VAUGHAN

CITY OF VAUGHAN

TELECOMMUNICATION FACILITY SITING PROTOCOL TASK FORCE

AGENDA

Committee Room 244
2nd Floor, Vaughan City Hall
2141 Major Mackenzie Drive
Vaughan, Ontario

Thursday, March 22, 2012

7:00 p.m.

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1. **CONFIRMATION OF AGENDA**

2. **DISCLOSURE OF INTEREST**

3. **COMMUNICATIONS**
   See attached

4. **ITEMS FOR CONSIDERATION / INFORMATION OF THE COMMITTEE**

   4.1 Reorganized Issues List – brainstorming session

6. **ADJOURNMENT**

7. **NEXT MEETING** – April 19, 2012 @ 7 pm

Committee Members		
Representing Vaughan Council	*Representing the Public*	Representing the Industry
Regional Councillor Schulte, Vice-Chair	Mubarak Ahmed	Stephen D'Agostino
Councillor DeFrancesca	Tina Catalano	Colin Lavery
	Von Chaleunsouk	Michelle Vivar
	Ann-Marie Colosimo	
	Mark Goldberg	
	Christina Sgro, Chair	
	Jack Haft	

TELECOMMUNICATION FACILITY SITING PROTOCOL TASK FORCE – MARCH 22, 2012

COMMUNICATIONS

Distributed March 16, 2012

C1. Extract from Council meeting minutes of February 21, 2012

C2. News article of March 19, 2012 titled “Bell Canada erecting cellphone towers disguised as trees in cottage country”.

C3. Von Chaleunsouk dated March 22, 2012.

Please note there may be further Communications.

CITY OF VAUGHAN

EXTRACT FROM COUNCIL MEETING MINUTES OF FEBRUARY 21, 2012

Item 1, Report No. 4, of the Committee of the Whole, which was adopted without amendment by the Council of the City of Vaughan on February 21, 2012.

1 **TELECOMMUNICATION FACILITY SITING PROTOCOL TASK FORCE**
1) REVISION TO THE TERMS OF REFERENCE
2) REQUEST RE: RADIO FREQUENCY ELECTROMAGNETIC FIELDS TESTING

The Committee of the Whole recommends:

1) **That the recommendation contained in the following report of the City Clerk, dated February 7, 2012, be approved subject to adding Clause 3 as follows:**
   3) **That the information requested of York Region Health Services and Public Health Ontario be accompanied by additional data on electromagnetic fields as measured from other sources, both short term and long term, and their known impacts on human health, in order that the public may make an informed judgement on these matters; and**

2) **That Communication C3, memorandum from the Director of Building Facilities, dated January 26, 2012, be received.**

Recommendation

The City Clerk, on behalf of the Telecommunication Facility Siting Protocol Task Force, recommends:

1) That the Terms of Reference be amended to increase the number of months that the Task Force was given to complete the Findings Report from five months to eight months; and

2) That representatives from York Region Health Services and Public Health Ontario be requested to conduct radio frequency electromagnetic fields testing at the Al Palladini Community Centre in the Spring.

Contribution to Sustainability

N/A

Economic Impact

N/A

Communication Plan

Any changes in policy or requirements resulting from consideration of this report will be communicated to the appropriate parties, as required.

Purpose

To respond to the request by the Telecommunication Facility Siting Protocol Task Force to revise the Terms of Reference and request York Region Health Services and Public Health Ontario to conduct radio frequency electromagnetic fields testing at the Al Palladini Community Centre in the Spring.

.../2

Background – Analysis and Options

Council, at it's meeting of September 27, 2011, approved the establishment of the Telecommunication Facility Siting Protocol Task Force. The mandate of the Task Force is to bring together various stakeholders to develop recommendations for siting telecommunication towers and antenna facilities in the City of Vaughan.

At the Committee of the Whole (Closed Session) of November 15, 2011, the Committee approved the Task Force's request that Council increase the members of the general public from five members to seven members. The Task Force also requested that its term be extended from five to eight months to finalize its findings.

The Task Force, at its meeting of January 12, 2012, recommended that representatives from York Region Health Services and Public Health Ontario be requested to conduct radio frequency electromagnetic fields testing at the Al Palladini Community Centre in the Spring.

Relationship to Vaughan Vision 2020/Strategic Plan

This report is in keeping with the provisions of Vaughan Vision 2020, particularly:

Demonstrate Leadership and Promote Effective Governance

Regional Implications

Any field testing which is carried out in response to this request will be the responsibility of York Region staff.

Conclusion

This report is submitted on behalf of the Telecommunications Facility Siting Protocol Task Force and seeks to 1) increase the number of months that the Task Force was given to complete the Findings Report from five months to eight months; and 2) request York Region Health Services and Public Health Ontario to conduct radio frequency electromagnetic fields testing at the Al Palladini Community Centre in the Spring.

Attachments

None

Report prepared by:

R. Magnifico
Assistant City Clerk

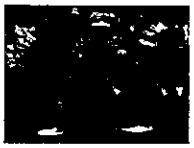
John Britto
Assistant City Clerk

TELECOMMUNICATION FACILITY SITING PROTOCOL TASK FORCE COMMUNICATION C2

Date: March 22, 2012

Inside thestar.com

Montreal students march against tuition hikes



Mali soldiers loot palace in coup

Romney draws fire over 'Etch A Sketch'

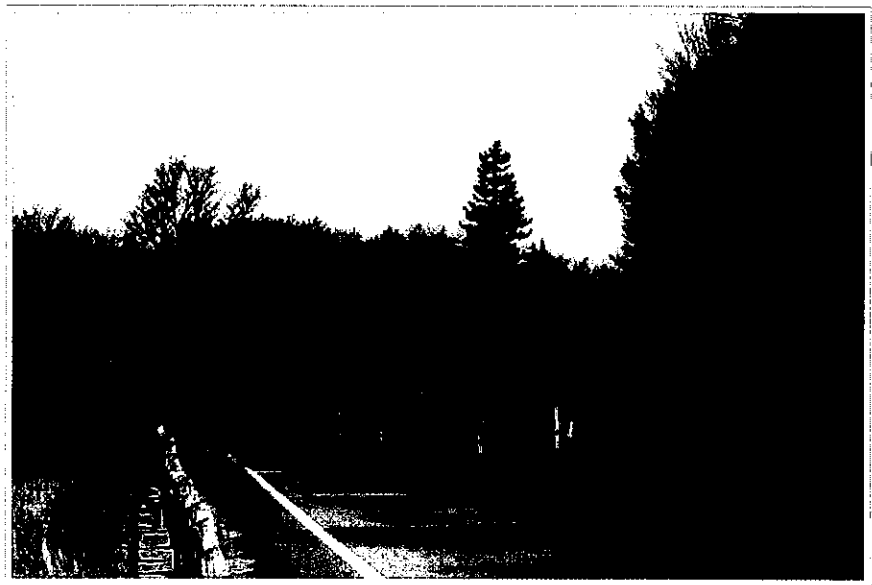
council votes 24-19 for LRT

Toulouse killings suspect dead

Bell Canada erecting cellphone towers disguised as trees in cottage country

Article Comments (61)

Published On Mon Mar 19 2012 Email | Print (61)



Bell plans to construct seven of the disguised towers, which look like large trees. Construction will begin in May.

BELL CANADA PHOTO

Richard J. Brennan
National Affairs Writer

They may look like white pines on steroids, but they're actually Bell Canada towers.

The telecommunications company plans to disguise the towers it erects in cottage country to look like trees so they don't stick out like a sore thumb.

Bell plans to construct seven of the disguised towers and construction will begin in May. Because they will be under 30 metres, they don't require municipal approval.

"It's really bizarre looking at them in the picture ... it's like a white pine on steroids," Alice Murphy, the mayor of the Township of Muskoka Lakes, told the *Toronto Star*.

The idea has been tried elsewhere in the U.S. in the form of palm trees and street lamps, but it's the first time in Canada the conifer disguise has been used.

The so-called tree trunks are made of steel and the branches are made of fibre glass. Bell has plans for the towers in Brackenrig, Foot's Bay, Port Carling East, Port Sandfield, Walker's Point East, Breezy Point Road and Little Lake Joseph.

A Bell spokesperson said the tree design was introduced as a pilot project in Algonquin.

"While we are still in the planning stages, we expect to install approximately 20 tree sites throughout many communities in the greater Muskoka area," Jason Laszlo said.

"The equipment comes to the location prefabricated and is assembled on site. When complete, the tree will stand between 25 and 29 meters and will be positioned to blend with existing trees," he said,

Some concerns have been raised about radiofrequency, but Murphy expects that the treelike towers will be located on private property in woodlots that are away from built-up areas.

Health Canada says exposure from cellphone towers is typically below its exposure standards. Even so, erecting large towers in Ontario has sometimes been controversial with residents complaining that radiofrequency is detrimental to public health.

Murphy said the truth is local residents are glad about improved cellphone coverage in an area where communications can be hit and miss.

"You used to see people out in their canoes or their boats in the middle of the lake holding their cellphone in a certain way trying to get reception," she said.

But on the whole, the mayor said, reception in cottage country is getting better all the time.

"And it needs to be because people do their work there. There are people conducting business in Muskoka, particularly during the summer, and they (cottagers) are trying to make it as seamless as possible from their Toronto offices. And that's important to us," she said.

Murphy said good telecommunications means cottagers drive up to their summer homes during the week knowing they can still conduct their business, which she says cuts down on the summertime weekend rush.

"It's great for the economy, it's better for our roads and it's just easier on everyone's disposition," she said.

Top Comments

It's not all about the cottagers...: Please take into consideration that not all people in Muskoka are tourists/cottagers, some of us..... Lloyd24

"You used to see people out in their canoes or their boats in the middle of the lake holding their cellphone in a certain way trying to get reception,": No, you used to see people out in the middle of the lake spending time with their families, enjoying..... IbRAD

Comment on this story »

I grew up in the Algonquin area and I agree that when you go to the area you go to get away from... ... i'm a mom 2

Whatever...: bell has been mandated by the provincial government to provide service for cell and HS internet as..... westender

More Photos and Videos »

Other Star Sites

2012 tax season: What's new this year

These road signs tell it like it is

8 ways to get kids to do chores

Toronto Trump Tower's design is controlled but sexy

The Dish: Choose your sandwich with care at Panera

Your Guide to Stylish Neighbourhoods in TO

Introduction

Research in the field of health effects of radiofrequency fields is very controversial since it is a technology that most of the developed world currently relies on. Despite much rhetoric to the contrary, research exists showing biological effects of radiofrequency radiation (RFR) on animal, human, and plant systems. Much of the recently published studies showing potential effects have not been taken into account by many federal regulatory agencies (most notably Industry Canada in Canada) because they are criticized as not being "replicated and therefore not valid for standards setting". This is in fact quite hypocritical as most of the evidence used by industry to defend the safety of RF technology is also not replicated and completed by only a very small number or researchers. Although mobile phone base station (MPBS) specific epidemiological studies reviewing health effects are sparse, some do exist, and will be discussed in this summary. There are also many other studies in vitro or in animal models which can be used to make extrapolations regarding biological effects at exposure levels that are **significantly below current guidelines.**

The goal of this document is to support this task force by outlining and explaining some key findings in the peer reviewed published literature that have not been discussed to date. The information presented in this document includes summaries of the research. Detailed research information can be provided if needed. Summary of findings include:

- Studies that were key in developing the current ICNIRP guidelines
- Specific MPBS research
- Studies on low intensity RFR and biological effects
- The latest 2 studies that were presented by Public Health Ontario.
- 2010 Systematic Review of the Health Effects of Exposure to RF-EMF from Mobile Phone Base Stations

A Note On RF Doses and Animal Studies:

Many studies performed today utilize animal models. Caution must be taken when extrapolating the results of the study to humans. There is often a *conversion factor* required when translating doses from animal studies to human equivalent dosing (HED). In the pharmaceutical industry, when converting a dose used in a mouse study, there is about a $1/10^{th}$ conversion of dose to human dosing. Often at this conversion, the dose is at a level that could be damaging, and requires another $1/10^{th}$ or so of safety factored in. This must be considered as we read through the research.

Biological Effects of Radiofrequency radiation (RFR)

These effects may depend on various factors:

- **Power density** - which is the energy/intensity of the field in space
- **SAR (specific absorption rate)** – energy deposited in or absorbed by the body
- **Propagation characteristics of the RFR:** modulation or waveform or shape have different effects on living systems
- **Type and duration of exposure**

It is insufficient to look at one or 2 variables when we discuss biological impact of RFR on humans health.

SAR studies involved in ICNIRP Guidelines

Two critical "behavior-disruption experiments" performed in the 1980's contributed to the present SAR standards

De Lorge et al (1980)

- trained **rats** on an auditory observing-response task
- presented 2 bars: pressing the bar would produce either a HIGH-pitched or LOW pitched tone
- Low pitched – no reward
- High pitched – food reward
- After learning the task, rats were then irradiated with 1280 MHz or 5620 MHz RFR during the performance
- **Observed within 30-60 minutes: disruption of behavior (rats did not perform well at the task)**
- **SAR of 3.75 W/kg** for 1280 MHz, and **4.9 W/kg** for 5620 MHz

De Lorge (1984)

- trained **monkeys** on similar auditory response task
- monkeys exposed to RFR 225, 1300, and 5800 MHz
- disruption of performance occurred at 8.1mW/cm^2 (**SAR 3.2 W/kg**) for 225 MHz, 57 mW/cm^2 (**SAR 7.4 W/kg**) for 1300 MHz, and 140 mW/cm^2 (**SAR 4.3 W/kg**) for 5800 MHz
- **disruption occurred when body temperature was increased by 1^0**

Conclusion of experiments: "disruption of behavior occurred when animal was exposed to SAR of approx. 4 W/kg, and disruption occurred after 30-60 minutes and when body temperature increased by 1^0 C

4 W/kg SAR standard

1/10th added theoretical safety margin for occupational exposure

0.4 W/kg

1/5 of occupational exposure for public whole body exposure

0.08 W/kg

THIS MEANS THAT: a SAR of 0.08 W/kg would be the level that would be sufficient to protect the public from SHORT TERM EXPOSURE

Comments:

- These standards were **established based on a few animal studies**
- These studies only looked at **behavioural** effects
- These were studies looking at **short term exposure (<1 hour)** – which is not valid to set the guidelines for long-term exposure
- These studies have also not been "replicated" independently
- If we look at RFR exposure studies in a similar manner to drug studies: **translating the dose from animal model to human equivalent dose (HED) requires appropriate conversion using BODY SURFACE AREA normalization method, rather than per kg extrapolation.**
- If we utilize this method of conversion for a rat model study, we need to take 1/10 of the SAR dosage to have it be a comparable human equivalent dosage (ie. **SAR 0.08 W/kg x 1/10 = 0.008 W/kg** → this is however still at a level for SHORT TERM EXPOSURE

Summary of Epidemiological Studies of Mobile Phone Base Station Health Effects (Khurana et al. 2010)

see Appendix A

1. Santini et al (2003)
   - Showed **increase in complaint frequencies for tiredness, headache, sleep disturbance, discomfort, irritability, depression, loss of memory, dizziness, libido decrease,** in people who lived within **300 m** of mobile phone base stations.

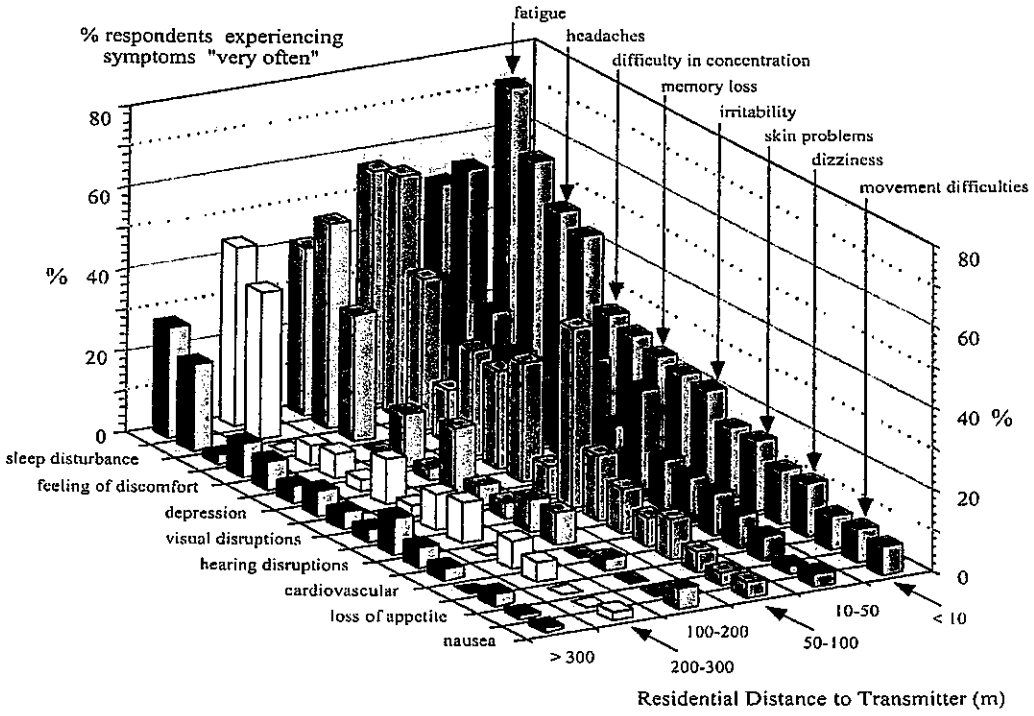


Figure 2. Response of residents living in the vicinity of a cellular phone base station in Spain

2. Abdel- Rassoul et al (2007)
   - **Found increased prevalence of headaches, memory changes, dizziness, tremors, sleep disturbance, depressive symptoms in exposed** compared to controls

3. Hutter et al (2006)
   - maximum levels of exposure **0.000002 and 0.41 uW/cm²**
   - **Found relationship between symptoms and power densities** – highest adverse effects were headaches, cold hands and feet, cardiovascular symptoms, concentration difficulties
   - Found no effect on sleep quality

Summary of Epidemiological Studies of Mobile Phone Base Station Health Effects (Khurana et al. 2010)

see Appendix A

4. Navarro et al (2003)
   - Measured electrical field in bedrooms of 97 participants
   - **Found highest associations for depressive tendencies, fatigue, sleeping disorders, concentration difficulties**

5. Eger et al (2004)
   - Results showed **significantly higher incidence of cancer** among those who lived for 5-10 years at distance of up to **400m** from cell installation that had been in operation since 1993
   - After 5 years exposure, showed about **3x risk of developing cancer** for residents near cell installation compared to those living outside the area

6. Wolf and Wolf (2004)
   - People lived within **350m** semi-circle of antennas
   - **8 cases of different cancers were diagnosed in a period of 1 year** (ovarian – 1, breast – 3, Hodgkins – 1, lung -1, osteoid osteoma – 1, nypernephroma -1)
   - 2 cases of cancer in the control group
   - found **4.15x more cases of cancer** in exposed group than in the entire population
   - **measured RFR 03.-0.5 uW/cm² (well below guidelines)**

List of Studies Reporting Biological Effects at Low Intensities of RFR (Levitt and Lai, 2010)

see Appendix B

- Out of 56 studies listed, 37 reported SAR values
- **Average SAR value 0.022 W/kg** – showing biological effects (well below SAR guideline for whole body 0.08 W/kg)

Comments:

- At about **100-200 feet (30-60 metres)** from cell phone base station
  - possible power density exposure could be 0.001 mW/cm² (or **1.0 uW/cm²)**
  - possible **SAR could be 0.001 W/kg**
- Many of the studies (some highlighted in Appendix B) **showing biological effects are at RFR intensities comparable to what the population may experience within 200-500 feet (60-150 metres)**

- Effects include: growth and reproductive problems, increased permeability of the blood-brain-barrier (which protects the brain from toxins), behavioural problems, increased cancer risk

Long Term Exposure Studies

Reference	Frequency	Exposure Duration	SAR (W/kg)	SAR (W/kg) HUMAN DOSE CONVERSION	Power Density	Effects Reported
D'Andrea et al (1986) rat study	2450 MHz	7 h/day 7 days per week for 14 weeks	0.7 W/kg	0.07 W/kg	2.5 mW/cm^2	Disruption of behaviour
D'Andrea et al (1986) rat study	2450 MHz	7 h/day 7 day/wk for 90 days	0.14 W/kg	0.014 W/kg	0.5 mW/cm^2	Disruption of behaviour
Baranski (1972)						
Takashima et al (1979)						
Lai et al (1989)						
John Hopkins Foreign Service Health Status Study/Lilienfeld study (1978)	0.6 - 9.5 GHz	Conducted between 1953-1976 US Embassy in Moscow 6-8h/day 5d/week for 2-4 years			2 – 28 uW/cm^2	Eczema, psoriasis, neurological problems in males, reproductive issues in females during pregnancy, childbearing, tumour increases, effects on mood and well-being, depression, loss of appetite, concentration, eye problems

Noteworthy Recently Released Studies

The latest studies presented by Public Health Ontario were studies looking at cell phones, and not cell phone base stations. The presentation also did not include are recent systematic review published in the WHO Bulletin in 2010.

Interphone (2010)

- Basis for the IARC's (International Agency for Research on Cancer) an arm of the WHO decision to classify RFR as a Possible 2B Carcinogen
- 13 country epidemiological study looking at cell phone and tumour risk
- **Study investigators admit many biases in this study underestimated the risk for brain cancer development**
- Even with these biases – authors still found **40% increased risk for glioma** on same side as exposure for those who used cell phone for at **least 1640 hours of cumulative use (less than 30min/day)**

Danish Cohort Study (update October 2011)

- Tracking >400,000 mobile phone users since 1980's (follow up period 1990-2007)
- Matched cell phone users with tumour registries
- **Underestimated the effect of cell phones on cancer**
- Categorized the **corporate subscribers to the non-user group** as they could not be "matched" to another individual in the cancer registry → adding the likely the **heaviest users** into a group of non-users

Systematic Review – WHO (Roosli et al 2010)

- Systematic review of recent literature on health effects of exposure to MPBS (mobile phone base stations)
- Looked only at human trials
- 134 potentially relevant studies identified
- included only 17 studies in their analysis
- excluded 3 cancer studies because they did not fulfill quality criteria
- Found no evidence of those who were "electrically sensitive" were more susceptible to RFR than the rest of the population
- No occurrence of acute symptoms shown after exposure to the radiation
- **Found significant positive correlation between exposure level and headache score**
- **No conclusive evidence on long-term effects**
- **More information required on the effects on children and adolescents regarding the potential risk**
- ***"where data is scarce, the absence of evidence of harm should not necessarily be interpreted as evidence that no harm exists"*** – taken directly from Systematic Review by Roosli et al 2010

Exposure Guidelines by Country

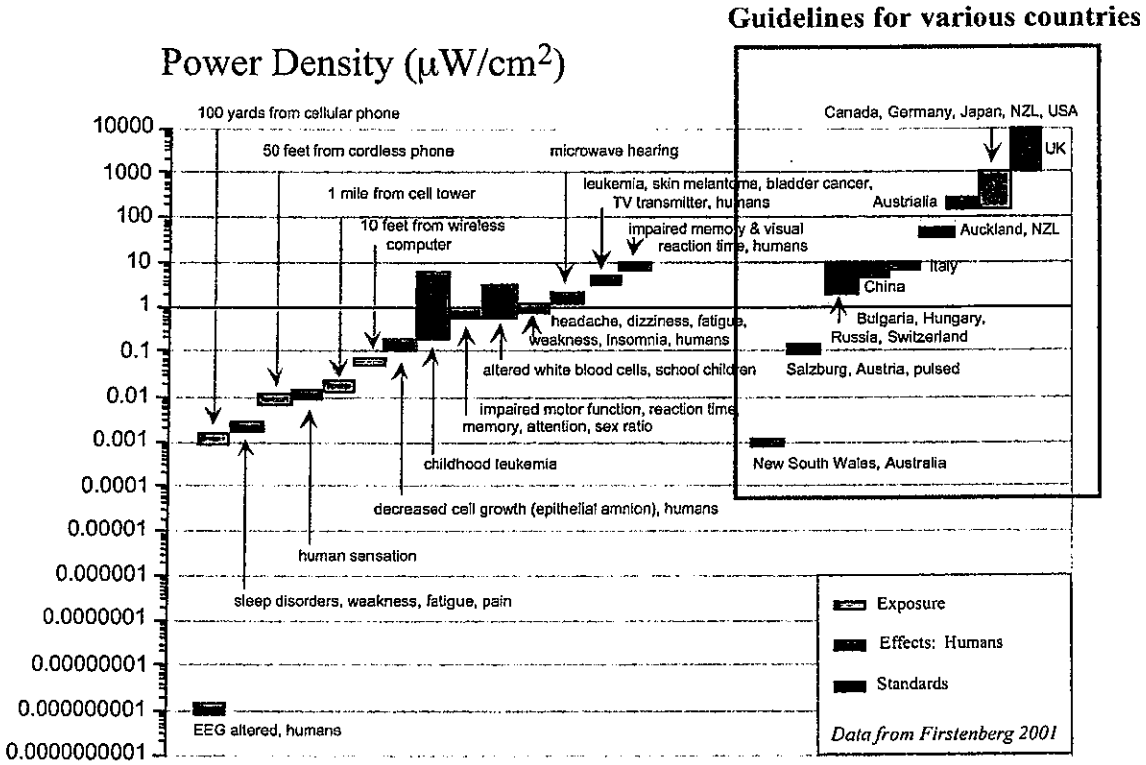


Figure 1. Guidelines, exposures and effects of radio frequency radiation at various power densities. Data from Firstenberg (6).

Appendix A

TABLE 1 Summary of Epidemiological Studies of Mobile Phone Base Station Health Effects

Publication (Year; Country)	Clinical Assessment	Study Design	Base Station Details	Participants	EMF Measured	Key Findings	Strengths	Limitations
Navarro[2] (2003; Spain)	Neuro-behavioral	Survey-questionnaire	GSM-DCS 1800 MHz	101	Yes	More symptoms with closer proximity to base station (< 150 m)	Detailed questionnaire, EMF measured, distances studied[a]	Low participation, self-estimated distances, subjects aware[b]
Santini[2] (2003; France)	Neuro-behavioral	Survey-questionnaire	n/s	530	No	More symptoms with closer proximity to base station (< 300 m)	Detailed questionnaire, distances & other EMF exposures assessed	As above, plus no EMF measurements, no base station details
Eger[7] (2004; Germany)	Cancer incidence	Retrospective case review	GSM 935 MHz	967	No	3 x risk of cancer after 5 yrs of exposure (< 400 m); early age of cancer diagnosis	Maximum beam intensity calculated, reliable cancer data collection	Other environmental risk factors not assessed; analysis not adjusted for age and sex.
Wolf & Wolf[8] (2004; Israel)	Cancer incidence	Retrospective case review	TDMA 850 MHz	1844	Yes	> 4 x risk of cancer after 3–7 yrs exposure (< 350 m); early age of cancer diagnosis	Reliable cancer & demographic data, no other major environmental pollutant identified	Not all environmental risk factors assessed; possible selection bias; no age, sex adjustment.
Gadzicka[4] (2006; Poland)	Neuro-behavioral	Survey-questionnaire	n/s	500	No	More headache with proximity < 150 m; nocebo unlikely[c]	Detailed questionnaire, distances & EMF studied, nocebo studied	Subjects aware, no base station details
Hutter[5] (2006; Austria)	Neuro-behavioral	Cross-sectional	900 MHz	336	Yes	Headaches & impaired concentration at higher power density; nocebo unlikely	Detailed questionnaire and testing, EMF measured, distances studied; nocebo effect studied	Subjects aware, low participation rate
Meyer[9] (2006; Germany)	Cancer incidence	Retrospective case review	n/s	177,428	No	No increased cancer incidence in municipalities with or without base stations	Wide population assessed (Bavaria)	Observation period only 2 years, vague definitions of exposure, exposure onset unknown, distance to base station unknown
Abdel-Rassoul[6] (2007; Egypt)	Neuro-behavioral	Cross-sectional	n/s	165	Yes	More symptoms & lower cognitive performance if living under or < 10 m from base station	Detailed questionnaire and testing, EMF measured, distances studied, subjects unaware	Exact base station details n/s, low number of participants
Blettner[10] (2009; Germany)	Neuro-behavioral	Cross-sectional	n/s	30,047	No	More health complaints closer to base station (< 500 m)	Wide population assessed, detailed survey, nocebo effect assessed	EMF measurements not carried out (see phase II in Berg-Beckhoff et al., 2009; below)
Berg-Beckhoff[11] (2009; Germany)	Neuro-behavioral	Cross-sectional	GSM 900 MHz GSM 1800 MHz UMTS 1920–1980 MHz	1326	Yes	Health effects probably caused by stress and not by RF-EMF	Measured EMF emissions, standardized questionnaires	Low participation, no detailed list of symptoms published, single "spot" measurement in one place in dwelling, no occupational exposure assessed, time lag from assessment of symptoms and EMF measurement

n / s = not specified.
[a]"Distance" refers to distance between base station and subjects' households.
[b]"Subjects aware" refers to study participants having an idea of the purpose of the study

Appendix B

Table 1. List of studies reporting biological effects at low intensities of radiofrequency radiation (RFR).

Reference	Frequency	Form of RFR	Exposure duration	SAR (W/kg)	Power density ($\mu W/cm^2$)	Effects reported
Balmori (2010) (in vivo) (eggs and tadpoles of frog)	88.5–1873.6 MHz	Cell phone base station emission	2 months		3.25	Retarded development
Belyaev et al. (2005) (in vitro)	915 MHz	GSM	24, 48 h	0.037		Genetic changes in human white blood cells
Belyaev et al. (2009) (in vitro)	915 MHz, 1947 MHz	GSM, UMTS	24, 72 h	0.037		DNA repair mechanism in human white blood cells
Blackman et al. (1980) (in vitro)	50 MHz	AM at 16 Hz		0.0014		Calcium in forebrain of chickens
Boscol et al. (2001) (in vivo) (human whole body)	500 KHz–3 GHz	TV broadcast			0.5	Immunological system in women
Campisi et al. (2010) (in vitro)	900 MHz	CW (CW– no effect observed) AM at 50 Hz	14 days, 5, 10, 20 min per day		26	DNA damage in human glial cells
Capri et al. (2004) (in vitro)	900 MHz	GSM	1 h/day, 3 days	0.07		A slight decrease in cell proliferation when human immune cells were stimulated with mitogen and a slight increase in the number of cells with altered distribution of phosphatidylserine across the membrane
Chiang et al. (1989) (in vivo) (human whole body)	Lived and worked close to AM radio and radar installations for more than 1 year				10	People lived and worked near AM radio antennas and radar installations showed deficits in psychological and short-term memory tests
de Pomerai et al. (2003) (in vitro)	1 GHz		24, 48 h	0.015		Protein damages
D'Inzeo et al. (1988) (in vitro)	10.75 GHz	CW	30–120 s	0.008		Operation of acetylcholine-related ion-channels in cells. These channels play important roles in physiological and behavioral functions
Dutta et al. (1984) (in vitro)	915 MHz	Sinusoidal AM at 16 Hz	30 min	0.05		Increase in calcium efflux in brain cancer cells
Dutta et al. (1989) (in vitro)	147 MHz	Sinusoidal AM at 16 Hz	30 min	0.005		Increase in calcium efflux in brain cancer cells
Fesenko et al. (1999) (in vivo) (mouse- wavelength in mm range)	From 8.15–18 GHz		5 h to 7 days direction of response depended on exposure duration		1	Change in immunological functions
Forgacs et al. (2006) (in vivo) (mouse whole body)	1800 MHz	GSM, 217 Hz pulses, 576 μs pulse width	2 h/day, 10 days	0.018		Increase in serum testosterone
Guler et al. (2010) (In vivo) (rabbit whole body)	1800 MHz	AM at 217 Hz	15 min/day, 7 days		52	Oxidative lipid and DNA damages in the brain of pregnant rabbits

Table 1 (*continued*).

Reference	Frequency	Form of RFR	Exposure duration	SAR (W/kg)	Power density ($\mu W/cm^2$)	Effects reported
Hjollund et al. (1997) (in vivo) (human partial or whole body)	Military radars				10	Sperm counts of Danish military personnel, who operated mobile ground-to-air missile units that use several RFR emitting radar systems, were significantly lower compared to references
Ivaschuk et al. (1997) (in vitro)	836.55 MHz	TDMA	20 min	0.026		A gene related to cancer
Jech et al. (2001) (in vivo) (human partial body exposure-narcoleptic patients)	900 MHz	GSM— 217 Hz pulses, 577 μs pulse width	45 min	0.06		Improved cognitive functions
Kesari and Behari (2009) (in vivo) (rat whole body)	50 GHz		2 h/day, 45 days	0.0008		Double strand DNA breaks observed in brain cells
Kesari and Behari (2010) (in vivo) (rat whole body)	50 GHz		2 h/day, 45 days	0.0008		Reproductive system of male rats
Kesari et al. (2010) (in vivo) (rat whole body)	2450 MHz	50 Hz modulation	2 h/day, 35 days	0.11		DNA double strand breaks in brain cells
Kwee et al. (2001) (in vitro)	960 MHz	GSM	20 min	0.0021		Increased stress protein in human epithelial amnion cells
Lebedeva et al. (2000) (in vivo) (human partial body)	902.4 MHz	GSM	20 min		60	Brain wave activation
Lerchl et al. (2008) (in vivo) (hamster whole body)	383 MHz 900 and 1800 MHz	TETRA GSM	24 h/day, 60 days	0.08		Metabolic changes
Magras and Xenos (1997) (in vivo) (mouse whole body)	"Antenna park"	TV and FM-radio	Exposure over several generations		0.168	Decrease in reproductive function
Mann et al. (1998) (in vivo) (human whole body)	900 MHz	GSM pulse-modulated at 217 Hz, 577 μs width	8 h		20	A transient increase in blood cortisol
Marinelli et al. (2004) (in vitro)	900 MHz	CW	2–48 h	0.0035		Cell's self-defense responses triggered by DNA damage
Markovà et al. (2005) (in vitro)	915 and 905 MHz	GSM	1 h	0.037		Chromatin conformation in human white blood cells
Navakatikian and Tomashevskaya (1994) (in vivo) (rat whole body)	2450 MHz 3000 MHz	CW (no effect observed) Pulse-modulated 2 μs pulses at 400 Hz	Single (0.5–12hr) or repeated (15–60 days, 7–12 h/day) exposure, CW–no effect	0.0027		Behavioral and endocrine changes, and decreases in blood concentrations of testosterone and insulin
Nittby et al. (2008) (in vivo) (rat whole body)	900 MHz,	GSM	2 h/week, 55 weeks	0.0006		Reduced memory functions
Novoselova et al. (1999) (in vivo) (mouse whole body – wavelength in mm range)	From 8.15–18 GHz		1 s sweep time – 16 ms reverse, 5 h		1	Functions of the immune system
Novoselova et al. (2004) (in vivo) (mouse whole body – wavelength in mm range)	From 8.15–18 GHz		1 s sweep time16 ms reverse, 1.5 h/day, 30 days		1	Decreased tumor growth rate and enhanced survival

Table 1 (*continued*).

Reference	Frequency	Form of RFR	Exposure duration	SAR (W/kg)	Power density ($\mu W/cm^2$)	Effects reported
Panagopoulos et al. (2010) (in vivo) (fly whole body)	900 and 1800 MHz	GSM	6 min/day, 5 days		1–10	Reproductive capacity and induced cell death
Panagopoulos and Margaritis (2010*a*) (in vivo) (fly whole body)	900 and 1800 MHz	GSM	6 min/day, 5 days		10	'Window' effect of GSM radiation on reproductive capacity and cell death
Panagopoulos and Margaritis (2010*b*) (in vivo) (fly whole body)	900 and 1800 MHz	GSM	1–21 min/day, 5 days		10	Reproductive capacity of the fly decreased linearly with increased duration of exposure
Pavicic and Trosic (2008) (in vitro)	864 and 935 MHz	CW	1–3 h	0.08		Growth affected in Chinese hamster V79 cells
Pérez-Castejón et al. (2009) (in vitro)	9.6 GHz	90% AM	24 h	0.0004		Increased proliferation rate in human astrocytoma cancer cells
Persson et al. (1997) (in vivo) (mouse whole body)	915 MHz	CW and pulse-modulated (217 Hz, 0.57 ms; 50 Hz, 6.6 ms)	2–960 min; CW more potent	0.0004		Increase in permeability of the blood–brain barrier
Phillips et al. (1998) (in vitro)	813.5625 MHz 836.55 MHz	iDEN TDMA	2, 21 h 2, 21 h	0.0024		DNA damage in human leukemia cells
Pologea-Moraru et al. (2002) (in vitro)	2.45 GHz		1 h		15	Change in membrane of cells in the retina
Pyrpasopoulou et al. (2004) (in vivo) (rat whole body)	9.4 GHz	GSM (50 Hz pulses, 20 μs pulse length)	1–7 days postcoitum	0.0005		Exposure during early gestation affected kidney development
Roux et al. (2008*a*) (in vivo) (tomato whole body)	900 MHz				7	Gene expression and energy metabolism
Roux et al. (2008*b*) (in vivo) (plant whole body)	900 MHz				7	Energy metabolism
Salford et al. (2003) (in vivo) (rat whole body)	915 MHz	GSM	2 h	0.02		Nerve cell damage in brain
Sarimov et al. (2004) (in vitro)	895–915 MHz	GSM	30 min	0.0054		Human lymphocyte chromatin affected similar to stress response
Schwartz et al. (1990) (in vitro)	240 MHz	CW and sinusoidal modulation at 0.5 and 16 Hz, effect only observed at 16 Hz modulation	30 min	0.00015		Calcium movement in the heart
Schwarz et al. (2008) (in vitro)	1950 MHz	UMTS	24 h	0.05		Genes in human fibroblasts
Somosy et al. (1991) (in vitro)	2.45 GHz	CW and 16 Hz square-modulation, modulated field more potent than CW		0.024		Molecular and structural changes in cells of mouse embryos

Table 1 (*concluded*).

Reference	Frequency	Form of RFR	Exposure duration	SAR (W/kg)	Power density ($\mu W/cm^2$)	Effects reported
Stagg et al. (1997) (in vitro)	836.55 MHz	TDMA duty cycle 33%	24 h	0.0059		Glioma cells showed significant increases in thymidine incorporation, which may be an indication of an increase in cell division
Stankiewicz et al. (2006) (in vitro)	900 MHz	GSM 217 Hz pulses, 577 ms width		0.024		Immune activities of human white blood cells
Tattersall et al. (2001) (in vitro)	700 MHz	CW	5–15 min	0.0016		Function of the hippocampus
Velizarov et al. (1999) (in vitro)	960 MHz	GSM 217 Hz square-pulse, duty cycle 12%	30 min	0.000021		Decrease in proliferation of human epithelial amnion cells
Veyret et al. (1991) (in vivo) (mouse whole body)	9.4 GHz	1 μs pulses at 1000 pps, also with or without sinusoidal AM between 14 and 41 MHz, response only with AM, direction of response depended on AM frequency		0.015		Functions of the immune system
Vian et al. (2006) (in vivo) plant	900 MHz				7	Stress gene expression
Wolke et al. (1996) (in vitro)	900, 1300, 1800 MHz	Square-wave modulated at 217 Hz		0.001		Calcium concentration in heart muscle cells of guinea pig
	900 MHz	CW, 16 Hz, 50 Hz, and 30 KHz modulations				
Yurekli et al. (2006) (in vivo) (rat whole body)	945 MHz	GSM, 217 Hz pulse-modulation	7 h/day, 8 days	0.0113		Free radical chemistry

Note: These papers gave either specific absorption rate, SAR, (W/kg) or power density ($\mu W/cm^2$) of exposure. (Studies that did not contain these values were excluded). AM, amplitude-modulated or amplitude-modulation; CW, continuous wave; GSM, global system for mobile communication; iDEN, integrated digital enhanced network; TDMA, time division multiple access, TETRA, terrestrial trunked radio; UMTS, universal mobile telecommunications system.