

# HEALTH DANGERS OF WIRELESS CONTROL NETWORKS, WIRELESS SMART METERS AND WIFI RADIATION

## Overview

- Radiation from wireless control networks, wireless smart meters and WiFi is escalating rapidly.
- This type of radiation has long-term health dangers for all and short-term dangers for some.
- International biological guidelines offer protection. The ICNIRP heating guidelines do not.
- Wired connectivity is a safer alternative to wireless.

## 1 Wireless controls, microphones, monitors and smart meters

<b>ISM (Industrial, Scientific and Medical) unlicensed (UK) and other licensed microwave frequencies (1m-1mm) with typical uses</b>					
unlicensed			licensed		
frequency	wavelength	typical usage	frequency	wavelength	typical usage
433 MHz	69 cm	microphone, monitor, RFID, remote control, smart meter, street light controls	412 MHz	72.8 cm	BT/Arqiva nPower Southern Electric smart meter
868 MHz	34.5 cm		925 MHz	32.7 cm	GSM mobile phone [ISM only region 2 Americas]
2.45 GHz	12.2 cm	baby monitor, Bluetooth, Brit. Gas ZigBee smart meter, oven, WiFi	1.8 GHz	16.7 cm	some DECT cordless phones, baby monitor, mobile phone
5.8 GHz	5.2 cm	WiFi			

## 2 Wireless controls, microphones, monitors and smart meters: radiation powers, exposure levels and limits

<b>Typical transmitting power and limits for wireless control, data and monitor systems (unlicensed ISM bands, UK) with typical exposure times and long-term health risks</b>								
device	car key remote, garage remote, wireless doorbell	Bluetooth Power Class 2, Play Station 3, Wii	infra-red movement detector, smoke detector	wireless microphone	smart meter, street lamps	active RFID, biomedical / utility monitor, stock location	smart meter, WiFi	smart meter, street lamps
function	control	data, control	sensor link	data (sound)	data, control: leaf node	monitor, active RFID	data, control	data, control: branch node
range	0 – 100 m (max.: 500 m)	SRD (Short Range Device)			1–2 km	2 km (10 max)	500 m	2 km
frequency	433 MHz, 868 MHz	2.45 GHz Bluetooth	868 MHz	868 MHz	868 MHz	433 MHz, 868 MHz [DASH7] [CC1101]	2.45 GHz WiFi	868 MHz
transmitter power	0.25mW (to 5 mW)	2.5 mW	10 mW	10 mW	25 mW	100 mW (up to)	100 mW	500mW
transmitter power limit	10 mW SRD	100 mW	10 mW SRD	10 mW SRD	25mW: Eur 1mW: USA	[Japan: 10 dBm/m <sup>2</sup> ] 100 mW	20 dBm/m <sup>2</sup> 100 mW	
power (mW) dBm/m <sup>2</sup>	-2 dBm/m <sup>2</sup>	4 dBm/m <sup>2</sup>	10 dBm/m <sup>2</sup>	10 dBm/m <sup>2</sup>	14 dBm/m <sup>2</sup>	20 dBm/m <sup>2</sup>	16 dBm/m <sup>2</sup>	27 dBm/m <sup>2</sup>
poss. power flux density	0.00025 W/m <sup>2</sup>	0.0027 W/m <sup>2</sup>	0.01 W/m <sup>2</sup>	0.01 W/m <sup>2</sup>	0.024 W/m <sup>2</sup>	0.1 W/m <sup>2</sup>	0.05 W/m <sup>2</sup>	0.66 W/m <sup>2</sup>
approx. electric field	0.5 V/m	1.0 V/m	2.0 V/m	2.0 V/m	3 V/m	6 V/m	4 V/m	15 V/m
common duty cycle / latency	single pulse	almost constant	regular pulse (e.g. every 4 s to 4 m)	almost constant	regular pulse [maximum.: 1%]	intermittent pulse	regular pulse, (0.5%, every 0.01 sec.)	regular pulse [maximum: 1%]
exposure time	seconds	hours / days	continuous residential	hours	continuous residential	occasional / continuous	continuous residential	continuous residential
typical close proximity	0 m	0 m	1 m	0 m	1-3+ m	0.5 m	1+ m	1-3+ m
long-term health risk	low risk	medium risk	medium risk	high risk	medium risk	low / medium risk	high risk	high risk

Controls for models: 2.45 GHz, 2 mW, 100m (0.6 V/m), or 60 mW, 2 km (5 V/m).

Transmitter power: YELLOW: transmitter over 0.2 V/m (international biological BioInitiative safety limit, indoors).

ORANGE: transmitter over 0.6 V/m (international biological BioInitiative safety limit, outdoors).

Long-term health risk (bottom row): based on length and level of exposure, and known bio-effects.

### 3 Safety limits and exposure levels

#### A Sub-thermal and thermal safety limits

The USSR adopted a biological safety limit in 1958 of 6 Volts/metre, recognising that low-level long-term radiation exposure causes health problems at sub-thermal (below heating) levels. These biological limits were revised down to 0.6 Volts/metre (outdoors) and 0.2 Volts/metre (indoors) in the international BioInitiative report of 2007. Most involved scientists now accept biological effects at below thermal levels, as do an increasing number of governments and courts. The European Union Parliament in 2009 passed a resolution condemning the old ICNIRP 1998 heating limits as “obsolete” and calling for new biological guidance levels.

In contrast, the UK government still keeps to the ICNIRP’s 1998 thermal safety limits, with 61 Volts/metre for the 2.45 GHz frequency (WiFi). These assume that the only possible health danger from non-ionising radiation comes from an increase in body heat. This follows the USA’s heating limit, originally set in 1957 at 194 Volts/metre.

#### B Biological response threshold for beneficial bio-effects

The biological response threshold is relatively low, suggesting that most unregulated devices could be bio-active even at surprisingly long distances. When very low-level and intermittent pulsed electro-magnetic field (PEMF) therapy is used for bone healing, it depends on a biological response above a threshold of  $\sim 0.0001$  V/m from an induced electric current in the body. Other electro-magnetic radiation, like sunlight, can be beneficial at low levels, but higher exposure can be dangerous.

<b>ELECTRIC FIELDS</b> <b>Volts/metre (peak to peak)</b> <b>NATURE, THRESHOLD AND SAFETY LIMITS</b>								
<i>nature</i>	<i>biological response threshold</i>  (some reactions at 0.00006)	<i>biological safety limit</i>  Burger-form proposed	<i>biological safety limit</i>  Salzburg indoors	<i>conscious symptom threshold</i>  *(people allergic to EMFs)	<i>conscious symptom threshold</i>  (30% gen. population, Oberfranken study)	<i>biological safety limit</i>  Bio-Initiative indoors	<i>biological safety limit</i>  Bio-Initiative outdoors	<i>heating safety limit</i>  (6 min. av.)  ICNIRP
<0.00002	0.0001	0.002	0.02	0.02 - 0.05	< 0.06	0.2	0.6	61.0 (1,952 peaks)

\* Sensitivity thresholds vary between individual people, over time and depending on ambient levels of electrosmog.

<b>ELECTRIC FIELDS</b> <b>Volts/metre (peak to peak)</b> <b>TYPICAL MEASURED EXPOSURE LEVELS</b>					
<i>range (m.)</i>	<i>transmitter power (mW)</i>				
	2.5 mW	10 mW	25 mW	*100 mW (e.g. WiFi)	
				<i>minimum</i>	<i>maximum</i>
0	(1)	(2)	(3)	(2)	(7)
0.5	0.02	0.04	0.14	1.1	4.9
1	0.01	0.02	0.07	0.7	2.8
2	0.005	0.01	0.03	0.4	1.5
5	0.0002	0.004	0.01	0.1	0.7
10	0.0001	0.002	0.007	0.05	0.4
20	0.00005	0.001	0.003	0.03	0.2
50	0.00003	0.0005	0.002	0.01	0.1
100	0.00001	0.0003	0.001	0.006	0.05

A WiFi classroom or office is typically 1.9-4.7 V/m; up to 6.7 V/m 1m from access points (Verloock L et al., 2010).

\*Many of the values for the electric fields from a 100 milliWatt transmitter are taken from the **measured exposures** given in the Swiss government’s report on *Electrosmog in the Environment* (2005, p.54), with minimum measured exposures on the left and maximum measured exposures on the right.

**Measured exposures** often vary by four times or more between the minimum and maximum.

**Calculated exposures** are usually higher than measured exposures.

**Electric fields** (V/m) decrease in inverse proportion to distance (i.e. if the distance doubles, the electric field is halved).

**Power density** (W/m<sup>2</sup>) is proportional to the inverse of the square of the distance from the source in free space (i.e. if the distance doubles, the power density is reduced to one quarter).

For **biological effects** V/m rather than W/m<sup>2</sup> is now regarded as a more useful metric for peak pulse values.

#### 4 Organisations and attitudes to adverse sub-thermal bio-effects

<b>ORGANISATIONS AND TYPICAL VIEWPOINTS GROUPED BY ATTITUDES TO SUB-THERMAL BIO-EFFECTS</b>	
<b>MAJORITY OF SCIENTISTS</b>	<b>SCEPTICS</b>
<b>accept adverse sub-thermal bio-effects</b>	<b>deny adverse sub-thermal bio-effects</b>
independent scientists	'military-industrial' pressure groups
some governments, some courts, some journalists	some governments, some courts, some journalists
low-level: biological (sub-thermal)	high-level: heating and shock only (thermal)
long-term (e.g. 10 years)	short-term (6 minutes)
cumulative, repeated exposures	single exposure
peak exposure	average exposure
allowance for vulnerable: children, elderly, ill	healthy adult only (SAR), no allowance for vulnerable
health arguments	cost and 'public benefit' outweigh health arguments
precautionary attitude towards public health	no precautionary attitude towards public health
independent studies	some study findings are skewed by industry finance
USSR: 1958: biological limits: 6 V/m (0.01 mW/cm <sup>2</sup> )	USA: 1957: heating only limits: 194 V/m (10 mW/cm <sup>2</sup> )
BioInitiative Group (international independent scientists)	ICNIRP (International Committee on Non-Ionising Radiation Protection), World Health Organisation: 1998, re-affirmed 2009: 61 V/m (as IEEE, 1982)
2007: 0.2 and 0.6 V/m (as Salzburg, 2002 and 1998)	UK HPA (Health Protection Agency), Department of Health
ICEMS (International Committee on Electromagnetic Safety)	UK MTHR (Mobile Telecommunications and Health Research Programme) – studies since 2001
European Union Parliament (resolution, 2009): old ICNIRP limits 'obsolete'; new limits needed	European Union SCENIHR (Scientific Committee on Emerging and Newly Identified Health Risks)
European Environment Agency (2007)	
RCNIRP (Russian National Committee on Non-Ionising Radiation Protection)	
US National Academy of Sciences' National Research Council: accepts sub-thermal effects (1985)	
United Nations Environmental Programme, IRPA, WHO: 'a substantial body of data' (1993)	
Afsset (French Agency for Environmental and Occupational Health Safety) : 'indisputable' (2009)	
AUVA Insurance: 'confirmed' (2009)	
Italy uses wired connectivity for smart meters (2000)	
German Federal Office of Radiation Protection warns against use of WiFi; Bavaria: WiFi warning. (2007)	
Austrian Medical Assoc.: against school WiFi (2007)	
French National Library: moratorium on WiFi (2008)	
Départments of the Drôme and the Ardèche, France, replace WiFi etc. with fibre-optic cables (2010)	
Fairfax, Marin County, CA, and other cities consider moratorium on wireless smart meters (2010)	
[beneficial sub-thermal radiation: bone healing: 1974]	

#### 5 Complexities in assessing bio-effects from pulsed radiation

##### A Individual peak pulses are significant, not just the mean power density and carrier frequency

Most of the unregulated devices use digital transmissions and pulsed signals. Although these may seem to be small or infrequent, such as every four minutes, the individual pulses can still be bio-active.

Some people sensitised to electro-magnetic fields, for instance, can feel a WiFi access point which has a mean transmission rate of only 0.5 %. This low mean is because a WiFi access point sends a 0.5 millisecond signal every 100 ms. If it is a beacon transmitting at theoretically 100 milliWatts, each individual pulse is at 100 mW, although the mean power is only 0.5 mW. For the transmission of data the mean power can be up to 70 mW. Some people sensitised to electro-magnetic fields can sometimes feel adverse effects from a single electric pulse, as well as continuous transmissions. A transmitter radiating every four minutes, therefore, would be bio-active for each pulse. Moreover, studies suggest that cell membranes react with stress reactions to each initial pulse but sometimes with a potential latency time for attempted adaptation, perhaps indicating that intermittent stress reactions spread over time may be damaging as well as a continuous signal.

A separate bio-effect from WiFi may arise from the signal's repetition rate of 10 Hz, within the alpha brain frequency and close to the maximum calcium efflux at 16 Hz, warned against in the Stewart Report. An additional bio-effect from 2.45 GHz carrier radiation is exciting water molecules, as in microwave ovens.

**B Head irradiation and whole body irradiation: SAR average limits (heating, not biological)**

Many studies on the health effects of electro-magnetic radiation have concentrated on the bio-effects in the head from the long-term use of mobile phones. Thus the growing evidence of brain tumours reflects the near-field plume of radiation from a handset. Most wireless devices, however, irradiate the whole body, not just the head, and there are few studies on long-term whole-body bio-effects. SAR (Specific Energy Absorption Rate) limits, like ICNIRP's, prevent heating, not long-term bio-effects. SAR heating levels are difficult to apply to whole body exposure, and for infants as well as adults. Some studies show that present SAR limits, even just for heating and induced currents, excluding long-term effects, are too high for some young children at higher frequencies, when seated, and for legs/ankles and grounding.

<b>SAR (SPECIFIC ENERGY ABSORPTION RATE) - Watts/kilogram (averaged)*</b>							
<b>APPROXIMATE THRESHOLD AND EXPOSURE LEVELS AND HEATING (NOT BIOLOGICAL) SAFETY LIMITS</b>							
<i>biological damage threshold</i>	<i>neuron (brain cell) death threshold</i>	<i>SAR heating limit, (av.6 min.) whole body</i>	<i>WiFi laptop at 1 metre</i>	<i>mobile phone good reception</i>	<i>mobile phone full power &lt; 3 cm from head</i>	<i>SAR heating limit, (av. for 6 min., 10 grams, EU) head</i>	<i>WiFi laptop on lap and at access point</i>
0.00002 – 0.002	0.012	0.08	0.05–0.11	0.1	0.12 – 1.6	2.0	2.0

\* Averages reduce SAR substantially: DECT cordless phone handsets give 100 bursts of 0.4 ms every second (i.e. 100 Hz) at 250 mW, but when averaged the power is 10 mW, transmission rate 2.5%, and SAR 0.008-0.06 W/kg.

**6 Exposure problems from mesh networks and multiple radiation sources****A Cumulative and synergistic bio-effects from different radiation sources**

Studies have shown that low-level long-term radiation has cumulative bio-effects. This means that the health dangers of a single radiation source cannot be considered in isolation. Some biological effects appear more severe from synergistic effects of several different sources of radiation.

**B Mesh networking or "piggy-backing" can produce heavy individual node usage**

Some wireless systems for smart meter grids at both neighbourhood and individual home level involve communication between different nodes or devices, with each device able to operate as a relay to pass on the data or command to further nodes along the network. Although this "piggy-backing" has the advantage of reducing the power of radiation from any given node, in that it does not have to communicate at higher power directly with the control centre, it does mean that any node can act as a relay station for many extra messages and therefore total radiation levels will increase. Thus, although the system may be designed to have a duty cycle of, say, 0.5%, based on a short incoming and outgoing message every few seconds or minutes, if it has to relay up to 500 other messages as well, because it happens to be a strategically-located node in the network mesh, its cumulative radiation level will be much higher. There appears to be no means of checking this apart from constant measurement.

*Example:* A test showed a utility smart meter was sending out strong pulses of microwave radiation every few seconds. This was because the smart meter was a repeater in a mesh network, relaying not only one house's information but those of up to 500 other homes if they needed to reach an access point through that particular house. The official information admitted a worst case scenario in which the smart meter would communicate 3.3% of the time. Although they were supposed to 'send' only every 15 minutes, they could actually send microwave signals over 100 times a minute. For 3.3%, the meter would be transmitting 47.52 minutes in one day. At 66% of this rate it would be transmitting for 30 minutes a day, the length of exposure used to define a 'heavy user' in the Interphone study on mobile phones, which showed (Interphone Appendix 2) significantly raised risks for brain tumours after ten years' 'heavy use'.

**C Wireless smart grids and networks increase EMF pollution**

In both neighbourhoods and homes, it is now possible to create 'smart grids' to limit or control use of electricity or redistribute it. These are excellent ideas if wired. If wireless they will increase the growing health dangers of electrosmog. This also applies to a classroom or office network with wireless laptops.

**D Environmental safety levels and individual devices**

The international biological BioInitiative safety levels are set for ambient or environmental exposure to electro-magnetic radiation. Individual unlicensed wireless devices may not themselves breach the safety levels, yet when combined with other radiation, such as from phone masts, TV, radio, cordless phones, home WiFi and other unregulated wireless devices, the combined radiation may do so. In such cases it is not clear legally whether any constituent source of the electro-magnetic pollution may be regarded as partially responsible for breaching the biological safety level.

**E Low-level radiation can cause bio-active voltage transients ('dirty electricity')**

There are also health dangers from voltage transients caused by wireless frequencies on power lines. dLAN (direct Local Area Network) plugs transfer data in this way, effectively using power cables as

antenna for radio signals. If a house or locality has a network of wireless smart transmitters, these could induce bio-active voltage transients across the whole house and neighbouring properties.

#### **F Conclusion: assessments of wireless data networks (e.g. WiFi frequencies)**

International Commission on Electromagnetic Safety (2009): "The licensing and/or use of WiFi, WiMAX, or any other forms of wireless communications technology, indoors or outdoor, shall preferably not include siting or signal transmission in residences, schools, day-care centres, senior centres, hospitals or any other buildings where people spend considerable time." Dr M Havas (2009): "it is irresponsible to introduce WiFi microwave radiation into a school environment where young children spend hours each day." French Health & Security Agency (2009): WiFi should be switched off whenever possible. GEW Union, Germany (2007): against WiFi, since a healthy school should allow students to study in a radiation-free environment. German Federal Government (2007) recommended avoidance of WLAN at work and home. Austrian Medical Association and Salzburg Public Health Department warned against WiFi in schools and nurseries (2005). Dr D Carpenter, Director of Institute for Health & the Environment, Albany University, New York: "it is important that all of us ... limit exposure to background levels of WiFi. The importance of this public health issue cannot be underestimated." Dr M Clark, HPA, (2007) confirmed we are "all guinea pigs in some multi-billion pound commercial experiment" ([www.starweave.com/clarkletter](http://www.starweave.com/clarkletter)).

#### **G Conclusion: assessment of wireless smart grids and multiple wireless devices**

Blake Levitt (2010), a medical and science writer ([emfsafetynetwork.org/?page\\_id=898](http://emfsafetynetwork.org/?page_id=898)):

"One preliminary estimate of ambient radiation that such systems will cause found the average smart grid could use up a full 1% of the total allowance for RF according to the FCC standards for thermal heating. Add cell towers, WiFi, WiMAX and other common RF environmental contributors and this could get serious. Smart grid proposals do not consider potential cumulative exposures from the other myriad RF-emitting devices in our midst today. Nor do they factor in the recent research regarding what's called 'dirty electricity' — the phenomenon of multifrequencies coupling on lines to create complex energy exposures. Dirty electricity has been linked in some studies to numerous cancers, diabetes, Alzheimer's and Parkinson's. A smart meter, using RF to 'talk' with the central information-gathering hub will couple with the extremely low frequency range used in powerlines."

Wireless "smart grids are a spectacularly dumb idea. ... In our headlong rush toward anything green, we might just be doing far more harm than good. This writer has yet to find a single person who, once given the details of what smart grids entail, thinks this is smart in any way."

## **7 Biological studies on long-term low-level radio and microwave radiation**

#### **A Health studies on long-term exposure to 2.45 GHz are still awaited**

The use of the 2.45 GHz for Bluetooth in its present format and WiFi dates from 2000. So far there have been no studies on the long-term human health effects. Given that its radiation characteristics are similar to mobile phones and its exposure levels are sometimes not far below, it can be assumed that similar health problems will surface from long-term exposure to WiFi, although perhaps with a slightly greater latency period. Sensitive individuals already report health problems from WiFi, often immediately after its introduction. Short-term effects: after 2 hours' exposure at 2.45 GHz below thermal levels Lee et al. (2005) showed 221 changes in gene expression for cultured human cells and in 759 genes after 6 hours.

<b>TYPICAL EXPOSURE VALUES, EXPOSURE TIMES AND LONG-TERM HEALTH OUTCOMES</b>									
<b>radiation device</b>	<b>radio and TV masts</b>	<b>2.45 mW WiFi - 100 mW</b>			<b>1.8 GHz DECT cordless phone</b>			<b>mobile phone</b>	
		<b>access</b>		<b>lap- top</b>	<b>250 mW basestation</b>		<b>10 mW</b>	<b>mast</b>	<b>handset</b>
<b>distance</b>	5-9 km	5 m	10 m	1 m	5 m	10m	hand't	< 350 m	handset
<b>electric field V/m</b>	~ 0.01-0.3	0.1 -0.7	0.005 -0.4	0.7- 1.3	0.1	0.03	>10.0	0.05-2.0	0.00003 - >10.0 (listen - call)
<b>typical exposure length</b>	> 10 years residential				> 10 years			5 - 10 years residential	> 10 years (1,640 hrs=30 min. per day: 'heavy user')
<b>long- term adverse health outcomes</b>	312% increased risk of leukaemia and lymphoma (479% women only) (Vatican Radio study)	<i>No long-term human studies.</i> (Chronic sub- thermal exposure SAR 0.14 W/kg, altered behaviour of rats (D'Andrea 1986), and 45 min. SAR 0.6 W/kg retarded rats' learning (Lai 1994))			500% increased risk of brain tumour; 440% increased risk of brain tumour for starting < 18- years-old (Hardell)			300% increased risk of cancer (Naila study); 1,000% increased risk of female cancers (Netanya); ill health in dose-response relationship (La Nora study)	330% increased risk of brain tumour; 520% increased risk of brain tumour for starting < 18- years-old (Hardell, see also Interphone Appendix 2)



**B Bio-effects of lower frequencies (412, 433 and 868 MHz)**

Other commonly used microwave (1m-1mm) frequencies are 412, 433 and 868 MHz. Some doctors are concerned that the closer such frequencies are to the human body's greatest resonance frequency of about 100 MHz, the more bio-active they become. Lower frequencies also have greater ability to penetrate building materials, water and also the human body. This is why they have been chosen for some types of wireless smart meters and active RFID (Radio Frequency Identification).

**C Comments on long-term low-level radiation exposure**

The Stewart Report on mobile phone health dangers in 2000 warned that "there may be biological effects", a fear now confirmed by many studies. In 2007 Sir William Stewart, then HPA chairman, said the World Health Organisation was "wrong" to deny adverse health effects from low-level long-term exposure, and he called for a WiFi health enquiry. The ICNIRP limits, according to its members, do not "protect against possible hazards from long-term exposures at low levels". Yet, under pressure from the industry, in 1996 the US and UK governments exempted phone masts from health considerations.

**D Greater health effects on children, the elderly and ill**

**Children:** a child's head and brain absorb significantly more radiation than those of an adult (de Salles 2006; Gandhi 1996; Kang 2002; Wang 2003; Wiart 2008). 'SAR' heating safety levels, however, are based on radiation absorbed by an adult. As head size decreases, the percentage of energy absorbed increases, (Martinez-Burdalo 2004) and children's tissues have higher water and ion content compared to adults' (Peyman 2009) increasing radiation absorption (Gandhi 2002; Keshvari 2006; Peyman 2009). The UK expert group discouraged children <16 from using mobiles for non-essential calls. France is banning mobiles in schools for pupils <15. San Francisco requires SAR levels to be shown on mobiles. The most common causes of death in UK children are brain tumours and leukaemia, both linked with EM radiation.

**Elderly and ill people:** studies of the general population suffering from electro-magnetic radiation often show a preponderance of elderly persons. This may fit with evidence of cumulative immuno-suppression. Similar increased dangers may exist for people who are ill, especially if their autonomic nervous system has been compromised.

**8 Diseases associated with electromagnetic radiation**

<b>SOME DISEASES (CARCINOGENIC, NEUROTOXIC, TERATOGENIC) ASSOCIATED WITH ELECTRO-MAGNETIC RADIATION</b>		
<i>Extremely Low Frequency 10-300 Hz</i>	<i>Radio Frequency 4 kHz – 300 MHz</i>	<i>Microwave Frequency 0.3 – 300 GHz</i>
IARC (2001): 'possibly carcinogenic'		
ALS (Amyotrophic lateral sclerosis)		
Alzheimer's		
		behavioural problems
		cataracts
cancer: brain, brain tumours		cancer: brain, brain tumours
cancer: breast	cancer: breast	
cancer: malignant melanoma	cancer: malignant melanoma	
cancer: prostate	cancer: prostate	
cancer: testicular	cancer: testicular	cancer: testicular
cardiovascular disease	cardiovascular disease	cardiovascular disease
childhood leukaemia	childhood leukaemia	
		cognition impairment
depression and suicide		
leukaemia	leukaemia	leukaemia
lymphoma	non-Hodgkin's lymphoma	
male infertility		male infertility
		memory impairment
miscarriage		miscarriage
motor neuron disease		
	multiple sclerosis	
obesity		obesity
Parkinson's disease		

NB: (i) Teratogenic bio-effects (diseases in offspring from maternal and paternal electro-magnetic radiation exposure) include fewer male births and increased leukaemia following ELF and possibly MF radiation.  
(ii) WiFi has data transmission at ELF 10-250 Hz, and a Microwave Frequency carrier of 2.45 GHz.

**4-100 kHz voltage transients on 50-60 Hz wiring circuits**

These have become common since the 1970s; their potent bio-effects were first published in 2008.

Ahonen MP (2010) "Voltage transients and possible effects on health through cell membrane functionality disturbance" [beyondcreativity.blogs.com/files/ahonen-voltage-transients-and-possible-effects-on-health-a4-2010.pdf](http://beyondcreativity.blogs.com/files/ahonen-voltage-transients-and-possible-effects-on-health-a4-2010.pdf)

Milham S, Morgan LL (2008) "A new electromagnetic exposure metric: High frequency voltage transients associated with increased cancer incidence in teachers in a California school" *Am J Ind Med.* 51(8): 579-586.  
[www.electricalpollution.com/documents/MilhamMorganAmJIndMed2008.pdf](http://www.electricalpollution.com/documents/MilhamMorganAmJIndMed2008.pdf)

## 9 Direct and indirect sub-thermal mechanisms and pathways

<b>SOME DIRECT AND INDIRECT MECHANISMS AND PATHWAYS ASSOCIATED WITH ELECTRO-MAGNETIC RADIATION*</b>		
reduction in antioxidants effect on biogenic magnetite breaches of the blood-brain barrier effect on brain response and frequencies bystander effects calcium efflux from cell membranes affecting inter-cellular information transfer effects on chromosomes co-carcinogenesis effects on cryptochromes	single and double-strand DNA breaks electron spin resonance effects on endogenous EMF increase in free radicals effects on gene expression effects on HbA oxygen affinity effects on hippocampal cells immunosuppression ion cyclotron resonance effects on lymphocytes magnetoreception	mast cell degranulation, histamine melatonin reduction, pineal effects piezoelectricity effects on (bio-)photons effects on protein expression, heat shock proteins radical pairs reactive oxygen species effects on sleep stochastic resonance thrombosis effects on the thyroid gland

\* Studies on animals, birds, insects and plants show similar sensitivity to electro-magnetic radiation.

## 10 Conscious adverse health associated with electro-magnetic radiation

**All humans** react to low-level electro-magnetic radiation, such as visible light, with the eyes and skin. Studies show that 30-50% of the general population react occasionally or in just one area to pulsed EMFs, as in disturbed sleep, but this is not usually perceived by the individual. Swedish studies show 3-5% significantly affected. The Schwarzenburg study showed problems with concentration, fatigue, sleep, depression and cardiovascular conditions at > 0.05 V/m. The Oberfranken study showed adverse health symptoms in 30% of people < 0.06 V/m, and 95% in the range 0.2–0.6 V/m. People moving into a WiFi radiation area may present adverse health symptoms after 10-20 days. Thereafter they may display such symptoms with greater frequency than before, perhaps because their immune system is compromised.

<b>SOME ADVERSE CONSCIOUS BIO-EFFECTS FROM ELECTRO-MAGNETIC RADIATION</b>		
VERY COMMON	COMMON	OCCASIONAL
depression	aches, pains	eye blur, dry eyes, eye 'tics'
dizziness	digestion problems	hair loss
headaches	heart pain	nausea
heart arrhythmia	irritability	nose-bleeds
impaired cognition / 'brain blur'	muscle problems	sensitivity to dental amalgam and metal implants
impaired sleep, fatigue	skin problems	urinary / bowel urgency
memory loss	tinnitus	other sensitivities, smell, chemicals

**A few people** become sensitized to one form of electro-magnetic radiation, such as WiFi, and then become allergic to other frequencies too, such as mobile phones and CFLs. Symptoms are often delayed and become more severe with cumulative exposure. No cure is known at present. The most effective treatment is removal from, or protection from, radiation exposure, especially in the sleeping area.

This illness, often called **Electro-magnetic Hypersensitivity**, is categorized as a multi-symptomatic 'Ei-allergy' (Nordic classification, 2000), and is recognized as a 'disabling condition' (IEI-EMF, World Health Organisation, 2005). In 1932 it was called **Radio Wave Sickness** in Germany and was studied in Russia and Poland as **Microwave Sickness** in the 1960s. With mobile phones from 1984 and WiFi from 2000 it has spread from electrical, radar and radio workers into the general population. Thousands now suffer worldwide, with up to 50% predicted by 2017, depending on the rate of increase in EMF pollution.

It is considered a **functional disability** in some countries and comes under the United Nations Convention on the Rights of Persons with Disabilities. Some military personnel suffer this illness because of electronic warfare and jamming. Military protective materials are often used by sufferers from this allergy and by others, such as athletes and executives, to avoid the known bio-effects of EM radiation.

## 11 Possible mitigation from radiation health dangers

### A Protection from individual sources of radiation

Partial mitigation can be achieved by the following measures.

- Switching off transmitters when not in use or at night; doctors regard low-level radiation as particularly harmful in sleeping areas.
- Shielding buildings from radiation with protective paint and window films.
- Shielding individuals with EMF-protective clothing.
- Restricting access to radiation zones
- Creating Radiation-free zones (or Wireless smart-meter-free zones, or WiFi-free zones).

These may not comply with the United Nations Convention on Rights of Persons with Disabilities of 2007 for people already sensitised to electro-magnetic radiation. Many utility companies allow customers to opt out of wireless smart meters but this may not prevent irradiation from a neighbour's smart meter. In some countries, if a pupil or teacher is allergic to EM radiation, WiFi has to be removed from a school.

**B Issues in locating transmitters and wiring**

- Interference between transmitters, and building reflection, can produce dangerous 'hot spots'.
- A wireless device should be located away from power cables to prevent voltage transients.
- Transmitters and power cables should be located away from where people spend a long time.
- Transmitters in dwellings close to adjoining properties which are then also exposed to radiation from the smart meter or router are particularly ill-advised, or on lamp-posts close to bedrooms.

**C Alternatives to wireless control networks, wireless smart meters and WiFi**

A growing number of countries are making wireless smart meters voluntary, as in the Netherlands. There is also a move towards replacing all dangerous wireless systems with alternative systems of connectivity.

- **Fibre optic cable**, as adopted by some Departments in France. This is the best fixed solution and is ideal for new-build homes, apartment blocks, schools and offices.
- **Visual Light Communication**, a new technology with portability, broadband width, speed and security, but no known adverse bio-effects. Standards are being agreed in 2010-2011.
- **Broadband over Power Lines**, as used in much of Italy. This causes bio-active high frequency voltage transients. In home wiring these can radiate short distances but can be shielded.

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