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Expert Testimony prepared by Magda Havas, B.Sc., Ph.D.
Health Effects Associated with Radio Frequency Radiation

Introduction

Our use of radio frequency radiation started with the invention of the radio that allowed wireless communication at great distances. During World War II, the higher end of the radio frequency spectrum was used for radar. After the war, television and then mobile telecommunications technology (i.e. pagers) became popular followed by the most recent revolution of the cellular phone industry.

Today, more than at any other time in history, this planet is being inundated by radio frequency radiation from man-made sources. The electromagnetic energy is used to send voice and visual messages within frequency bands that range from thousands (kilo-Hertz, kHz) to billions (giga-Hertz, GHz) of cycles per second. Currently there is no international consensus on exposure guidelines, which range orders of magnitude in various countries around the world.

Exposure to radar installations was a concern in the 1950s until the 1980s and interest in this area has been reignited because of our growing reliance on cell phones and the need for more antennas and base stations. Research on the health effects associated with exposure to radio frequency radiation from antennas is at an early stage of development. However, results from many of the studies that have examined adverse health effects for residents living near antennas are alarming.

For my expert testimony I propose to introduce scientific studies of exposure to broadcast antennas (both TV and radio), military radio frequency installations, mobile phone antennas, as well as other studies that indicate adverse health effects of radio frequency radiation. I also propose to introduce a medical condition, known as electrohypersensitivity (EHS) that is

becoming increasingly common and appears to be related to exposure to radio frequency radiation (RFR) at levels well below existing guidelines.

Summary

Biological effects of radio frequency radiation have been document and range from cancers to cognitive disorders and sleeping dysfunction among humans and abnormal behavior, reduced milk yield, miscarriages and premature death among farm animals. People who live near broadcast antennas and cell phone antennas have a higher risk of developing leukemia. An increasing number of individuals are also becoming sensitive to this form of radiation and exhibit signs of *electrohypersensitivity* (EHS), which has been recognized as a disability in Sweden. This illness appears to be increasing and may already affect approximately 35% of the population according to one estimate in the United Kingdom.

Local governing bodies need access to this scientific information so they can make intelligent decisions regarding placement of these antennas. It is critical that antennas not be placed near residential areas and near schools since children seem to be particularly vulnerable to this form of energy. Farm animals are also sensitive and exposure can result in economic hardship to farmers in the form of sick animals and reduced milk production. For broadcast antennas the critical distance appears to be around 4 km.

Neither Canada nor the United States has non-thermal guidelines for RFR and the existing thermal guidelines do not protect the public. The Public Health Office of the government of Salzburg recommended that levels for the sum total of all antennas at a particular site not exceed a power density of 1 microwatt/m^2 (0.0001 microwatts/cm^2.). Until new guidelines are introduced in North America the Precautionary Principle needs to be applied to minimize exposure.

Currently we are conducting a human experiment on a massive scale by exposing a large population worldwide to radio frequency radiation without understanding the long-term biological and health consequences.

Broadcast Antennas

Broadcast antennas differ from cell phone antennas in that the transmitting frequency is lower, the radiation is stronger and transmission is more consistent with a broadcast antenna. However, in both cases, surrounding populations are exposed to radio frequency radiation and the biological results are similar although the distances, within which effects are documented, differ.

Example #1: Study of Health Effects of the Shortwave Transmitter Station of Schwarzenburg, Berne, Switzerland. **[Altpeter et al. 1995. Federal Office of Energy, BEW Publication Series, Study No. 55].**

Residents living near a shortwave transmitter station in Switzerland began to complain about ill health in the 1970s. In 1990, the Federal Department of Traffic and Energy, the licensing authority, commissioned a health study of the residents. Two zones were identified that decreased in distance and exposure to RFR and these were compared with reference zone C. Those who lived closest to the transmitter (zone A) had the highest incidence of sleeping disorders, restlessness, pain, weakness, fatigue, constipation and disturbed concentration.

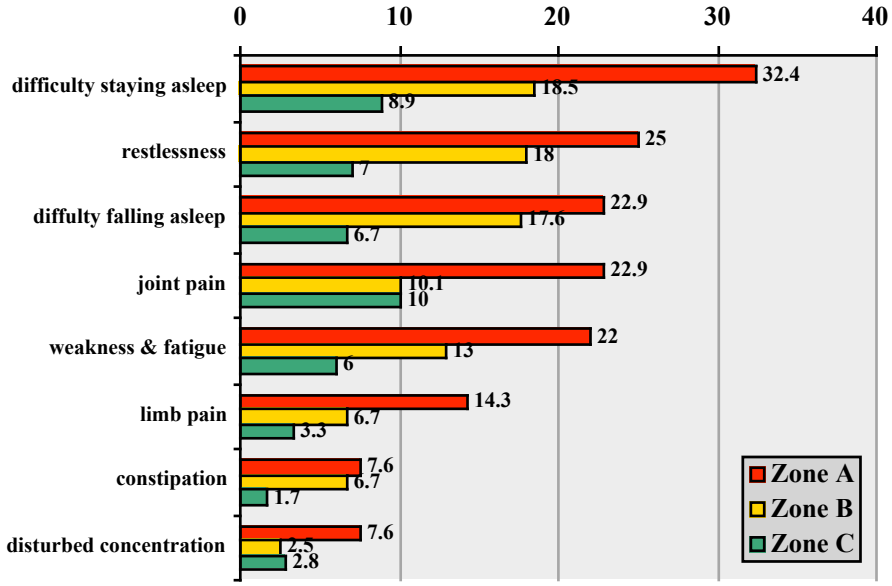

Figure 1. Response of residents living near a shortwave transmitter station near Schwarzenburg, Switzerland (Altpeter et al. 1995).

During the course of this research the transmitter failed for 3 days and during that period individuals experienced improved sleep that was detected after a 1-day delay. Since neither the researchers nor the residents were aware of this malfunction it demonstrates a biological rather than a psychological response to the transmitters.

Additional analyses showed an increased incidence of cancers (62% increase); diabetes (90% increase) and psychosis (3.8 fold increase) for those living near the transmitter.

Studies of two schools, one exposed and the other a reference school found reduced academic performance among the students in the school exposed to RFR.

Summary: People living within zone A and B experienced symptoms of electrohypersensitivity, had a higher incidence of cancers, diabetes and psychosis, and children exposed to this radiation had poorer academic performance.

Example #2: Cancer Incidence & Mortality & Proximity to TV Towers.
[Hocking et al. 1996. Med. J. Aust. 165(11-12):601-605.]

In North Sidney, Australia, both adults and children who lived within 4 km of a TV tower had

higher incidence of leukemia. For adults it was a 24% increase and for children it was a 58% with a 2.3 fold increase in mortality. All of these were statistically significant. Radio frequencies ranged from 8 to 0.2 microwatts/cm^2 within a 4 km radius of the tower and decreased to 0.02 microwatts/cm^2 at 12 km for the reference population.

Example #3: Risk of leukemia and residence near a radio transmitter in Italy. [Michelozzi et al. 1998. Epidemiology 9 (Suppl): 354.]

Adults who lived within 3.5 km radius of a radio transmitter near Rome Italy had a 2.5-fold elevated mortality rate (SMR[1] 2.5, 1.07-4.83 95% CI) associated with leukemia. The risk significantly declined with distance from the transmitter for men (P=0.005).

Example #4: Extraordinary behavior disorders in cows in proximity to transmission stations. [Loscher and Kas. 1998. Der Pratische Tierarz 79:5:437-444, translated from German.]

A cellular phone transmission antenna was installed on a tower with a pre-existing TV transmission antenna on a farm in Germany. After this new installation the cows produced less milk, miscarried, developed health problems, and exhibited unusual behavior that included conjunctivitis, repetitive head motion, reduced grazing in the field, and rapid deterioration after the third or forth calving which lead to premature death.

Food quality was high and could not account for the metabolic disturbances. The increased miscarriages did not related to either viral or bacterial infection. Autopsies indicated acute heart and circulatory problems with internal bleeding in several organs. This is consistent with microwave exposure.

Measurements of radio frequency radiation ranged from 400 to 936 MHz and the highest power density recorded was 7 milliwatts/m^2, well below international guidelines.

One cow with abnormal head movements was moved to a farm 20 km away and the head movements disappeared within 5 days. When this animal was returned to its home farm the abnormal head movements returned with a few days.

In a similar study of cows on a farm close to a transmission station, the micronuclei in cow blood were elevated indicating a genotoxic effects of exposure (Balode 1996, cited in Loscher and Kas 1998).

[1] SMR = standard mortality rate; CI = confidence interval

Example #5: Cancer rate and FM TV in Sweden.

Cancer mortality and long term sick leave

(Translated by Ö Hallberg from the original article "Cancerdödlighet och långtidssjukskrivning", Medikament 1-02; 40-41 in Swedish by Ö Hallberg and Olle Johansson, Assoc. Professor, Experimental Dermatology, Institution of Neuroscience, Karolinska Institute, Sweden).

The figure below shows that the cancer rate in Sweden began to increase when FM television was introduced in the late 1950s and it has continued to rise until the present period.

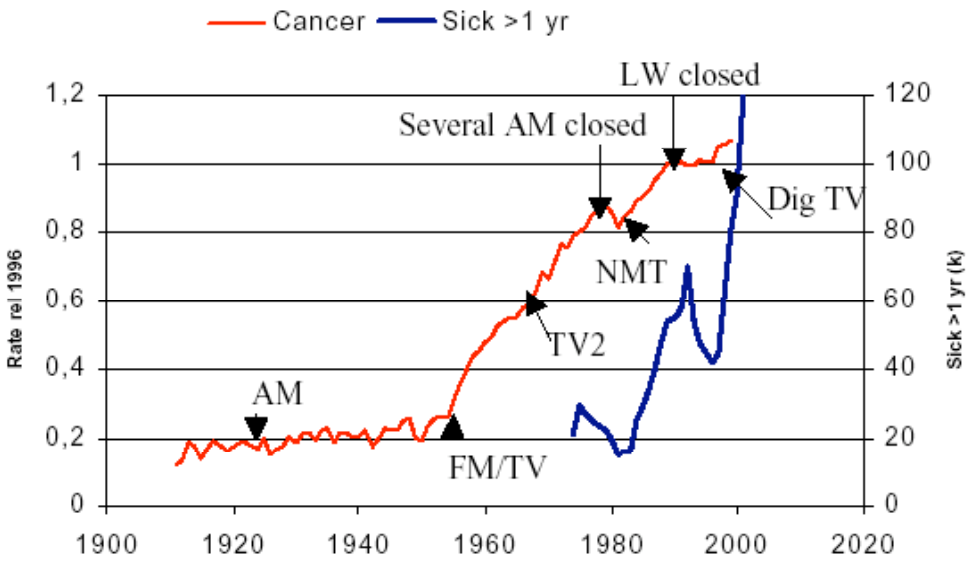

Figure 2. Normalized cancer-rate (see text) and the number of people who have been sick for more than one year in Sweden. The sharp reduction of the number of long-term sick registered in 1993 has been connected to increased possibilities of early retirement from that year.

Summary: What these studies show is that humans who live within 4 km of a broadcast antenna experience behavioral disorders, cognitive dysfunction, and adverse health effects including leukemia, diabetes, psychoses. Dairy cows provide less milk, miscarry, show abnormal behavior, and die prematurely when they live near a radio frequency antennas.

Radio Frequency Radiation and Microwave Radiation and Military Personnel

Example #6: Cancer morbidity in subjects occupationally exposed to high frequency (radio frequency and microwave) electromagnetic radiation. Szmigielski (1996).

Exposure of military personnel to radio frequency radiation and to microwaves has been associated with an increased incidence of various types of cancer as shown in the tables below. Cancers that show statistically significant increases include: nervous system and brain tumors

(91% increase); colorectal cancer (3.19-fold increase); esophageal and stomach cancer (3.24-fold increase); and blood forming and lymphatic cancers (6.31-fold increase).

For the blood forming and lymphatic cancers, chronic myeloblastic leukemia had the highest relative risk (13.9-fold increase), followed by acute myeloblastic leukemia (8.62-fold increase); non-Hodgkin lymphoma (5.82-fold increase) and acute lymphoblasic leukemia (5.82-fold increase).

Table 1.

Table: Incidence of neoplasms (per 100,000 subjects annually) in military personnel exposed and non-exposed (control) to radiofrequency and microwave radiation, Szmigielski (1996).

Localization of malignancies	Incidence (Expected)	Incidence (Exposed)	Risk Ratio	95% CI limits	p-value
Pharynx	1.96	2.12	1.08	0.82-1.24	N.S.
Esophageal and stomach	4.83	15.64	3.24	1.85-5.06	<0.01
Colorectal	3.96	12.65	3.19	1.54-6.18	<0.01
Liver, pancreas	2.43	3.58	1.47	0.76-3.02	N.S.
Laryngeal, lung	21.89	23.26	1.06	0.72-1.56	N.S.
Skin, including melanomas	3.28	5.46	1.67	0.92-4.13	<0.05
Nervous system including brain tumour	2.28	4.36	1.91	1.08-3.47	<0.05
Thyroid	1.38	2.12	1.54	0.82-2.59	N.S.
Haematopoietic system and lymphatic organs	6.83	43.12	6.31	3.12-14.32	<0.001
All malignancies	57.60	119.12	2.07	1.12-3.58	<0.05

Table 2.

Table: Incidence of haemopoietic and lymphatic malignancies (per 100,000 subjects annually) in military personnel exposed and non-exposed (control) to radiofrequency and microwave radiation.

Type of malignancy	Incidence Non-exposed	Incidence Exposed	RR	95 % Confid.	Significance
Hodgkin's disease	1.73	5.12	2.96	1.32 - 4.37	<0.05
Lymphoma (non-Hodgkin and lymphosarcoma	1.82	10.65	5.82	2.11 - 9.74	<0.001
Chronic lymphacytic leukaemia	1.37	5.04	3.68	1.45 - 5.18	<0.01
Acute lymphoblastic leukaemia	0.32	1.84	5.75	1.22 - 18.16	<0.05
Chronic myelocytic leukaemia	0.88	12.23	13.90	6.72 - 22.12	<0.001
Acute myeloblastic leukaemia	0.71	6.12	8.62	3.54 - 13.67	<0.001
Total	6.83	43.12	6.31	3.12 - 14.32	<0.001

Exposure of military personnel to radio frequency and microwave radiation is likely to be much higher than exposure of populations to RFR around a broadcast antenna. However, both

exposure result in an increased risk of cancers and this should provide a warning regarding the placement of broadcast antennas.

Mobile Phone Antennas

Cell phone antennas use a higher frequency than broadcast antennas and their radiation is normally intermittent and at a lower intensity than broadcast antennas. Despite this studies in various countries are documenting adverse health effects for people who live near cell phone antennas. According to Dr. Gahame Blackwell, as of Feb 2005 all five epidemiological studies of people who live near such installations show ill health effects from the masts. These include studies in Spain, Netherlands, Israel and Germany. Three of those studies are presented below:

Example #7: Symptoms experience by people in the vicinity of cellular phone base station. [Santini 2001, La Presse Medicale]

In this study the people who lived closest to the cellular antennas had the highest incidences of the following disorders: fatigue, sleep disturbances, headaches, feeling of discomfort, difficulty concentrating, depression, memory loss, visual disruptions, irritability, hearing disruptions, skin problems, cardiovascular disorders, and dizziness (See Figure 3).

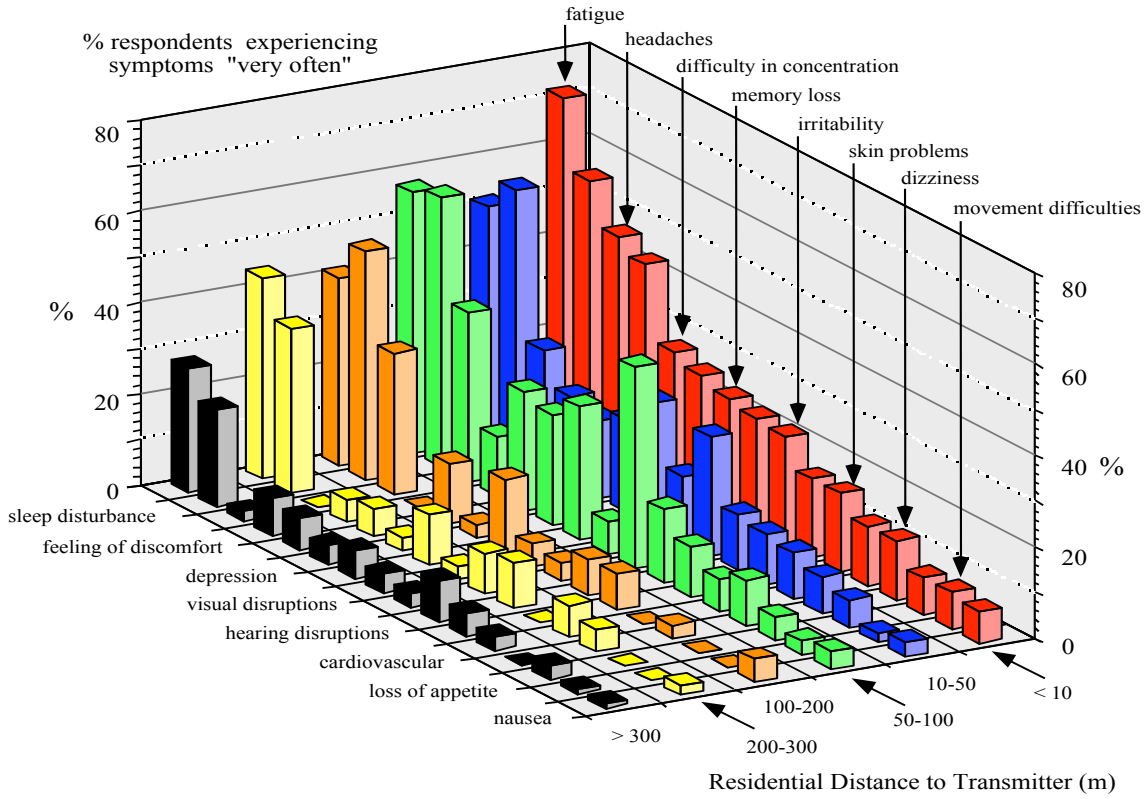

Figure 3. Response of residents living in the vicinity of a cellular phone base station in Spain (Santini 2001).

Adverse health effects were reported at distances up to 300 meters. In this case, health is defined according to the World Health Organization definition as "*the state of complete physical, mental and social well-being, and not merely the absence of disease or infirmity*".

Example #8: The Microwave Syndrome: A Preliminary Study in Spain.
[Navarro,E.A., J. Segura, M. Portoles, C. G-P de Mateo. 2003. Electromagnetic Biology & Medicine Vol. 22 (2):161-169.]

In Murcia Spain, scientists conducted a health survey near a cellular phone base station. Measurements of power density were below guidelines in both exposed and reference populations. Exposed individuals lived within 50 and 150 meters of the base station and the reference population lived 260 to 308 meters away. Exposed residents experienced more headaches, sleep disturbances, irritability, difficulty concentrating, discomfort, dizziness, appetite loss and nausea, symptoms that are typical of electrohypersensitivity syndrome. These results are similar to those reported in Study #1, (see Table 3).

Table 3. Response of residents living near a cellular phone base station in Spain (Navarro et al. 2003).

	Exposed	**Reference**	**P-value**
Respondents	54	47	–
Distance to Base Station	50 to 150 m	260 to 308 m	< 0.001
Average Power Density (mW/cm^2)	0.11 $\pm$ 0.19	0.01 $\pm$ 0.04	< 0.001
Headache	2.17	1.53	<0.001
Sleep disturbance	1.94	1.28	<0.01
Irritability	1.56	1.04	<0.05
Difficulty concentrating	1.56	1.00	<0.02
Discomfort	1.41	0.87	<0.02
Depression	1.30	0.74	<0.02
Dizziness	1.26	0.74	<0.05
Appetite loss	0.96	0.55	<0.05
Nausea	0.93	0.53	<0.05

0 = never; 1 = sometimes; 2 = often; 3 = very often

Example #9: Naila Study, Germany (November 2004); Report by five medical doctors.

The aim of this study was to examine whether people living close to cellular transmitter antennas were exposed to a heightened risk of taking ill with malignant tumours. What the researchers found was that the proportion of newly developing cancer cases was significantly higher among those patients who had lived during the past ten years at a distance of up to 400 metres from the cellular transmitter site, which bas been in operation since 1993, compared to those patients living further away, and that the patients fell ill on average 8 years earlier. After five years' operation of the transmitting installation, the relative risk of getting cancer had trebled for the residents of the area in the proximity of the installation compared to the inhabitants of Naila outside the area.

Example #10: RF radiation-induced changes in the prenatal development of mice. [Magras, 1997. Bioelectromagnetics 18(6):455-461.]

In an experiment, 12 pairs of mice (6 reference pairs) and (6 exposed pairs) were exposed to the radiation from an antenna park where levels were in the order of 1.053 to 0.168 microW/cm^2. Mice were mated 5 times and resulted in a total of 118 newborn offspring. The number of newborns per dam significantly decreased for mice exposed to the radio frequency radiation resulting in irreversible infertility.

What these studies show is that animals and humans who live within 300 to 400 meters of a cell phone transmission antenna experience behavioral disorders and adverse health effects.

These studies collectively show that there is an increased incidence of diabetes, psychosis, sleeping disturbances, depression, pain, fatigue, memory loss, impaired balance, reduced milk yield (cattle), and reproductive impairment (cattle and mice). The critical distances appear to be around 400 m from cell phone antennas and about 4 km from broadcast antennas (Table 4). More research is needed to determine these distances more accurately.

Table 4. Summary of Examples 1 to 10 provided in this testimony.

#	Source: Location	Power Density (microW/cm^2)	Distance	Effects	Reference
1	Shortwave Switzerland	Below guidelines 3 to 41 mA/m 1-2 mA/m (guideline=73 mA/m)	No data Zone A & B Zone C (reference)	Sleep disorder Restlessness Pain Weakness & fatigue Constipation Difficulty concentrating Cancer Diabetes Psychoses Poor academic performance	Altpeter et al. 1995
2	TV Tower Australia	8 0.2 0.02	Near 4 km 12 km	Leukemia incidence higher	Hocking et al. 1996
3	Radio Tower Italy	Below guidelines	3.5 km	Leukemia mortality higher (2.5 fold)	Michelozzi et al. 1998
4	TV & Cell Phone Germany	Max: 0.7	Adjacent to farm	Cows: Miscarriage Reduced milk yield Premature death Abnormal behavior	Loscher and Kas 1998
5	FM TV Sweden	No data	No data	Increased cancer rate	Hallberg and Johansson 2004
6	RFR & Microwave	Exposed vs not exposed	No data	Increase in various cancers Leukemias, Lymphomas, Esophageal Stomach Colorectal Nervous system Brain	Szmigielski 1996
7	Cell Phone Spain	Below guidelines	300 m	EHS: Fatigue Headaches, Cognitive disorders Depression, Visual and hearing disruptions, Cardiovascular problems Skin disorders Dizziness	Santini et al. 2001
8	Cell Phone Spain	0.11 $\pm$ 0.19 0.01 $\pm$ 0.04	50-150 m 260-308 m	EHS: Headache, Sleep disturbance Irritability Difficulty concentrating Depression Dizziness Loss of appetite	Navarro et al. 2003
9	Cell Phone Germany	Below guidelines	400 m	After 5 years a 3-fold increase in cancer incidence	Naila Study, 2004
10	Antenna Park	1.053-0.168	No data	Infertility in mice experimentally exposed for 5 gestations	Magras 1997

Placement of Cell Phone Antennas:

Even though cell phone antennas are unlikely to be as harmful as broadcast antennas, based on the studies previously mentioned, many jurisdictions worldwide are struggling with siting of cell phone base stations.

Example #11: The International Association of Fire Fighters (IAFF) ratified Resolution 15 in Boston, August 2004. Resolution 15 states that "*The IAFF oppose the use of fire stations as base stations for antennas and towers for the conduction of cell phone transmissions until such installations are proven not to be hazardous to the health of our members*." Evidence in California indicates that fire fighters in a fire hall with a cell phone antenna on the roof have abnormal brain activity.

Example #12: In Toronto as of 2000 there were more than 10,000 antennas in the City. The Toronto Health Department, concerned about this proliferation, requested that "applicants who wish to install new, replacement or modified antennas demonstrate that radio frequency exposures in the areas where people other than telecommunications workers would normally use will be at least 100 times lower than those currently recommended by Safety Code 6." This would reduce guidelines from 200-1000 mW/cm^2 (Canada) to 2-10 mW/cm2 (Toronto). *[Ronald Macfarlane, Health Concerns of Radio Frequency Fields near Base Telephone Transmission Towers. Toronto Public Health, Health Promotion and Environmental Protection Office, November 1999.]*

Example #13: Belfast City Council Ratified decisions of its Development Committee (Aug 18, 1999) that no transmitter masts should be permitted on any Council Property, due to unknown risk and substantial public concern.

Example #14: Wyre Borough Council, Lancashire believed it was unsuitable to site telecommunication towers 190 m from primary school and 40 m from houses.

Example #15: Scotland Planning Authorities adopted "Precautionary Policy" due to "perceived inadequate official advice from Government Departments"

Example #16: In England & Wales, the Local Government Association (LGA) advised member authorities to adopt "Precautionary Approach". This decision making process was based on the concept that waiting for "conclusive scientific evidence" before acting is potentially flawed.

If siting of cell phone antennas has received so much attention and concern, at least the same amount of concern, if not more, is required for siting of broadcast antennas.

Other Evidence that Radio Frequency Radiation is Harmful.

Example #17: In vivo Experiments

A number of laboratory studies with rodents support the claim that RFR is genotoxic. Lai and Singh (2005) reported single- and double-strand breaks in the brains cells of microwave-exposed

rats (at cell phone frequencies of 2450 MHz, continuous wave) compared with sham-exposed animals. *[Lai and Singh. 2005. Interaction of Microwaves and a Temporally Incoherent Magnetic Field on Single and Double DNA Strand Breaks in Rat Brain Cells. Electromagnetic Biology and Medicine (formerly Electro- and Magnetobiology) Volume 24, Number 1 / 2005 Pages: 23 - 29]*

Example 18: Radio frequency on indoor wires and health effects.

We normally assume that radio frequency travels only through the air since it is a "wireless" form of energy. However, any conducting object can act like an antenna and pick up RFR. Stetzer and Havas (2005) were able to detect RFR coming from a radio station (MHz range) in Bermuda that came in through the electrical wire attached to a brass lamp. The lamp then reradiated this frequency, which was also measured on a nearby bed (metal bedsprings) and was absorbed by anyone sitting or standing close to the lamp or touching the bed. This form of energy induces symptoms of electrical hypersensitivity.

Example #19: A Review of the Potential Health Risks of Radiofrequency Fields from Wireless Telecommunication Devices 1999. An Expert Panel Report prepared at the request of The Royal Society of Canada for Health Canada

According to this expert panel there is a growing body of scientific evidence which suggests that exposure to RF fields at intensities far less than levels required to produce measurable heating can cause effects in cells and tissues. These biological effects include alterations in the activity of the enzyme ornithine decarboxylase (ODC), in calcium regulation, and in the permeability of the blood-brain barrier. Some of these biological effects brought about by non-thermal exposure levels of RF could potentially be associated with adverse health effects.

Electrohypersensitivity (EHS)

Example #20: One of the most famous people who have become hypersensitive to radio frequency radiation is Gro Harlem Brundtland, the former Prime Minister of Norway. Dr. Brundtland develops headaches when she uses a cell phone and can no longer use one. She even develops headaches when people within 4 meters (12 feet) of her have a cell phoned turned on but not in use. . *[Mobile phone radiation gives Gro Harlem Brundtland headaches. Translation from Norwegian "Dagblad et" March 9, 2002, by Aud Dalsegg.].*

Electrohypersensitivity (EHS) is now recognized by the World Health Organization (WHO) and is defined as:

> *". . . a phenomenon where individuals experience adverse health effects while using or being in the vicinity of devices emanating electric, magnetic, or electromagnetic fields (EMFs). . . Whatever its cause, EHS is a real and sometimes a debilitating problem for the affected persons, while the level of EMF in their neighborhood is no greater than is encountered in normal living environments. Their exposures are generally several orders of magnitude under the limits in internationally accepted standards.* [WHO International Seminar and Working Group meeting on EMF Hypersensitivity, Prague, October 25-27, 2004].

EHS is classified as a disability in Sweden. As many as 35% of the population may be sensitive to electromagnetic energy and this syndrome may be increasing. Symptoms include: cognitive dysfunction (memory, concentration, problem-solving); balance, dizziness & vertigo; facial flushing, skin rash; chest pressure, rapid heart rate; depression, anxiety, irritability, frustration, temper; fatigue, poor sleep; body aches, headaches; ringing in the ear (tinnitus) and are consistent with chronic fatigue and fibromyalgia.

Precautionary Principle

Until appropriate guidelines can be introduced a number of international and national agencies, including the US National Institute of Environmental Health Sciences, are recommending adoption of the Precautionary Principle that was presented at the Rio Conference on Environment and Development in Brazil in 1992.

The Precautionary Principle (PP) states that: *"In order to protect the environment, the precautionary approach shall be widely applied by States according to their capability. 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 overarching Considerations include:

1. Scientific Basis for Application
2. Transparency, Accountability & Public Involvement
3. Cost-Effectiveness
4. Legal-Issues
5. International Considerations

I strongly urge all levels of government to adopt this principle to ensure protection of the populations who live near existing radio frequency antennas and to place new antennas at a sufficient distance to minimize human and animal exposure.

This expert testimony is respectfully submitted by Dr. Magda Havas, October 10, 2005.