

For AEHF's International Symposium 2007

## **EMF and RF Emission: Products, Devices and Their Intensities**

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March 23, 2007  
Calgary, Alberta, Canada  
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### **1.0 Radio Frequency & Electromagnetic Waves**

Radio Frequency is a naturally occurring phenomenon in all of nature. It is one of the attributes of the atomic makeup and system for measuring the behaviour and structure of elements. Frequency is a measurement to determine the energy contained in matter.

All of matter is made of elements that produce frequency. Frequency represents sound, motion, light, and the physical structure of life. A frequency represents life at rest, life in motion, and the potential of energy stored. It is also a measurement to determine motion, the potential of motion, and the transfer of energy.

Waves and their motion are modes of transporting energy and momentum. Frequency measures the number of waves that occurs over a period of time. This time period is called the wavelength. The shorter the distance between waves, the higher the frequency. The amplitude determines the strength of a wave.

The measurement of frequency is in Hertz, after the German physicist Heinrich Rudolf Hertz. This measurement is a numerical value showing the number of waves that pass by a specified point per second. For example, the A note on a violin vibrates at 440 Hz. This means its wave frequency vibrates at 440 vibrations per second.

There is a broad frequency spectrum that measures radio waves. It includes light waves, x-rays, gamma rays, and cosmic rays. Frequencies in the range of 10 kHz to 100 GHz are called radio frequencies. Radio frequencies for the telecommunications and broadcasting industry are broken down into groups called bands. Radio frequencies are broken down within a band into smaller ranges called channels.

The radio frequency spectrum ranges from an Extremely Low Frequency (ELF 3 – 30 Hz) such as that frequency used in underwater communication with submarines and is produced by power distribution systems, to Extremely High Frequency (EHF 30 -300 GHz) used in radio astronomy and microwave radio relay. Microwave radio relay is the technology that transmits worldwide communication signals for radio, television, telephone, and other digital signalling such as those used on the Internet (data transfer, email, and document exchange).

Frequencies produce electromagnetic (EM) waves. These waves are referred to as radio waves, heat rays, and light rays. Most commonly, we think of radio waves and frequency as a result from the operation of cellular phones, televisions, radio stations, walkie-talkies and other telecommunication devices. In addition, EM waves are produced from electric motors, ignition systems, gasoline engines, medical equipment, lighting, computers, common household appliances, and various chemicals.

### **2.0 What is an Electromagnetic Field**

An electromagnetic (EM) field is produced from the transfer of energy. An EM field happens when charged particles are accelerated and moved from one point to another in space. It is a “force” field that is capable of producing an action from a distance. An EM field is made up of two components: electricity (E) and magnetism (H). The moving charged particle creates the electrical field and when it stops, the charged particles are not accelerated and create the magnetic field. When particles are accelerated they make light, when they are static they store heat, resulting in magnetism.

All EM fields have components of electricity and magnetism. Electrical fields and their intensity are measured in volts per meter (V/m). Magnetic fields and their intensity are measured in amperes per meter (A/m). The power is the energy given off by a radiation source and transferred through space by the EM wave. Power is measured in watts (W).

Electromagnetic fields happen both naturally and by manmade activities. Naturally occurring EM fields include the earth's magnetic field, electrical charges in clouds, lightning, volcanoes, earthquakes, rain, and wind.

Manmade EM fields are the by product of mining, production, and storage of electricity. EM fields are generated by:

- 1 Energy Exploration & Mining (petroleum, gas, coal, nuclear)
- 2 Transformers
- 3 Substations
- 4 Power Lines
- 5 Communication Devices
- 6 Medical Diagnostic Imaging
- 7 Common Household Appliances
- 8 Modes of Transportation (gas and electric engines)

The occurrence of an EM field happens whenever there is an alternating current in an enclosed area. This occurrence of EM fielding happens in electrical conductors, similar to that of a common household lamp or television set, or in those found in large electrical transformers, or satellite/radio communication towers. It also occurs during the operation of gas and electric motors, engines, and with chemical vapours. The common term to describe the various ranges of radio frequency from all sources is "Electromagnetic Frequency".

Electromagnetic frequency and its field produce radiation. Radiation is the physical process of transferring heat. Some electromagnetic frequencies are ionizing frequencies such as those used in x-ray imaging, and are self propagating. Low electromagnetic frequency produced by small intelligent devices such as cellular telephones produce frequency with measurable heat emission during operation.

### **3.0 Increasing Radio Frequency Emissions**

The products, material, and devices that emit radio frequency and produce EM fields are growing in our technological society. Our society's need for energy, agriculture, and communication is the driving agent. All current communication devices such as cell phones, PDAs, computers, handheld telephones, microwaves, residential satellite dishes, and televisions produce EM fields and radio frequency. In fact, all household and workplace electronic items that we use everyday have measurable level of radio frequency. In addition, the energy sources from which we derive electricity such as oil, gas, coal, uranium, and chemicals produce radio frequency.

Radio frequency emissions are caused by three sources: Energy Production, Storage, and Usage. This is applicable on a large scale such as a coal fired electrical generator and also on a small scale such as a lithium battery in a common cell phone. It applies to the gas range, microwave, and laundry detergent in the average North American home.

The proliferation of technology demands, products, equipment, and networks using radio frequency technology is increasing the electromagnetic frequency emissions worldwide. Mining and coal burning plant production and global satellite communications deployment is growing every year. The product from operation emissions from all sources is called electropollution. It contributes to the total electromagnetic radiation emissions from all sources around the world, and is an additional factor creating heat in the atmospheric environment contributing to climate change.

Publication from the Clean Air Task Force report on coal "Cradle to Grave: The Environmental Impacts from Coal" (Published: June 2001) notes in its first paragraph:

The electric power industry is the largest toxic polluter in the country, and coal, which is used to generate over half of the electricity produced in the U.S., is the dirtiest of all fuels. From mining to coal cleaning, from transportation to electricity generation to disposal, coal releases numerous toxic pollutants into our air, our waters and onto our lands. Nationally, the cumulative impact of all of these effects is magnified by the enormous quantities of coal burned each year nearly 900 million tons. Promoting more coal use without also providing additional environmental safeguards will only increase this

toxic abuse of our health and ecosystems. (<http://www.catf.us/publications/view/7>)

Several industry sectors contribute to the spread of Radio Frequency technology and its usage demands. These include chemical, manufacturing, petroleum exploration, development, and processing; space exploration, communications, medicine, pharmaceutical, agriculture, and government (military). Virtually every aspect of a technical, industrialized society contributes to the demand and usage of energy and its radio frequencies.

As energy needs continue to climb, so does the requirement for production and manufacturing infrastructures to support its distribution. Increasing demand for energy creates requirements for facilities, installations, transformers, generators, distribution blocks and networks from which to generate and distribute the energy. In addition, subinfrastructures supporting telecommunication needs also need be deployed.

## **4.0 Technology Emission - Intensity**

Since all forms of modern technology devices and delivery platforms emit some form of electromagnetic radiation, it has become the sheer number of products, processes, and infrastructure in industrialized society that contributes to its propagation thus contributing to intensity.

Undoubtedly, the larger the electrical equipment, the greater the radio frequency emission is going to be from its operation. Transformers, generators, electrical storage facilities, communication towers, wireless networks, and frame relay systems all emit levels of radio frequency at the point of storage, transmission, and operation.

Intensity of radio frequency emission is not only a function of the equipment and technology we use, it is the amount of time we spend in an exposure period. Exposure to radio frequency occurs in the home, workplace, grocery store, movie theatre, and during the operation of a motor vehicle. Exposure occurs at the wireless network “Hotspots” that are encroaching the air space of coffee shops around the world.

Intensity is also contributed to by proximity to residential areas encroachment into industrial and manufacturing zones. It is acknowledged that the particulate matter of coal mining and burning are carried in the atmosphere for distances up to 1,600 kilometres from the production facility.

Governmental Health & Safety commission and bodies recognize that everyone in society is exposed to some level of “natural background ionizing radiation”. This radiation is sourced from: X-rays, gamma rays, alpha particles and beta particles; chemical products such as radon gas, medical diagnostic imaging, industry and the production of electricity. (Great Britain: Health & Safety Commission Executive: Web Statement: Radiation.)

According to the United States Department of Energy through the Low Dose Radiation Research Program, “Radiation exposures associated with human activity are expected to be low dose and low dose rate radiation from medical tests, waste clean up, terrorism events (e.g., dirty bombs) and environmental isolation of materials associated with nuclear weapons and nuclear power production. The major type of radiation exposures will be low Linear Energy Transfer (LET) ionizing radiation (primarily x and gamma radiation) from fission products.” (US Department of Energy: Low Dose Radiation Research Program)

Consideration must be made for work place and home exposures to ionizing radiation sourced from petroleum products, mercury gas lighting systems, herbicides, pesticides, biocides, cleaning products, and dental products.

In addition to the “natural background ionizing radiation”, there is exposure to radio frequency radiation from sources such as the sun, electrical supply equipment, and cellular telephones, tanning beds, computers and television sets.

### **4.1 Intensity as a Function of Proximity**

As communities grow they move closer and closer to the sources of large outputs of electromagnetic fields. The closer communities move and set up foundation in the proximity of refineries, mining, chemical production such as fertilizer companies, communication, industrial, and energy production, storage, and transmission operations the higher level of electromagnetic pollution to which they are exposed. Not only does the intensity of radio frequency increase, so does the

length of time in which people, families, and communities are exposed. Constant, persistent exposure to radio frequency at any intensity, without cessation, is damaging to all forms of life on this planet, not only human.

As technology for homes, educational institutes, business, and government advances it increases the need for energy and devices used. This increases the amount of radio frequency within a measured area of space and increases the total amount of time exposure occurs. Growing markets for communication devices, proliferation of technology in the home and other living spaces within the "emission area" only adds to the intensity of radio frequency exposure.

As electromagnetic waves travel through space they transfer energy and heat to objects within the field. Objects within the field include all organic and inorganic mass. Exposure to EM fields is measured and evaluated based on the amount and rate of energy absorbed.

EM fields and radio frequency are problematic to the environment as they increase the rate of oxidation and corrosion. Environmental oxidation and corrosion stress cause the weakening of structures and increases the risk of failure.

Increasing electromagnetic fields producing unnatural frequencies creates variances in the naturally occurring electromagnetic field and temperature of the earth, affecting all ecosystems. It changes the temperature at which these ecosystems, and the earth, operate. This increase in heat also affects human physiology.

## 4.2 Measuring Human Electromagnetic Field and Radio Frequency Exposure

Current human exposure to electromagnetic field and radio frequency is growing in incredible ways. Exposure to radio frequency is coming from multiple sources and industries that use radio and microwave technology. These include the energy sector its producers, suppliers, and distributors, the health care industry, and the food industry. Byproduct emissions result from all sources of EM fields.

How does a family, an individual, measure the amount of exposure to ELF on a daily basis? There are commercial options for EMF reading such as the EMF-822, but there is no quantifiable way to take measure, from all sources, to determine total daily human exposure.

## 5.0 The Emerging Evidence of Electromagnetic Field and Radio Frequency Impact on Human Health

Currently, there is much debate as to whether radio frequencies emitted from various products and instrumentation is harmful. Environmental and Public health agencies are commissioning studies to determine the effects of ELF radio frequency on human health. To date, the results are inconclusive, however, studies are surfacing that show exposure to electromagnetic field, caused by radio frequency emission and byproduct and volatile organic compounds (VOC) are having a significant impact on human health.

### Example Study 1:

Kavet R, Zaffanella LE, Daigle JP and Ebi KL. The possible role of contact current in cancer risk associated with residential magnetic fields. *Bioelectromagnetics* 2000;21(7):538-553.

The principal author is with the Electric Power Research Institute (EPRI), Palo Alto, California 94303, USA.

**Abstract:** Residential electrical wiring safety practices in the US result in the possibility of a small voltage (up to a few tenths of a volt) on appliance surfaces with respect to water pipes or other grounded surfaces. This "open circuit voltage" (V(OC)) will cause "contact current" to flow in a person who touches the appliance and completes an electrical circuit to ground. This paper presents data suggesting that contact current due to V(OC) is an exposure that may explain the reported associations of residential magnetic fields with childhood leukemia. Our analysis is based on a computer model of a 40 house (single unit, detached dwelling) neighborhood with electrical service that is representative of US grounding practices. The analysis was motivated by recent research suggesting that the physical

location of power lines in the backyard, in contrast to the street, may be relevant to a relationship of power lines with childhood leukemia. In the model, the highest magnetic field levels and V(OC)s were both associated with backyard lines, and the highest V(OC)s were also associated with long ground paths in the residence. Across the entire neighborhood, magnetic field exposure was highly correlated with V(OC)  $r = 0.93$ ). Dosimetric modeling indicates that, compared to a very high residential level of a uniform horizontal magnetic field (10  $\mu$ T) or a vertical electric field (100 V/m), a modest level of contact current (approximately 18  $\mu$ A) leads to **considerably greater induced electric fields** ( $> 1$  mV/m) averaged across tissue, such as bone marrow and heart. The correlation of V(OC) with magnetic fields in the model, combined with the dose estimates, lead us to **conclude** that V(OC) is a **potentially important exposure with respect to childhood leukemia risks associated with residential magnetic fields**. These findings, nonetheless, may not apply to residential service used in several European countries or to the Scandinavian studies concerned with populations exposed to magnetic fields from overhead transmission lines.

(Excerpt: Health Effects and Exposure Guidelines Related to Extremely Low Frequency Electric and Magnetic Fields – An Overview, prepared by The ELF Working Group of the Federal-Provincial-Territorial Radiation Protection Committee – Canada, January 2005)

“In Canada, there are no national standards for occupational and general public exposure at frequencies below 3 kHz.” Standards for exposure are being established by a number of governments worldwide based on the studies of biological effects as the epidemiological studies are inconclusive.

The difficulty with making definitive correlations showing impact to health from exposure to radio frequency to date is that the transfer agent between ELF and EM fields and disease has not been established.

It can be shown from many disciplines that the suspected transfer agent causing disease and biological affectation is that of compound fluoride, a byproduct emission of petroleum energy production, a gas among the greenhouse gases emitted from industry, and a radio frequency found in Volatile Organic Compounds (VOCs).

Studies showing toxicity, oxidation, and thermological damage from exposure to compound fluoride are prodigious. Compound fluoride includes any fluoride in a compound state such as sodium fluoride, thionyl fluoride, uranium hexafluoride, aluminum fluoride, hydrogen fluoride and thousands of others. Industrialized society is being exposed to fluoride compounds and their electromagnetic fields and radio frequency on a daily basis from multiple sources.

## 5.1 Investigating Health Effects from EM Field & Frequency Exposure

All ecosystems on earth are exposed to low levels of natural electromagnetic field. These naturally occurring fields give shape, form, light, and sound to the visible and audible world around us. The naturally occurring EM fields contribute to all life on this planet. These fields vary in strength and density depending on the seasons and the activity of the ecosystems.

For years, health advocates have been concerned that radio frequency emissions from all sources could be potentially harmful. There are multiple and various studies researching the implications and health effects of exposure. The primary issue about radio frequency exposure is the generation of heat and how that heat affects the human biosphere.

It is recognized by the Occupational Safety and Health Department of the Communication Workers of America (CWA) “As high radio frequency radiation...penetrates the body, the exposed molecules move about and collide with one another causing friction and, thus, heat...If the radiation is powerful enough, the tissue or skin will be heated or burned.” (The Environmental Magazine, Earth Talk, October 22, 2006: Effects of Radio Frequencies on Our Health)

The CWA recognizes that there are substantial scientific data that establishes the negative health effects of radio frequency associated with microwave radiation.

The World Health Organization, through the International EMF Project is tasked with the examination of electric and magnetic fields ranging from 0 to 300 GHz. The focus of the investigation is to determine the risk of cancer and disease by exposure to static electric and magnetic fields and establish guidelines for exposure. The International EMF Project is expected to release its finding in 2007. It is the only international organization with the mandate to determine health impacts

from exposure.

The International EMF Project is working under the umbrella of the Environmental Health Unit. This Unit investigates and plans for radiation protection from both ionizing and "nonionizing" radiation activities and sources. (World Health Organization, EMF, The International EMF Project)

To determine the health impact of radio frequencies, private and corporate institutes and bodies have undertaken additional studies and research. Multiple research reports are concluding the impacts of radio frequency exposure are causing serious health complications, disease, morbidity, and death. In an article published in the Science News Online, Kendal Morgan reported that a Swedish Research team had determined that a 2 hour exposure to a microwave caused the death of brain cells in rats. When confirmed, these results would be the first that would directly link microwave exposure to brain damage in an animal. (Science News Online; Feb22, 2003;Vol.163, No 8, p. 115)

However, the article notes that research conducted 10 years ago by Dr. Leif G. Salford (Lund University Hospital Sweden) and associates that rat brains exposed to cell phone radiation caused the "...protective barrier in rats' brains to leak, permitting blood proteins that are normally kept away from brain tissue to contact neurons. Now, Salford's team reports in a forthcoming *Environmental Health Perspectives* that this breach of the so called blood-brain barrier is accompanied by the death of brain cells."

As reported in the Israeli Technology News, an Israeli research team found that there *might* be a link between visual damage and microwave radiation. The research by the Israeli team pointed out that "At least one kind of damage seems to accumulate over time and not heal, challenging the common view and leading the researchers to the assertion that the duration of exposure is not less important than the intensity of the irradiation. The researchers also emphasized that existing exposure guidelines for microwave radiation might have to change." (IsraCast: Israeli Technology News, Jul. 25, 2005, IsraCast.com)

Many more studies are coming forward showing the link between radio frequency exposure and disease. This is particularly evident in the electricity production industries, notably the oil & gas, coal, and ore mining such as uranium. Much of this reporting is done on the greenhouse gases and their environmental impact. Parallel study is also occurring on the impact of the radio frequencies and their identified chemicals, particularly the polyaromahydrocarbons and their compound by products.

As it is still to be absolutely proven there are no health risks, it would behoove doctors and health care providers to caution their patients with complaints to add some shielding to cellular and battery operated telephones. While the various science fields sort out what is what, it is better to err on the side of caution with the protection of the patients as the priority.

## 5.2 Investigative Findings

Epidemiological studies abound implicating the impact of artificial (manmade) spread frequencies on earth's ecosystems. Reports and boards and scientific agencies are inundating our news with studies about global climate and environmental changes. The problem is compounded by another heat emitting activity, radio frequency emissions.

The principal dynamic of how EM fields and radio frequencies affect biological systems is understood through thermodynamics. Radiation, or thermodynamics, is the physical transfer of heat. All radiation is ionizing. It can be self propagating, and heat generating; or it can be less ionizing, meaning it will dissipate and disperse. It has no charged particle that can maintain heat.

When heat enters a human body it causes motion in the cells. Moving cells make friction and this friction makes **exothermic** heat. In small, undetected increments the cells begin to heat up.

The biological processes induced by heat transfer are:

- 1 Emulsification
- 2 Dehydration
- 3 Desalination

Combined, these processes have major health impact on human biology and health. Artificially increased body heat at the cellular level changes the way the body produces and manufactures enzymes, constructs proteins, and burns complex sugars.

Heat destroys essential fatty acids necessary for the construction of biological enzymes and proteins. As the heat increases, it continues to destroy the fats, there are less essential amino acids, and without amino acids there is no protein construction. Complex protein metabolism interference then occurs with human growth hormone, insulin, myelin, thyroid, secondary sexual hormones like testosterone, estrogen, adrenal, and pituitary.

Research about the health impacts of radio frequency using standard epidemiological and toxicological standards have been used for decades. These studies characterize the health response to high radiation exposure and helped set minimal standards for exposure in the workplace and home. Multiple studies have shown increased heat from radio frequency at the cellular level affects all primary proteins and their synthesis.

More recent investigative findings are discovering the effects of radio frequency radiation exposure implicated in Alzheimer's Disease. Scientist studying the brain of an 86 year old patient with Alzheimer's Disease found that there was evidence to indicate radon daughters in different areas of the brain. This indicating exposure to the noble gas radon produced cell damaging high energy alpha particles. The study concluded:

“AD is a complex and progressive brain disease characterized by the failing ability to cope with environmental xenobiotic hazards [2,3], excessive free radical injury, inflammation and immunity deficiency [46], cell repair impairment [47], and the protein synthesis [48]. The ubiquitous environmental RAD exposure, and high RAD accumulation in the sensitive brain structures may either induce or hasten or both the irreversible "shut down" process of the ailing human brain in AD.”

(Published in Molecular Neurodegeneration Journal V.1; 2006, PubMed Central, Journal List, September 11, 2006)

## **6.0 Observed Effects of Radio Frequency Heat on Human Health**

The human body is an example of naturally occurring frequency within an electromagnetic field. To understand the effects of ionizing ELF on human health, development, and disease it is helpful to think of human anatomy and systems as an interconnection of magnetic and electric fields contained inside a permeable air envelope.

The dense muscular areas of the body being magnetic fields represented by bone, muscle, ligaments, tendons, and the structural formation of the cells. The electrical fields of the body are comprised of flowing fluid. This includes the blood, lymphatic, pericardium, brain, and interstitial fluid both within and surrounding the cells. Electrical exchange within the human anatomy is conducted through ionic channels with acetylcholine and maintained within an electrolyte medium.

Virtually all ionizing radio frequency produces charged particle matter that can be inhaled, ingested, and absorbed. Exposure causes acceleration of electrolyte mediums found in the blood, brain, heart and bone, with principle effect antagonistic to acetylcholine based bioprocesses in the central nervous system, and potassium concentrations in bodily fluid causing depletion and systemic stenosis.

Exposure to ionizing Radio Frequency produces cellular kinetic reactions. The primary physiology affected by radio frequency ionization are the electrolytes calcium ( $\text{Ca}^{2+}$ ), phosphorus ( $\text{PO}_4^{3-}$ ), magnesium ( $\text{Mg}^{2+}$ ), sodium ( $\text{Na}^+$ ), potassium ( $\text{K}^+$ ), chloride ( $\text{Cl}^-$ ), and hydrogen carbonate ( $\text{HCO}_3^-$ ).

In the human organism, there is a complex balance between the intracellular and extracellular milieu. The thermodynamic balance and regulation of the natural human environment determines the efficiency of hydration, mineralization, ion channel reception, blood pH, and protein synthesis. In addition, the electrolyte balance is critical to the central nervous system for both nerve and muscle function throughout the body.

Ionic channels regulate fluid exchange and transfer of electrochemical information between the structural components of the body, enabling the body's autonomic and peripheral nervous system to respond and stabilize to changes in its environment. The principal dynamics of this exchange are explained by the principle developed by Henry Louis Le Chatelier.

The dynamic of Mr. Le Chatelier Principle defines how a homeostatic system is affected by concentration, temperature, and pressure changes. Le Chatelier's Principle states that when a chemical system at equilibrium experiences a change in concentration, temperature, or total pressure the equilibrium will shift to maintain homeostasis and minimize the change.

When the human organism is exposed to EM field and its radio frequency it causes a change in cellular equilibrium by increasing cellular pressure through increased kinetic heat exchange. The change in pressure and heat changes the concentration of the electrolyte medium, producing gases and water, and further increases in temperature.

Human exposure to ionizing radio frequency causes exothermic stress in human tissue, affecting the tissues concentration, mass, and temperature. Exothermic stress affects amino acid synthesis, metabolism of proteins, and neurochemical acetylcholine transfer and synthesis throughout the central nervous system.

The increased exothermic reactions within human tissue after acute and chronic exposure to ionizing radio frequency causes changes in cellular equilibrium, concentration, and total pressure resulting in temperature change increase. Increased thermo-kinetic cellular reaction causes electrolyte medium emulsification, dehydration, and demineralization. The thermal changes in electrolyte homeostasis causes decreases in total body core temperature that affects all metabolic process in human physiology.

The disruption of body thermodynamics causes a loss of water and salt and structural integrity at the cellular level.

## 7.0 Exothermic Effects of Accumulating Radio Frequency Exposure on Physiology

Exposure, acute or chronic, to EM fields and its radio frequency accelerates the electrolyte medium of the human body. Acceleration of the electrolyte chemicals calcium, potassium, phosphate, magnesium sodium, chloride, and hydrogen carbonate causes an increase in kinetic biochemical processes.

The heat that is produced accelerates biological process and diminishes the biological availability of the electrolyte minerals. Potassium regulates fluid balance within cells. It is necessary for cellular enzymatic and electrochemical reactions and homeostasis (equilibrium) of interstitial fluids. When potassium is ionized, or depleted through bio-oxidation processes caused by chronic exposure to EM fields and radio frequency there is reduction in human nerve transmission, diminished body energy production caused by diminished conversion of stored glucose to glycogen (ATP and cAMP), impaired muscle function, and hormone secretion.

Exothermic reactions caused by ionizing radio frequency oxidize calcium stores within the human body and inhibits those processes associated with the electrolyte. When calcium is ionized, or oxidized, critical processes such as calcium blood exchange, blood pressure and pulse, cellular repair, and blood clotting do not occur normally.

Calcium that is accelerated, or ionized, cannot participate in biological processes such as neurotransmission, muscle contraction, heart function, bone development, and blood cell formation, lymphocyte production, haemoglobin production, or oxygen transport.

An example of the biological effects of ionizing radio frequency are symptomatic of reduced fertility. This reduction in fertility is caused by the acceleration of calcium signalling impeding calcium oscillations that interrupt the release of inositol (Vitamin B<sub>h</sub>) 1,45-trisphosphate (IP<sub>3</sub>). (Developmental Biology, 1999 Jul;15211(2);157-76)

Heat, under pressure within the human body, causes kinetic changes to occur in four critical human thermodynamic processes:

1. **Deamination** - making of amine groups and amino acids in the liver resulting in diminished enzyme and amino acid production, hormone metabolism, and interruption of glyconeogenesis (formation of glucose in liver).
2. **Hydrolysis** - phosphorylation and rate of ATP production and endocrine electrochemical transmission affecting the endocrine organs, lungs, and kidneys. Metabolism of amino acids affecting urea production (ureagenesis) and

kidney function.

3. **Acetylation** - formation of acetylcholine and associated autonomic and central nervous system function with nerve transmission, muscle contraction, neurological function, and cardiovascular health impairment.
4. **Methylation** – regulation of DNA methylation, methyltransferase, and production of cytosine to 5-methylcytosine and glutathione production, impacting gene activity/expression and transcription factors, fetal prenatal and post natal development, neurodevelopment and cognitive impairments, disruption of choline and hepatocyte formation disrupting albumin, fibrinogen, prothrombin (clotting factors).

## **7.1 How Radio Frequency Effects Human Health & Development: The Human Greenhouse Gassing Model**

When human tissue is exposed to EM fields and radio frequency it heats up, dehydrates, loses sodium, and over time coagulates. The exothermic process caused by ionizing radio frequency exposure produces extreme damage from mitochondrial cellular changes to liver enzyme function, demyelization, and amyloid protein formation in various organs.

In effect, the persistent and consistent exposure to radio frequency causes a condition called **Human Greenhouse Gassing**.

Mass, such as the human body, that is compressed and subjected to increases in heat and pressure combust protein material (Le Chatelier's Principle). Human protein under pressure and heat composts resulting in changes to the human blood and tissue gases and their concentrations. For example, exothermic events reduce through dissipation nitric oxide causing a loss of Endothelial Relaxing Factor causing coronary artery stenosis and restenosis.

The short term condition of the body with small levels of nitric oxide build up cause symptoms of Nitrogen Narcosis and central nervous system response. (Dalton's Law).

When human metabolic processes operate at higher temperatures, essential proteins breakdown to form nitrogen, sulfides, hydrogen, phosphates, and carbon dioxide gases within the body. Essential fat soluble vitamins A, D, E, and K are emulsified with their corresponding catalytic participation in production of hormones such as myelin are arrested.

Characteristic of human exposure to chronic, longterm exposure to radio frequency is reduced body temperature measuring below 97.4 degrees Fahrenheit. The lower body temperature demonstrates physiological changes in reduction of sodium, potassium, water and other electrolyte minerals. It also demonstrates the loss of participation of the endocrine system in human development and maintenance.

## **7.2 Symptom Expression of Human Exposure to EM Fields & Radio Frequency**

Acute exposure to EM fields and radio frequency is almost always fatal. The standard treatment practice for acute exposure is Calcium Gluconate, with standard medical practice treatment for burns.

Chronic exposure, defined as low level exposure that is continuous and constant over duration of time, causes various health ailments ranging from mild to severe, and can cause death. The symptom presentation of low level chronic exposure is difficult to ascertain and assess.

**Table 1.0: Symptom presentation in humans exposed to chronic low level ionizing radio frequency**

**I Circulatory**

1. Anemia
2. High or Low Blood Pressure
3. Irregular Heartbeat
4. Migraine
5. Raynaud's
6. Stroke/TIA's

**II Digestive**

7. Diarrhea
8. Esophageal Immotility/Difficulty Swallowing/Esophagitis
9. Gastrointestinal Distress - Bloating/Colic/Tenderness in Abdomen
10. Heartburn/Acid Reflux
11. Nausea/Vomiting
12. Weight Loss/Wasting

**III Glandular**

13. Allergies
14. Chronic/Severe Fatigue
15. Endocrine/Hormone Insufficiency
16. Excessive Sweating/Night Sweats
17. Hypermenorrhagia
18. Hypothermic Response
19. Sjogren's Syndrome

**IV Mental/Neurological**

20. Dementia/AZ Plaques
21. Depression
22. Difficulty Concentrating
23. Loss of Mental Acuity/Memory Cognition
24. Loss of Taste and Smell
25. Nervousness/Anxiety/Panic
26. Neurological Disorders
27. Numbness/Tingling in Extremities
28. Personality Changes
29. Sensory Disturbances
30. Short Term Memory Failure
31. Tinnitus

**V Organ**

32. Arrhythmia
33. Cirrhosis/Fatty Liver
34. Excessive Thirst/Dehydration
35. Heart Attack/Stroke
36. Kidney Distress/Renal Failure
37. Reproductive Failure/Infertility
38. Thyroid Dysfunction (Endocrine)
39. Urgent/Frequent Urination

**VI Respiratory**

40. Cough
41. Dyspnea
42. Respiratory Inflammation - Alveolitis/Fibrotic Emphysemateous Lung/Pneumonitis

**VII Skeletal/Joint**

43. Deep Burning Sensation
44. Osteoporosis
45. Pain/Tissue Inflammatory Response
46. Skeletal Fluorosis/Spinal Stenosis
47. Tooth Decay
48. TMJ

**VIII Tissue**

49. Cancer
50. Delayed Healing
51. Hair Loss
52. Muscle Weakness/Fatigue
53. Musculoskeletal Pain/Skeletal Fluorosis
54. Nipple Exudation
55. Photosensitization/Heat Sensitivity
56. Porphyria
57. Purpura
58. Skin Changes/Pigmentation/Ulcerations
59. Soft Tissue Tears
60. Swelling - Feet/Ankles/Legs/Hands/Wrists/  
Face

## 8.0 Identifying Human Radio Frequency Exposure

Exposure to EM fields and ionizing radio frequency comes from many sources. Low level chronic exposure produces escalating and worsening of symptom presentation. Most exposure goes undetected and persons are not aware of total body exposure until symptoms become persistent and difficult to manage.

### 8.1 Early Symptoms of Chronic Exposure

The early symptoms of chronic EM field and radio frequency exposure are diverse. There is complaint of general malaise, a sense of fatigue/lethargy and “feeling tired”, with little energy. Complaint of headache is common so to are complaints of light and heat sensitivities, especially with the teeth.

Often, inhalation and ingestion exposure produces symptoms similar to a cold or flu with inflammation in the ears, throat, and sinus. Chronic exposure effects the sensory perception of the ears and eyes causing blurred vision, ringing in the ears, TMJ, teeth grinding, and stress along the gums. In some instances, there can be swelling of the tongue.

Low level chronic exposure causes a loss of taste and smell, with a metallic taste often occurring. The tongue appears “coated” with red blisters appearing on the inner lip and cheek. There can also be reticular nodule formation in soft tissue of the gums and cheek. Hard lump like formations also occur on the finger tips and knuckles.

Small children express symptoms of lethargy, colic, indigestion, and failure to thrive with poor weight gain, appetites, and mental interest. Older children express poor attention, have difficulty sleeping or have excessive fatigue. Dark circles (Purpura) appear around the eyes, loss of coordination, headaches, teeth sensitivity, rashes, night sweats, asthma, and difficulty learning, with delayed development.

When chronic exposure is not mitigated and remediated, symptoms of exposure worsen and there is biological decline in major system organs such as the heart, kidney, lungs, thyroid, pineal, thalamus, renal gland, and pituitary. There is delay in puberty, menstruation, and fertility. In addition, thermo-physiological changes impede bone function and diminish connective tissue structure and elasticity. The spine is particularly affected with characteristic impediment occurring at the Cervical spine C6,C7 and Thoracic T1 vertebra resulting in spine curvature, with shoulder (rotator cuff) deterioration.

The pelvis structure from the lumbar spin, sacrum, coccyx, hips and joints, particularly the right hip and joint, are affected by softening, with dehydration of synovial membranes.

## 9.0 Medical Determination of Exposure

Currently, there are no clinical or laboratory tests that can determine ionizing radio frequency exposure. Multiple testing and studies have been performed to determine the thermophysiological consequences on human tissue exposed to radio frequencies, but there are no standard medical tests that can determine human exposure in clinical practice.

Clinical testing can be performed to determine the health of people exposed. These include: liver enzyme (elevated GGH levels), cholesterol HDL elevation, or blood test for chloroform levels.

Many cases of chronic exposure express heavy metal toxicity. Since demineralization and oxidation work on all elements and systems of human physiology, testing can be performed to determine elemental copper, zinc, and chromium levels. Iodine and thyroid testing is not a clear determinant to assessing exposure. Blood thyroid test can show thyroid gland function within normal/low range at moderate levels of exposure. Tests do not indicate iodine trapping capability and bioavailability of iodine present in the metabolism of T3 and T4 thyroid factors.

Irrespective of exposure route, dehydration and inflammation are characteristic presentations. In addition, the breakdown of  $\text{CHO}_3$  (hydrogen carbonate) causes over saturation of oxygen with presentations of chest heaviness and difficulty breathing.

## **10.0 Attenuating Radio Frequency Exposure**

With advancements in technology and the rate at which technology inundates everyday lives, the exposure from electromagnetic field and low dose radio frequencies has greatly increased, and can be expected to continue increasing. With more exposure there is an expectation of increasing health risks and disease, affecting the total quality of human life. The advancement and deployment of technology makes attenuation of exposure a difficult and complex problem to solve.

Attenuation of EM fields and radio frequency becomes an effort directed toward reducing and eliminating environmental exposure and length of exposure, by reducing the amount of technology and appliances used. Attention needs to be given to reducing this EM field and radio frequency pollution by filtering, reflection, redirection, neutralization, and wherever possible, elimination. This includes nonuse of unnecessary medical tests such as x-ray, CAT scan, and ultrasound.

### **Reducing Environmental Exposure**

Environmental pollution is a key contributor to the total amount of human exposure to EM fields and radio frequency. Stringent industry regulations are necessary to reduce the emissions from all sources of industry, including telecommunications. Environmental protection measures must be initiated and implemented for our personal and corporate safety.

Standards and guidelines greatly reducing manmade electromagnetic pollution, which inadvertently contributes to global warming through heat generation, must be established. All industries must become inherently interested in the safe construction of all electrical equipment, residential appliances, and their applications and usage. Safety driving standards and guidelines must be on an International scale.

### **Reducing Exposure Time in the Home and Workplace**

Individuals and families must be educated about complications and concerns with the use of technology and products, both in the home and workplace. Conscious effort is needed to become aware of electrical products and their emissions. Further education is needed to inform the public about the use of chemicals and petroleum products in the home and environment.

Environmental Protection standards and guidelines need be developed to outline the routes and sources of contamination by radio frequency.

### **Shielding and Reflection**

Total protection from EM fields and radio frequency radiation in this day and age is a virtual impossibility. There are, however, many products commercially available for shielding and protection. Some of these products have application in the home and workplace, and can be used for products such as cellular telephones, computer monitors, televisions, and stereo equipment; others are for automotive and personal wear.

Reducing dependence on EM field producing technology is also encouraged. The most significant effort we can make to attenuating radio frequency exposure is through education, continuing research, and implementing higher safety policies, guidelines, and standards. Reducing dependence on technology should be encouraged.

Education is required to teach the public the cost technology is having on human health and quality of life. Society needs to understand that the conveniences of modern technology become inconvenient to health and living. The best way to attenuate the effects of radio frequency is to limit production from all sources. This includes the electrochemical pollution from electrical energy produced by burning coal and petroleum, from nuclear power plants, from factories producing so called energy saving products like compact fluorescent bulbs; and refineries making processed foods that deplete the body's minerals, thereby reducing the natural biological electromagnetic field.

Investigation and research is underway by Professor Tang Lee (University of Calgary, Calgary, Alberta) to determine the efficacy of shielding products in building design. Professor Lee is determining the design and application of products such as Mu-Metals in the application of shielding radio frequency coming into residential housing.

Professor Lee is also researching various indoor heating methods using solar and silicon dioxide heating protocols, and convection.

## **Appendix A: Radio Frequency Guidelines and Standards: International, US, and Canada**

Radio Frequency bandwidth is a commodity. It, like all energy sources, is finite. There are a limited number of radio frequencies from which our everyday services can transmit. Radio frequency requirements and demand are also part of the government and national defence systems of countries. In times of political unrest, a greater demand is placed on radio frequency bands and their usage.

The International Treaty for Radio Regulations outlines and stipulates the management and administration of the world radio frequency spectrum. Managing and administrating radio frequency spectrum becomes a complex and political framework.

Internationally, the primary organization that manages radio frequency spectrum and compliance with the Radio Regulations International Treaty is the International Telecommunications Union (ITU). The ITU through three contributing sectors establishes the guidelines and usage of radio frequency spectrum for communications and broadcasting. These industry sectors are represented by industry bureaus and include: Radiocommunications, Telecommunications, and the Telecommunications Development Bureaus. Currently, the ITU has 190 Member States and 600 Sector Members who are participants in the regulatory guidelines of the Union.

In America, the Federal Communications Commission (FCC) regulates communications by radio, television, wire, satellite, and cable. It has governance and jurisdiction in all 50 States, the District of Columbia and United States possessions. It governs radio frequency transmissions, production, storage, operation, and transmission. In addition, it regulates and standardizes the production of all equipment using radio frequency operation or emitting radio frequency within its jurisdiction.

In Canada, radio frequency spectrum is regulated by Industry Canada. Radio frequency spectrum licensing is done through Spectrum Direct. It governs, maintains, and issues information about licensing, regulations, policies, standards, and practices for radio communications and telecommunications activities for all industry activities.

## **Appendix B: Related Studies**

**American Association for Cancer Research**, Depletion of Glutathione, Heat Shock Protein Synthesis, and the Development of Thermo-tolerance in Chinese Hamster Ovary Cells: Michael L. Freeman, Michael J. Meredith, and Andrei Laszlo

[http://cancerres.aacrjournals.org/cgi/content/abstract/48/24\\_Part\\_1/7033](http://cancerres.aacrjournals.org/cgi/content/abstract/48/24_Part_1/7033)

**Department of Information Technology and Electrical Engineering**, Papers 2003:

P. Achermann, R. Huber, J. Schuderer, N. Kuster, A. Borbély

"Effects of Exposure to Electromagnetic Fields of Type GSM on Sleep EEG and Regional Cerebral Blood Flow", Proc. 15th International Zurich Symposium and Technical Exhibition on Electromagnetic Compatibility, Supplement, Zurich, Switzerland, pp. 289-292, 2003.

## ***Annotated Studies on Exothermic Events on Animal Physiology***

**1. Modeling thermal responses in human subjects following extended exposure to radiofrequency energy**

National Library of Medicine /National Institute of Health; PubMed Central Journals Submission authors: Kenneth R Foster<sup>1</sup> and Eleanor R Adair<sup>2</sup>

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<http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=400246>

## **2. Comparison of blood pressure and thermal responses in rats exposed to millimeter wave energy or environmental heat.**

Millenbaugh NJ, Kiel JL, Ryan KL, Blystone RV, Kalns JE, Brott BJ, Cerna CZ, Lawrence WS, Soza LL, Mason PA.

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Electromagnetic fields at millimeter wave lengths are being developed for commercial and military use at power levels that can cause temperature increases in the skin. Previous work suggests that sustained exposure to millimeter waves causes greater heating of skin, leading to faster induction of circulatory failure than exposure to environmental heat (EH). We tested this hypothesis in three separate experiments by comparing temperature changes in skin, subcutis, and colon, and the time to reach circulatory collapse (mean arterial blood pressure, 20 mmHg) in male Sprague-Dawley rats exposed to the following conditions that produced similar rates of body core heating within each experiment: (1) EH at 42 degrees C, 35 GHz at 75 mW/cm, or 94 GHz at 75 mW/cm under ketamine and xylazine anesthesia; (2) EH at 43 degrees C, 35 GHz at 90 mW/cm, or 94 GHz at 90 mW/cm under ketamine and xylazine anesthesia; and (3) EH at 42 degrees C, 35 GHz at 90 mW/cm, or 94 GHz at 75 mW/cm under isoflurane anesthesia. In all three experiments, the rate and amount of temperature increase at the subcutis and skin surface differed significantly in the rank order of 94 GHz more than 35 GHz more than EH. The time to reach circulatory collapse was significantly less only for rats exposed to 94 GHz at 90 mW/cm, the group with the greatest rate of skin and subcutis heating of all groups in this study, compared with both the 35 GHz at 90 mW/cm and the EH at 43 degrees C groups. These data indicate that body core heating is the major determinant of induction of hemodynamic collapse, and the influence of heating of the skin and subcutis becomes significant only when a certain threshold rate of heating of these tissues is exceeded.

[PMID: 16721271 [PubMed - indexed for MEDLINE]

## **3. Effects of blood flow on skin heating induced by millimeter wave irradiation in humans.**

**Walters TJ, Ryan KL, Nelson DA, Blick DW, Mason PA.**

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We have previously reported species differences in the rate of skin heating in response to millimeter wavelength microwave exposure. We hypothesized that these differences were predominantly a function of species differences in the ability to increase skin blood flow during local heating. Mathematical modeling also suggested that, in humans, the rate of skin heating during prolonged millimeter wavelength exposure would be dependent on skin blood flow. In order to empirically test this hypothesis, we determined the role of baseline skin blood flow on the rate of cutaneous heating induced by 94-GHz microwave energy in humans (3 female, 3 male) using infrared thermography and laser Doppler imaging to measure skin temperature and relative skin blood flow, respectively. Millimeter wavelength exposure intensities used were high power (HP), 1 W x cm<sup>-2</sup> for 4 s and low power, 175 mW cm<sup>-2</sup> for 180 s. Skin blood flow was (a) normal, (b) eliminated using a blood pressure cuff to occlude forearm blood flow, or (c) elevated by heating the skin prior to irradiation. Results showed that for the HP exposures, these manipulations did not influence the rate of skin heating. For the low power exposures, occlusion of baseline skin blood flow had a small impact on the subsequent rate of heating. In contrast, a two-fold elevation in baseline skin blood flow had a profound impact on the subsequent rate of heating, resulting in a substantially lower rate of heating. Occlusion of an elevated skin blood flow reversed this lower rate of heating. The results of these studies demonstrate that relatively small changes in skin blood flow may produce substantial alterations in the rate of skin heating during prolonged 94-GHz exposure.

PMID: 14744044 [PubMed - indexed for MEDLINE]

## **4. Thermophysiological consequences of whole body resonant RF exposure (100 MHz) in human volunteers.**

**Adair ER, Mylacraine KS, Allen SJ.**

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Thermophysiological responses of heat production and heat loss were measured in seven adult volunteers (six males and one female, aged 31-74 years) during 45 min dorsal exposures of the whole body to 100 MHz continuous wave (CW) radio frequency (RF) energy. Three power densities (PD) (average PD = 4, 6, and 8 mW/cm<sup>2</sup>); whole body specific absorption rate [SAR] = 0.068 [W/kg]/[mW/cm<sup>2</sup>]) were tested in each of three ambient temperatures (T(a) = 24, 28, and 31 degrees C), as well as in T(a) controls (no RF). A standardized protocol (30 min baseline, 45 min RF or sham exposure, 10 min baseline) was used. Measured responses included esophageal and seven skin temperatures, metabolic heat production, local sweat rate, and local skin blood flow. No changes in metabolic heat production occurred under any test condition. Unlike published results of similar exposures at 450 and 2450 MHz, local skin temperatures, even those on the back that were irradiated directly, changed little or not at all during 100 MHz exposures. The sole exception was the temperature of the ankle skin, which increased by 3-4 degrees C in some subjects at PD = 8 mW/cm<sup>2</sup>). During the 45 min RF exposure, esophageal temperature showed modest changes (range = -0.15 to 0.13 degrees C) and never exceeded 37.2 degrees C. Thermoregulation was principally controlled by appropriate increases in evaporative heat loss (sweating) and, to a lesser extent, by changes in skin blood flow. Because of the deep penetration of RF energy at this frequency, effectively bypassing the skin, these changes must have been stimulated by thermal receptors deep in the body rather than those located in the skin. Published 2003 Wiley-Liss, Inc.

[PMID: 12955754 [PubMed - indexed for MEDLINE]

#### **5. Platelet-activating factor does not mediate circulatory failure induced by 35-GHz microwave heating.**

**Ryan KL, Jauchem JR, Tehrany MR, Boyle HL.**

Air Force Research Laboratory, Directed Energy Bioeffects Division, Radio Frequency Radiation Branch, Brooks Air Force Base, San Antonio, Texas, USA.

Sustained whole body exposure of anesthetized rats to 35-GHz radiofrequency radiation produces localized hyperthermia and hypotension, leading to circulatory failure and death. The physiological mechanism underlying the induction of circulatory failure by 35-GHz microwave (MW) heating is currently unknown. The purpose of this study was to determine whether platelet-activating factor (PAF) contributes to the hypotensive state induced by MW heating. Ketamine anesthetized rats were instrumented for the measurement of arterial blood pressure, ECG and temperature at five sites. Administration of the PAF-receptor antagonist WEB 2086 (0.5 or 5 mg/kg) following the induction of circulatory failure (defined as a decrease in mean arterial blood pressure to 75 mmHg) failed to reverse the hypotension induced by MW heating and consequently did not alter the subsequent survival time. Furthermore, pretreatment with WEB 2086 at either dose did not alter subsequent mean arterial blood pressure, temperature responses to MW heating or survival time. Finally, MW heating did not alter either blood PAF levels or serum or lung PAF acetylhydrolase levels. Taken together, these results demonstrate that PAF does not mediate the hypotension induced by 35-GHz MW heating.

[PMID: 12168504 [PubMed - indexed for MEDLINE]

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