standards which recognize this need to be set and adhered to (Grigoriev et al. 2003).

The SanPiN 2.1.8/2.2.4.1190-03 safety standard on mobile communications states that in the Russian Federation the maximum permissible exposure for the general public in the 300 MHz to 300 GHz range is 10 $\mu W/cm^2$. It also recommends: "*Use of mobile telecommunication devices should be restricted for those under 18 years of age and pregnant women*" (SanPiN 2003).

In particular, Russian Authorities recognize the need to develop appropriate new exposure standards for children that take into account likely localized brain exposures arising from mobile phone use and the ages of individual children. As noted by Grigoriev (2010) quoting WHO (2003): "*Children are different from adults. Children have a unique vulnerability. As they grow and develop, there are 'windows of susceptibility': periods when their organs and systems may be particularly sensitive to the effect of certain environmental threats."* He states that: "*Children should use mobile phones for emergencies only and also use hands free*" (RRT 2012).

> "*It is necessary to educate scientists, politicians, industries and the general public, including parents and children, that mobile communication devices (and hands-free devices) are not toys, and should be used carefully in a responsible manner. There is no room, or time, for complacency on these matters as related to health, and adopting such measures sooner rather than later could prove highly advantageous to all parties concerned*" Grigoriev (2010).

The RNCNIRP states that the following conditions are likely to arise in children who use mobile phones inappropriately include: poorer cognitive and learning abilities, reduced attention and memory, increased irritability, increased sensitivity to stress, and sleep difficulties and that standards should be more based on biological rather than engineering factors. Promoting the use of the 'Precautionary Principle', it also states that where possible, wired [instead of wireless networks] should be used in kindergartens, schools and educational institutions (RRT 2012).

Spectrum Use, Exposure Risk and Best Practice

In 2011, the World Health Organization (WHO)/International Agency for Research on Cancer (IARC) classified radiofrequency electromagnetic fields "*as possibly carcinogenic to humans (Group 2B)"* and further stated that *"A positive association has been observed between exposure to the agent and cancer for which a causal interpretation is considered … to be credible, …"* This classification covers the whole 30 kHz to 300 GHz radiofrequency (RF) range (WHO/IARC 2013, 2011).

Peer-reviewed research now suggests RF may be Group 2A, 'probably carcinogenic' (Davis et al. 2013), or even Group 1 'carcinogenic' (Hardell & Carlberg 2013).

Members of the telecommunications industry too appear to have concerns over the safety of RF radiation. In 2010, the Vice President, External & State Affairs, of CTIA - The Wireless Association® (which represents the international wireless telecommunications industry) admitted that "*… Industry has not said once, once, that ... [RF radiation is] safe. The federal government and various interagency working groups have said it is safe …*" (Safeschool 2010).

Additionally, a major telecommunications provider is on record as stating: "*The influence of electrosmog on the human body is a known problem. … The risk of damage to health through electrosmog has also become better understood ... When, for example, human blood cells are irradiated with electromagnetic fields, clear damage to hereditary material has been demonstrated and there have been indications of an increased cancer risk*" (Swiss Telecom 2003).

These concerns are also shared by the insurance industry. Swiss Re (2013) comments that electromagnetic pollution may cause "*potentially high financial, reputational and/or regulatory impact or significant stakeholder concern. … Over the last decade, the spread of wireless devices has accelerated enormously. … This development has increased exposure … the health impacts of which remain unknown… The WHO has classified extremely low-frequency magnetic fields and radiofrequency electromagnetic fields… as potentially carcinogenic … If a direct link … were established, it would open doors for new claims and could ultimately lead to large losses under product liability covers.*" Lloyd's of London (2010) state: "*The danger with EMF is that, like asbestos, the exposure insurers face is underestimated and could grow exponentially and be with us for many years*."

"*The current safety limits and reference levels are not adequate to protect public health. New public health standards and limits are needed"* Hardell et al. (2012).

There have already been legal rulings that electromagnetic fields can cause adverse health effects:

- In 2012, the Italian Supreme Court affirmed there was a casual link between a businessman's heavy mobile phone use and his brain tumour (Alleyne 2012, Microwave News 2012).
- In 2013, the Australian government was ordered to pay claims for damaging the health of an employee with EMF sensitivity (Administrative Appeals Tribunal of Australia 2013).
- In 2013, an Israeli cell phone company compensated a customer who contracted cancer (Leibovich 2013, Raz & ZivIsraeli 2013).

The biological effects of new technologies and frequency ranges should be properly assessed before they are even considered for rollouts. Where practical (as a precautionary measure) exposures should be reduced until such works can be carried out and low risk alternatives, such as fibreoptics, specified.

As noted by Professor Oleg Grigoriev, Deputy Chairman of the RNCNIRP: "*We need correct control and assessment of electromagnetic pollution. There are currently a lot of new frequencies containing modulation and no one knows the results which could be a serious problem*" (RRT 2012).

60 GHz Radiation

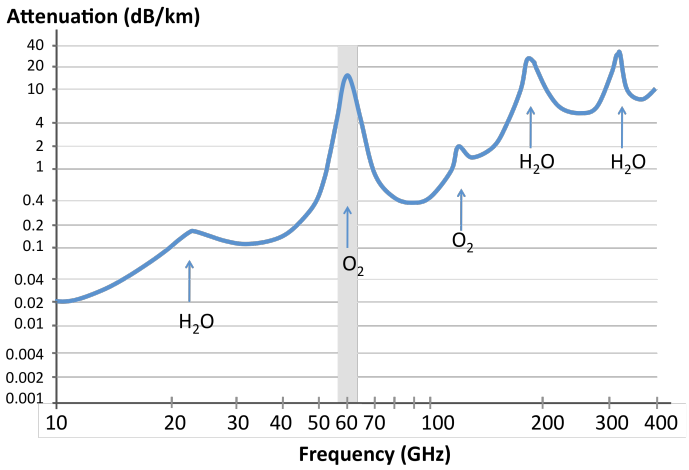

Figure 3: Average atmospheric absorption of millimeter waves (FCC 1997) [Graphic: Jamieson 2014].

Radiation in the 60 GHz waveband, which is now promoted for widespread unlicensed use, is rapidly absorbed by oxygen molecules [O_2] in the atmosphere (FCC 1997) (Figure 3). Though this radiation penetrates the surface of skin and eyes, and can enter skin up to a depth of approximately 0.48mm (Konno et al. 2005), potential health effects do not appear to have been fully considered.

> "*More than 90% of the transmitted power [in the 60 GHz range] is absorbed by the skin*" (Zhadobov et al. 2011).

Since, as noted by Wong & Khaizan (2013), "*… microwave technology is evidently feasible for use in promotion of drug permeation across the skin barrier*", it is hypothesised by the present author that 60 GHz radiation may [particularly over long-term periods] promote diffusive transport and perfusion clearance of biochemical damage caused as a result of oxygen molecule resonance within the outer layer of the skin (Jamieson 2013). Whether long-term exposure to such radiation may promote an increase skin cancers has yet to be determined.

The potential of 60 GHz regimes damaging flora and fauna should also be assessed, as should its likely affects on local and atmospheric concentrations of O_2 and other gases [such as H_2O_2, CO_2, CO and O_3] that are likely to be affected by molecular oxygen [O_2] resonance (Jamieson 2013).

Animal research by Bellossi et al. (2000) found that mice grafted with Lewis tumor cells irradiated with 60 GHz millimetre waves for 30 minutes a day, for five consecutive days a week [at an exposure level of 500 $\mu W/cm^2$] exhibited accelerated tumour growth. Those authors advocate "*prudence before using 60-GHz waves for indoor communications*."

The need for caution is echoed by Zhadobov et al. (2009), who whilst not finding any significant biological effects from up to 24 hours exposure of human cells to low power radiation of around 60 GHz in their work, noted *"… we cannot neglect possible synergistic effects and eliminate the possibility that other exposure parameters, like frequency, exposure time, or field polarization may have effects on biosystems.*"

It appears possible that 60 GHz radiation may cause pronounced detrimental biological effects and that it's proposed widespread use, both indoors and outdoors, may be ill advised.

> Taking the 'Precautionary Principle' into account, further scientific testing [including the assessment of chronic low-intensity 'real life' 60GHz exposures] appears to be urgently required.

[Information from Jamieson 2014].

Terahertz Radiation – T-Rays

It has been proposed that part of the 0.3-3 terahertz (THz) spectral region be used to achieve super fast Wi-Fi transmissions. Appropriate biological safety standards for this frequency range have yet to be fully developed.

In *in vitro* research by Bock et al. (2010), exposure to high intensity THz RF/microwave radiation resulted in changes in cellular functions strongly related to DNA-directed gene transcription, with cell morphology and gene specific accumulation of RNA transcripts being shown to be dependent on duration of exposure received. "… *THz radiation is a potential tool for cellular reprogramming*" (Bock et al. 2010).

In addition to humans, the possible effects of T-ray exposures on wildlife should be assessed. Many insect species are ≤1 mm in size, a size range for which RF/microwave 'body resonance' can occur in the 0.3 to 3 THz range.

Managing Risk

United Nations Rio Declaration on Environment and Development

Principle 9: "*States should cooperate to strengthen endogenous capacity-building for sustainable development by improving scientific understanding through exchanges of scientific and technological knowledge, and by enhancing the development, adaptation, diffusion and transfer of technologies, including new and innovative technologies*."

The objective of sustainable development of RF/microwave technologies, and other communications technologies, is achievable through cross-disciplinary research and design [carried out in conjunction with 'early warning' scientists and NGOs]. Such an approach "*could swiftly lead to the adoption of safer existing technologies and techniques, and the development of new generations of biosustainable technologies*" (Jamieson 2013).

Principle 15: "*In order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation*."

The potential risks that may arise from RF/microwave radiation emitters and their related infrastructures are often ignored, dismissed or underplayed. A better approach is [in the opinion of the present author] to acknowledge possible risks and actively seek solutions. As once noted by President Abraham Lincoln: "*You cannot escape the responsibility of tomorrow by evading it today*."

Council of Europe

The Council of Europe's Resolution 1815 (PACE 2011) provides a number of sound initiatives for good risk management of RF/microwaves:

- "… take all reasonable measures to reduce exposure … reconsider the scientific basis for the present standards on exposure … and apply ALARA principles … "

- "… put in place information and awareness-raising campaigns on the risks of potentially harmful long-term biological effects on the environment …"

- "[take all reasonable measures]… to reduce costs, save energy, and protect the environment and human health, … and encourage research to develop telecommunication based on other technologies which are just as efficient but whose effects are less negative on the environment and health …"

- "… undertake appropriate risk-assessment procedures for all new types of device prior to licensing … make risk assessment more prevention oriented …"

- "… improve risk-assessment standards and quality by creating a standard risk scale, making the indication of the risk level mandatory, commissioning several risk hypotheses to be studied and considering compatibility with real-life conditions …"

- "… pay heed to and protect "early warning" scientists …"

- " … increase public funding of independent research, in particular through grants from industry and taxation of products that are the subject of public research studies to evaluate health risks …"

- "… make the transparency of lobby groups mandatory …"

- "… promote pluralist and contradictory debates between all stakeholders, including civil society (Århus Convention)."

European Environment Agency

The European Environment Agency also provides sound advice for good risk management of RF/microwaves:

> *"There are many examples of the failure to use the precautionary principle …, which have resulted in serious and often irreversible damage to health and environments. Appropriate, … actions taken now to avoid plausible and potentially serious threats to health from EMF are likely to be seen as prudent and wise …,"*

Professor Jacqueline McGlade, Executive Director of the European Environment Agency (EEA 2007).

Late Lessons from Early Warnings

The European Environment Agency's 'Late Lessons from Early Warnings' (EEA 2013) provides 12 key lessons that can be applied as a matter of 'good practice':

1. "*Acknowledge and respond to ignorance, as well as uncertainty and risk, in technology appraisal and public policy-making*."
2. "*Provide adequate long-term environmental and health monitoring and research into early warnings*."
3. "*Identify and work to reduce 'blind spots' and gaps in scientific knowledge*."
4. "*Identify and reduce interdisciplinary obstacles to learning*."
5. "*Ensure that real world conditions are adequately accounted for in regulatory appraisal*."
6. "*Systematically scrutinise the claimed justifications and benefits alongside the potential risks*."
7. "*Evaluate a range of alternative options for meeting needs alongside the option under appraisal, and promote more robust, diverse and adaptable technologies so as to minimise the costs of surprises and maximise the benefits of innovation*."
8. "*Ensure use of 'lay' and local knowledge, as well as relevant specialist expertise in the appraisal*."
9. "*Take full account of the assumptions and values of different social groups*."
10. "*Maintain the regulatory independence of interested parties while retaining an inclusive approach to information and opinion gathering*."
11. "*Identify and reduce institutional obstacles to learning and action*."
12. "*Avoid 'paralysis by analysis' by acting to reduce potential harm when there are reasonable grounds for concern*."

Creating a Sustainable Future through Intelligent Risk Management

Companies that properly address environmental concerns [and become high sustainability companies] deliver considerable better returns on equity and returns of assets than others that fail to take such matters into concern (Eccles et al. 2011). In that research it was proven that sustainable companies greatly outperform their rivals. It is vital to better understand the advantages and disadvantages of wireless technologies and how to make them, and their alternatives, more biologically and environmentally friendly. Doing so could provide substantial benefits in real terms to all parties."*Investing $1 in 1993 in a value weighted portfolio of High Sustainability firms would have grown to [$]22.60 by the end of 2010, compared to $15.40 in the low sustainability portfolio*" (Chadwick 2013).

> "*Rather than detracting from investor returns, fully incorporating sustainability issues into corporate strategy provides the basis for growth and profitability, and taking a long term view is starting to allow companies to fully realise the potential benefits*" (Chadwick 2013).

Taking on board measures to create more biologically sustainable RF/microwave exposure regimes and technologies makes sound business sense, creates the opportunity for more successful future business ventures and greatly reduces risk.

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