Historical References for EMF

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Zory's Historical Archive of Microwave Radiation Effects

At the beginning of April 2010, a friend sent me a scanned document entitled "*Bibliography of Reported Biological Phenomena ('Effects') and Clinical Manifestations attributed to Microwave and Radio-Frequency Radiation*."

This document first appeared on October 4, 1971, and what I received was the second printing with revisions, corrections, and additions, dated April 20, 1972. It was a Research Report (Project MF12.524.05-0004B, Report No. 2) commissioned by the Naval Medical Research Institute, and was authored by Zorach ("Zory") R. Glaser, Ph.D., LT, MSC, USNR.

On page 4 of this 106-page document, the security classification reads "*unclassified*", and the distribution statement reads "*This document has been approved for public release and sale; its distribution is unlimited.*"

To my surprise, I learned that by 1971 there were more than 2,300 references to documents that detailed the biological effects of radio frequency and microwave radiation from various technologies including radar and mobile communications, navigational devices, and physical therapy devices such as microwave and shortwave diathermy. What an amazing find, especially since the World Health Organization and the wireless telecommunication industries continually state that there is no credible research showing that non-ionizing, non-thermal microwave radiation is harmful at levels below our existing thermal guidelines.

As I flipped through the report and the citations, I found hundreds of references translated from Czech, Russian, German and Polish laboratories; references from the U.S. Navy, Army and Air Force; as well as government reports and documents, many of which had not been published or mentioned in other literature.
What a treasure chest of research on the bioeffects and health effects of microwave radiation!

I wondered if Dr. Glaser was still alive, and/or still active in the field of radio frequency (RF)/microwave bioeffects, as I had no idea how old he was back in 1972. Consequently I looked him up on the Internet, found a phone number, and called. I reached an answering machine with a young woman's voice, and left a message saying I wanted to speak with Dr. Glaser and, if this was the correct phone number, could he please return my call. (It turned out that I had reached the phone of Dr. Glaser's adult daughter.) I wanted to thank Dr. Glaser for the remarkable work he did pulling together so many references on this topic.

The following day (Saturday), Dr. Glaser called me, and we had a long, animated conversation about his research during the past few decades and my research interests, which were remarkably similar. He informed me that he had produced 9 supplements to the original 1971 bibliography, and now had cited well over 6,000 studies on the bioeffects and health effects of

radio frequency and microwave radiation, and a number of these were studies showing that exposure to RF/microwave radiation was able, under certain conditions/circumstances, to produce changes, some of which could be considered dangerous (even at low levels where such exposure did not heat the body). He said he would send me copies or the references for the supplements he had in his possession.

For those of you who are new to the dangers of RF/microwave radiation, federal guidelines in Canada, the United States, the United Kingdom, Germany, Japan, New Zealand, and those recommended by the World Health Organization (WHO) are based on thermal effects. "If it does not heat you, it does not hurt you", the saying goes. These countries/organizations deny that electromagnetic fields (EMFs) cause biological effects below the thermal threshold for microwave radiation.

Countries such as Russia, Bulgaria, Hungary, Poland, the Czech Republic, Switzerland, China, Italy, Luxemburg, and Salzburg in Austria believe that non-thermal microwave radiation may harm you, and consequently have more conservative human safety guidelines.
Dr. Glaser is still considered to be one of the international experts in the RF/microwave bioeffects field, and I was most impressed with his knowledge, his insights, and his historical perspective.
Click HERE to visit his website to learn more about his credentials.

Just before we finished our long insightful telephone conversation into both of our careers, I asked him if, by chance, he had any paper copies of those references.
Dr. Glaser said, "funny you should ask. As a matter of fact I have them all. I kept the reports in my home (basement, attic and garage) for a number of years following my retirement from FDA, and then moved them into a large commercial storage space, and over the years offered them (consisting of about 45-50 large boxes) to scientists performing research in this field, and to government and university libraries, but no one seemed to want them. I was planning to discard them, as I am now looking toward real retirement, and storing them is quite costly."

Dr. Glaser mentioned that a number of lawyers, and a few individuals working for the wireless industry have asked him for parts of his collection but he declined to give the collection to them because he felt the information would be buried. He indicated that he wanted the collection to be available to the public.

Before I knew what I was saying, I asked if I could have them. I would digitize them as PDF, put them online, and make them available to the public via the Internet. He thought for a long moment, and finally said "yes", with the provision that I would pick them up or pay for their delivery. For a university research scientist like me, this was an opportunity equivalent to winning a lottery!

I learned that he lived in Maryland (between Baltimore and Washington, DC), and, as it happened, I was giving a lecture on the health effects of microwave radiation at the Johns Hopkins School of Public Health (his university where he earned the MPH degree in 1990) at the end of April, and we decided to meet. He came to my lectures, and actually became part of the lectures by joining me, at my invitation, in answering some questions raised by the students and professors, and sharing his expertise with those in attendance, in the hope that the concerns for the possible dangers of RF/microwave radiation exposure would be considered by the public.

We then later visited the commercial storage unit, which was overflowing with many boxes containing thousands of reports and printed documents, and-after a quick peek at this treasure house of knowledge–we decided that once the documents was sorted to remove unrelated material I could pick them up. A few months later, I flew to Baltimore, rented a U-haul truck, and brought back the boxes overflowing with reports and printed documents.
The plan is to have the documents scanned (starting with ones that are more difficult to access, including government and military reports and translations of foreign technical articles) as searchable PDFs, and then make them available at my website. This is obviously going to take some time.

I sorted through this collection, found some of the "gems", provided abstracts (where appropriate) and posted a summary in layman's language on my website. The series will be posted under the heading "From Zory's Archive".
The very first article that I will summarize (and make available) is the document that first brought Dr. Glaser's work to my attention, his bibliography dated 1971/1972.
For those who think there is no proof . . . stay tuned!

1 Origins of 1966 U.S. Safety Standards for Microwave Radiation

Steneck, NH, HJ Cook, AJ Vander and GL Kane. 1980. The Origins of U.S. Safety Standards for Microwave Radiation. Science, Vol. 208, 13 June 1980.

Summary
An analysis is made of the scientific research and values influencing the policy decisions that led to the adoption of the 1966 U.S. standard for exposure to microwave radiation. This analysis is used as a tool for understanding the problems faced by those who set standards. An effort is made to unravel the complex motivations that lay behind the adoption of the microwave standard. Based on the past record, it is suggested that standard setting remain distinct from basic scientific research and that adversary procedures be used only as a last resort in seeking consensus over a proposed standard.

Significance
Based on published and unpublished literature as well as interviews and questionnaires, the authors of this report pieced together the process that led to the 10 mW/cm^2 standard to protect military and occupationally exposed personnel from microwave radiation. For those new to this topic, it is well worth reading.

What is clear is that the original recommended standard (0.1 W/cm^2 or 100 mW/cm^2) established in 1953 was based on a quick-and-dirty calculation that was grossly flawed and was almost immediately revised downward to 10 mW/cm^2. This calculation was based entirely on the ability of a 70-kg man to dissipate heat. The 0.1 W/ cm^2 was obviously too high so a safety factor of 10 was introduced to reduce it to 10 mW/cm^2 (see graph below).

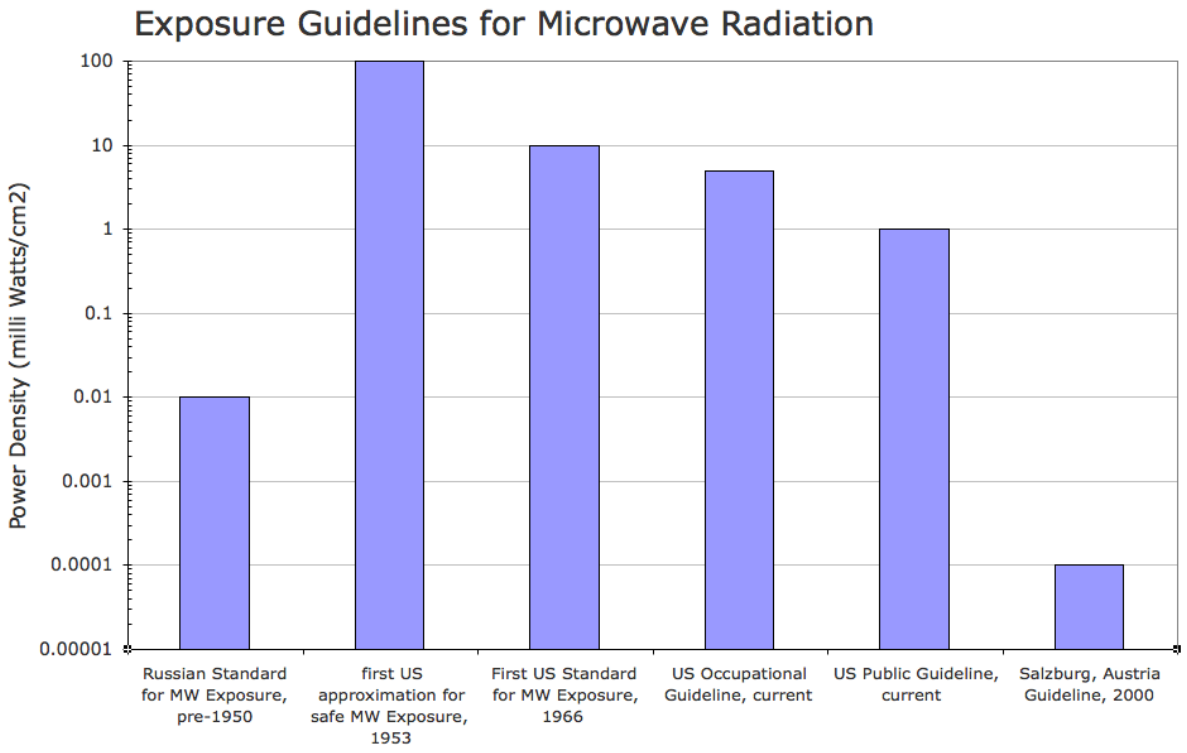
Initially the disagreement about the appropriate safety factor ranged from 10 recommended by the US military to 100 suggested by General Electric to 1,000 suggested by Bell Telephone Laboratories. The military prevailed.
Evidence for non-thermal effects was discounted.

At this time, the primary use of microwaves was for radar with limited research on medical diathermy. After the war, microwave use was extended to microwave equipment for heating for both industrial and medical use. The prevailing view at the time was that *microwaves, if used with caution, were apparently a safe, convenient and comfortable form of heating for local applications to tissues*.

Emphasis was to protect military operations and secondarily to protect military personnel. Protection of the general public was barely discussed and no public standards were set because microwaves were viewed as radar and radar was viewed as a military and industrial problem. At that time, except for those who lived near military bases, most people were unlikely to be exposed to microwave radiation.

According to the authors, two paths are available to the public, *legal action (making damage claims for alleged microwave-related injuries) . . .* and the *political path (introducing bills at the federal and local levels to regulate exposure to microwaves).* Both are adversarial and costly, but perhaps not as costly as non-action.

The excuse that is often used to delay establishing safer guidelines is that we don't know the mechanisms involved. One thing that we seem to have forgotten is that *"standard setting does not require detailed knowledge about mechanisms or explanations about anomalistic phenomena. To set a standard one simply needs to know at what level-for whatever reasons-harmful effects appear."*



Comments

Some of the deleterious effects resulting from microwave exposure available to those establishing the standards included:

1. 1926-39, effects of ultrashort wave radiation on malignant tumors in mice
2. 1930, changes in blood counts at 13 mW/cm^2
3. 1932, attenuation of bacterial toxins
4. 1932, brain responses at 12 to 74 mW/cm^2
5. 1935, effects of condenser fields on flies, rats, and mice
6. 1943, Daily reported a statistically significant increase in the concentration of immature red blood cells in exposed workers and a high incidence of headaches
7. 1948, research at the Mayo Clinic reported cataract formation in dogs
8. 1948, research at the University of Iowa showed cataracts and testicular degeneration in dogs
9. 1953, radar workers reported ill effects (internal bleeding, leukemia, cataracts, headaches, brain tumors, heart conditions and jaundice)
10. 1956, testicular damage in rats at 5 to 10 mW/cm^2

The Tri-Service program (Navy, Arm, Air Force) concluded that the biological effects of microwave exposure involved were: (i) thermal, (ii) noncumulative, and (iii) of little concern since "*man has a built-in alarm system coupled with his threshold of pain that protects him from thermal injury*."
The Tri-Service program was wrong on all three counts. Biological effects of microwave exposure can be both thermal and non-thermal; cumulative, and of great concern as most people are unable to detect exposure.

The view expressed by Paul Brodeur (a critic of past policy) was that a standard below 10 mW/cm^2 would interfere with national defense and military preparedness, and as a result all else was ignored, including truthfulness and public welfare. The authors did not support this view as various internal views, bickering, and factions made this a much more complex process.
However, the authors do state the following about the process and the outcome:
The decision makers were *preoccupied with winning a major war*, and then, during the first Cold War, *with erecting a strong defense*. They were not *primarily concerned with public health or environmental monitoring*. The decisions concerning technology were made *in the context of global or national security rather than that of individual welfare.*
The persons who drew up and accepted the 10 mW/cm^2 standard did not believe that this level of exposure was likely to cause any serious consequences in the foreseeable future . . . but, according to the authors *. . . that does not dictate that it was the best standard or that it was valid.*
The literature, upon which the standard was based, was superficial and deeply flawed. McLaughlin, a physician and medical consultant at Hughes Aircraft Corporation, reviewed the research on which the standard was based and noted that "*the early work done by the Navy and the AAF [Army Air Force] was not extensive, the power used was very small, the work was not quantitative in character, and the controls were inadequate. Therefore, this work cannot be relied upon as scientific background to establish the possible health hazards of microwave radiation.*"

The flow of information from the military and industry was limited in part due to threat of legal action stemming from unanticipated future effects. This is more true today than in 1966 as our use of and exposure to microwave radiation has increased exponentially and the public guideline of 1 mW/cm^2, still based on a heating effect and established more recently, does not protect public health.

A sister article, published the same year by the same authors, is worth reading: "Early Research on the Biological Effects of Microwave Radiation: 1940-1960." Cook et al. 1980. Annals of Science 37: 323-351.

2 More than 2000 Documents prior to 1972 on Bioeffects of Radio Frequency Radiation

NAVAL MEDICAL RESEARCH INSTITUTE

Glaser, Z.R. 1972. *Bibliography of reported biological phenomena ('effects') and clinical manifestations attributed to microwave and radio-frequency radiation.* Naval Medical Research Institute MF12.54.015-004B, Report No. 2, revised. 106 pp. [NOTE: this document was shorted to 25 pages so we could post it here and does not contain all the 2311 references.]

Abstract
More than 2000 references on the biological responses to radio frequency and microwave radiation, published up to June 1971, are included in the bibliography.* Particular attention has been paid to the effects on man of non-ionizing radiation at these frequencies. The citations are arranged alphabetically by author, and contain as much information as possible so as to assure effective retrieval of the original documents. An outline of the effects which have been attributed to radio frequency and microwave radiation is also part of the report.
*Three supplementary listings bring the number of citations to more than 2,300.
Note: This document is "*unclassified*" and "*has been approved for public release and sale; its distribution is unlimited.*"

Significance
The value of the Glaser 1972 document is to counter the statements that "credible" research does not exist showing non-thermal effects. This is a false statement promoted by those who are either unaware of the literature or unwilling to admit this radiation, at levels to which we are currently exposed, can be harmful.
Credible research does exist; it has been around for decades; and it has been largely ignored by those responsible for public and occupational health.

Comments
This is one of the first large scale reviews of the literature on the biological effects of microwave and radio frequency radiation and it first appeared in 1971. The author classified the biological effects, into 17 categories (see below). These categories include heating (thermal effects); changes in physiologic function; alterations of the central, autonomic and peripheral nervous

systems; psychological disorders; behavioral changes (animal studies); blood and vascular disorders; enzyme and other biochemical changes; metabolic, gastro-intestional, and hormonal disorders; histological changes; genetic and chromosomal effects; the pearl-change effect (related to orientation in bacteria and animals); and a miscellaneous group of symptoms that didn't fit into the above categories.

While it is clear that radiation that causes heating can also cause secondary effects, not all the effects listed above are heat-related. Indeed, much of the literature at the lower exposure levels is unrelated to heating. This is the type of research that helped regulators to formulate their microwave guidelines. The non-thermal studies have been ignored by the World Health Organization, upon which many countries look for guidence, and hence the guidelines differ by orders of magnitude from the lowest in Salzburg, Austria (0.1 microW/cm2) to the highest (5,000 microW/cm2 for occupational exposure) established by ICNIRP (International Commission on Non-Ionizing Radiation). This is a 50,000 times difference!

One way to interpret this is that we have two guidelines, one to prevent heating and, a more restrictive guideline, to prevent biological effects, some of which can have serious health consequences.

What is striking is that what we used to call *microwave sickness* (group of symptoms associated with radar workers) has been called *neuroasthenia* (feeling unwell) and is now called *electrohypersensitivity*. In all cases the symptoms are associated with exposure to radio frequency radiation initially radar; then RF heat sealers and computers; and more recently various sources of wireless technology including mobile phone, broadcast, and WiFi or WiMax antennas, wireless routers, smart meters, etc.
The specific biological and health effects, provided in Glaser 1972, are listed below:

A. Heating of Organs* (Applications: Diathermy, Electrosurgery, Electrocoagulation, Electrodesiccation, Electrotomy)
This includes heating of the whole body or part of the body like the skin, bone and bone marrow, lens of the eye with cataracts and damage to the cornea; genitalia causing tubular degeneration of testicles; brains and sinuses; metal implants causing burns near hip pins etc. These effects are reversible except for damage to the eye.

B. Changes in Physiologic Function
This includes contraction of striated muscles; altered diameter of blood vessels (increased vascular elasticity), dilation; changes in oxidative processes in tissues and organs; liver enlargement; altered sensitivity to drugs; decreased spermatogenesis leading to decreased fertility and to sterility; altered sex ratio of births in favor of girls; altered menstrual activity; altered fetal development; decreased lactation in nursing mothers; reduction in diuresis resulting in sodium excretion via urine output; altered renal function; changes in conditioned reflexes; decreased electrical resistance of skin; changes in the structure of skin receptors; altered rate of blood flow; altered biocurrents in cerebral cortex in animals; changes in the rate of clearance of tagged ions from tissues; reversible structural changes in the cerebral cortex and diencephalon; changes in electrocardiographs; altered sensitivity to light, sound, and olfactory stimuli; functional and pathological changes in the eyes; myocardial necrosis; hemorrhage in lungs, liver, gut and brain and generalized degeneration of body tissue at fatal levels of radiation; loss of anatomical parts; death; dehydration; altered rate of tissue calcification.

C. Central Nervous System Effects

This includes headaches; insomnia; restlessness (daytime and during sleep); changes in brain wave activity (EEG); cranial nerve disorders; pyramidal tract lesions; disorders of conditioned reflexes; vagomimetic and sympathomimetic action of the heart; seizure and convulsions.

D. Autonomic Nervous System Effects
Altered heart rhythm; fatigue, structural alterations in synapses of the vagus nerve; stimulation of the parasympathetic nervous system leading to Bradycardia and inhibition of the sympathetic nervous system.

E. Peripheral Nervous System Effects
Effects on locomotor nerves.

F. Psychological Disorders
Symptoms include neurasthenia (general bad feeling); depression; impotence; anxiety; lack of concentration; hypochondria; dizziness; hallucinations; sleepiness or insomnia; irritability; decreased appetite; loss of memory; scalp sensations; fatigue; chest pain, tremors.

G. Behavioral Changes in Animals Studies
Effects include changes in reflexive, operant, avoidance and discrimination behaviors.

H. Blood Disorders
Effects include changes in blood and bone marrow; increased phagocytic and bactericidal functions; increased rate of hemolysis (shorter lifespan of cells); increased blood sedimentation rate; decreased erythrocytes; increased blood glucose concentrations; altered blood histamine content; changes in lipids and cholesterol; changes in Gamma Globulin and total protein concentration; changes in number of eosinophils; decrease in albumin/globulin ratio; altered hemopoiesis (rate of blood corpuscles formation); leukopenia (increased number of white blood cells and leukocytosis; reticulocytosis (increase in immature red blood cells).

I. Vascular Disorders
This includes thrombosis and hypertension.

J. Enzyme and Other Biochemical Changes (in vitro)
Changes in the activity of cholinesterase (also in vivo); phosphatase; transaminase; amylase, carboxydismutase; denaturation of proteins; inactivation of fungi, viruses, and bacteria; killed tissue cultures; alterated rate of cell division; increased concentration of RNA in lymphocytes and decreased concentration of RNA in brain, liver and spleen; changes in pyruvic acid, lactic acid and creatinine excretions; changes in concentration of glycogen in liver (hyperglycemia); altered concentrationsof 17-ketosteroids in urine.

K. Metabolic Disorders
Effects include glycosuria (sugar in urne); increase in urinary phenols; altered processing of metabolic enzymes; altered carbohydrate metabolism.

L. Gastro-Intestinal Disorders
Effects include anorexia; epigastric pan; constipation; altered secretion of stomach digestive juices.

M. Endocrine Gland Changes

Effects include altered functioning of pituitary gland, thyroid gland (hyper-thyroidism and enlarged thyroid, increased uptake of radioactive iodine), and adrenal cortex; decreased corticosteroids in blood; decreased glucocorticoidal activity; hypogonadism (with decreased production of testosterone).

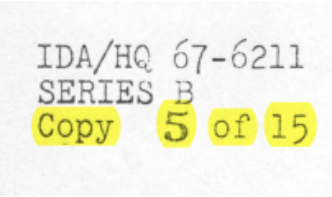
N. Histological Changes
Changes in tubular epithelium of testicles and gross changes.

O. Genetic and Chromosomal Changes
Effects include chromosomal aberrations (shortening, pseudochiasm, diploid structures, amitotic divisions, bridging, “stickiness”; irregularities in chromosomal envelope); mutations; mongolism; somatic alterations (not involving nucleus or chromosomes); neoplastic diseases (tumors).

P. Pearl Chain Effect
This refers to intracellular orientation of subcellular particles and orientation of cellular and other (non-biologic particles, i.e. mini magnetics) affecting orientation of animals, birds, and fish in electromagnetic fields.

Q. Miscellaneous Effects
These include sparking between dental fillings; metallic taste in mouth; changes in optical activity of colloidal solutions; treatment for syphilis, poliomyelitis, skin diseases; loss and brittleness of hair; sensations of buzzing, vibrations, pulsations, and tickling about head and ears; copious perspiration, salivation, and protrusion of tongue; changes in the operation of implanted cardiac pacemakers; changes in circadian rhythms.

3 1967 EMR Review, copy 5/15



Pollack, H. and J. Healer. 1967. Review of the Information on Hazards to Personnel from High-Frequency Electromagnetic Radiation. Institute for Defense Analyses, Research and Engineering Support Division. Internal Note N-451, IDA/HQ 67-6211, Series B, copy 5 of 15, 15 pages.

Summary
Foreign and domestic literature on biological effects of electromagnetic radiation has been examined for information relating to safety criteria. Emphasis was placed on obtaining relevant information on frequencies below 300 mc, most particularly on the high frequency (3 – 30 mc) region. This information is reviewed and evaluated.
Note: *mc* refers to millions of cycles per second or MHz.

Significance

This document, dated one year after the United States adopted the 10 mW/cm^2 standard for military and occupational exposure in the United States (See Pick of the Week #2), was written by a medical doctor who reviewed literature from the Tri-Services Conferences and English translations of research conducted in Germany, Poland, Ukraine, Czechoslovakia, and the former Soviet Union.

The most important paragraph in this document is the last one, which recommends the following: "*to the extent practical, a conservation approach to safety criteria (approaching the USSR standards) be applied, particularly where hazards to non-controlled personnel may be involved*." This conclusion is based on the finding that for both microwave (300 MHz to 300 GHz) and lower frequencies (0.01 to 300 MHz) "*limited clinical studies of humans and controlled animal experiments present evidence of harmful effects at intensities considerably lower than 10 mW/cm^2*."
At the time of this writing, the American guidelines were 10 mW/cm^2 averaged over 0.1 hour (6 minutes) and the USSR standards were frequency specific and orders of magnitude lower (see table 1 below).

What is clear from this document is that the U.S. Military was told that their guidelines were too high and should approach those of the former USSR in order to protect public health. The guidelines for public exposure are currently 1 mW/cm2 for the U.S. and 0.01 mW/cm2 for Russia (1% of the U.S. guidelines). Despite this warning back in 1967 little has been done. The U.S. guidelines for public exposure are still 100 times higher (less protective) than those in Russia.
There is also clear evidence that non-thermal effects were documented back in the late 1950s at intensities well below 10 mW/cm2 and both at and below microwave frequencies.

Comments
For those new to this topic, the intensity of the radiation is expressed as power density (mW/cm2) and is shown here in purple. The frequency of the radiation is shown in red. Microwaves (300 MHz to 300 GHz) constitute the upper part of the radio frequency band (1 KHz to 300 GHz) of the electromagnetic spectrum. Both intensityand frequency are important aspects of exposure. A third important aspect is whether the radiation is continuous or pulsed. Pulsed seems to be more harmful than continuous radiation (see item 4 below).
This internal document, written by a medical doctor from the Institute for Defense Analysis, had restricted access as only 15 copies were circulated and Dr. Glaser received copy 5 of the 15. Some of the key points include the following:

1. Thermal**:** Electromagnetic radiation increases the thermal load on the body; effect is primarily due to field strength and secondarily to wavelength (or frequency). Above 10 mW/cm^2 thermal effects predominate.

2. Athermal**:** Effects include disturbances of the central and vegetative nervous system causing cardiovascular changes; behavioral changes and general asthenia, tiredness, headache, irritability, loss of memory, loss of appetite, etc.
According to Gordon (1964) "*radiation over an interval of one-two months at an intensity not productive of the integral thermal effect, can produce severe functional changes in the central nervous system.*"
Osipov (1965) noted certain neurological and cardiovascular symptoms, slight changes in the blood, and functional disorders of the central nervous system at frequencies well below the microwave band (0.01 to 1.5 MHz).

Khazan (1958) exposed people to frequencies of 0.3, 0.5, 20, and 75 MHz and noted similar changes and disruption of the processes of excitation and inhibition of the nervous system. All of these radio frequencies are well below microwaves (300 MHz to 300 GHz).

3. Safe levels**:** Levels considered "safe" range from 0.003 to 10 mW/cm^2 and are frequency specific in some countries. The U.S. adopted the highest (least protective) values and the former USSR adopted some of the lowest (most protective) ones. In 1956, NATO recommend a limit of 0.5 mW/cm^2 and in 1963, the General Post Office of Great Britain recommended a value of 0.01 mW/cm^2 for frequencies greater than 300 MHz. In Czechoslovakia the power density ranged from 0.003 to 0.013 mW/cm^2 for frequencies between 10 kHz and 300 MHz. See Table 1 below.

4. Continuous vs. Pulsed Waves**:** For the most part, no distinction in these safety criteria was made for continuous vs. pulsed waves, although there was evidence that pulsed waves were more harmful than continuous waves. In Czechoslovakia the allowable intensity for continuous waves was 0.025 mW/cm^2 and for pulsed it was 0.01 mW/cm^2. Studies showed that continuous waves caused excitation, while pulsed waves caused inhibition of nervous system functions.

Table 1. Safety limits for power density at various frequencies and in various jurisdictions

Country Organization	Date	Frequency Range	Power density (mW/cm2)	Comments
Bell Laboratories	1953		0.1	safe level
NATO	1956		0.05	
Rome Air Development Center	1957	microwaves	10	hazardous microwave level
USSR	1958	< 3 MHz	0.003-0.013	
U.S. Navy Bureau of Medicine	1958		10	tolerable dose for constant exposure
U.S. Army	1958		10	adopted this as tentative safety criteria
Sweden	1963	< 87 MHz	6.5	
Czechoslovakia	1963	0.01 - 300 MHz	0.003-0.013	
Czechoslovakia	1963	>300 MHz?	0.025	continuous waves
Czechoslovakia	1963	>300 MHz?	0.01	pulsed waves
General Post Office of Great Britain	1963	> 300 MHz	0.01	
USSR	1964	3 - 30 MHz	0.053	
USSR	1964	30 - 300 MHz	0.003	
U.S. Armed Forces	1965	all frequencies	10	tenatively adopted
USSR	1965	0.01 - 0.1 MHz	0.013	maximum permissible values, occupational
USSR	1965	0.1 - 1.5 MHz	0.003	maximum permissible values, occupational
U.S.	1966	10 MHz - 100 GHz	10	Miliary and Occupational Exposure Standards

4 Cancer Mortality near Air Force Bases

Lester, J.R. and D.F. Moore. 1982. Cancer Mortality and Air Force Bases. Journal of Bioelectricity 1(1): 72-82.

Abstract
Nationally, counties with an Air Force Base were found to have significantly higher incidences of cancer mortality during 1950-1969 compared to counties without an Air Force Base.

Results
This study is based on 92 active Air Force bases that were in operation during 1950-1969 in the United States. The authors hypothesize that the chronic low intensity microwave exposure to peak pulse patterns, characteristic of radar, could influence immunocompetence and account for the high cancer mortality near air bases. They cite a 1979 study by Meecham and Shaw that documents a 20% higher mortality rate for residents within 2 to 3 miles of the Los Angeles International Airport compared to a neighborhood 8 to 9 miles away. In addition to cancers a higher incidence of birth defects and nervous breakdowns, among residents who live near airports, was reported in Japan and Great Britain.

Comments
This study brings to mind, PAVE PAWS, the US Air Force Radar Base that was installed in 1979 and was the focus of several cancer cluster studies in Cape Code, including an elevated rate of Ewing's Sarcoma (a malignant tumor often found in bone with a peak occurrence between 10 and 20 years of age). According to the National Academies' National Research Council report in 2005 and the Massachusetts Department of Health report in 2007 the radiation was unlikely to have played a primary role in the incidence of the various cancers and health effects.
However, based on Air Force measurements outside the security fence, values for average and maximum power density (attachment 4) are well above the Russian guidelines of 10 microW/cm2 with "corrected average" values ranging from 10 to 230 microW/cm2.

Then vs now
The 1982 study by Lester (PhD) and Moore (MD) was based on the period 1950 to 1969. Airports and air force bases have changed dramatically since that period with many more transmitters and frequencies.
The good news is that few homes are built near large international airports. The bad news is that those who work at an airport (or an air force base) and those who work near airports, like hotel employees, are exposed to radar. I stayed at an hotel that was several kilometers away from the Toronto International Airport and I was still able to measure the airport radar in my hotel room. At that hotel employees said that their customers had difficult sleeping but they attributed this to noise from car traffic.

Jerry Straub recently wrote, “When I first started flying, in the 1950’s, they still had aircraft radios which were tuned by a hand-crank or knob (analog device). As electronic technology has progressed, aircraft radios have become magnificent solid state devices with virtually unlimited ability to control frequencies and discriminate between them.”
Then airports had two frequencies; (control) tower and ground (control). Here’s the URL for the current airport information for Detroit Metro (DTW): http://www.airnav.com/airport/KDTW (see table below).

Airport Communications

UNICOM:	122.95
WX ASOS:	PHONE 734-941-7848
METRO GROUND:	119.25 SOUTHEAST 119.45 NORTHEAST 121.8 NORTHWEST 132.72 SOUTHWEST
METRO TOWER:	118.4 RYS 21L/3R/ 135.0 RY 04R/22L 287.1 RYS O4R/22L/21L/3R
DETROIT APPROACH:	124.05(WEST) 124.975 125.15(EAST) 363.2 118.575(EAST) 124.25
DETROIT DEPARTURE:	118.95(TURBOPROPS-WEST) 125.525(TURBOJETS-WEST) 132.025(TURBOJETS-EAST) 134.3(TURBOPROPS-EAST) 239.275 118.575(EAST)
CLEARANCE DELIVERY:	120.65
PRE-TAXI CLEARANCE:	120.65
AIR-EVAC:	259.6
CLASS B:	118.95(SW) 126.85(EAST ABV 3000 FT) 127.5(NW/NE) 134.3(SE) 239.275
D-ATIS:	133.675 734-941-5363
EMERG:	121.5 243.0
PRM RY 3R/21L:	128.35
PRM RY 4L/22R:	127.05
PRM RY 4R/22L:	135.775
RDR:	128.75
WX ASOS at YIP (8 nm W):	132.35 (734-485-9056)
WX AWOS-3 at ONZ (11 nm SE):	119.675 (734-692-9686)
WX AWOS-3 at TTF (17 nm S):	119.075 (313-384-0259)
WX ASOS at ARB (17 nm W):	PHONE 313-668-7173
WX ASOS at DET (19 nm NE):	PHONE 313-371-9696

- ASR-9 ELEVATION IS 650 FT. CPME '1' 42-12-45.8521 83-21-15.9231, CPME '2' 42-29-03.1926 83-40-44.1171, CPME '3' 42-29-11.9067 83-29-49.1825, CPME '4' 42-09-37.1832 83-32-21.5843, MTI '1' 42-11-37.9137 83-22-08.0101 & PARROT BCN 42-12-45.8942 82-21-15.8824.

Nearby radio navigation aids

VOR radial/distance	VOR name	Freq	Var
DXO at field	DETROIT VOR/DME	113.40	06W
CRLr028/10.9	CARLETON VORTAC	115.70	03W
SVMr141/15.9	SALEM VORTAC	114.30	03W
YQGr271/23.4	WINDSOR VOR/DME	113.80	06W
PSIr168/30.4	PONTIAC VORTAC	111.00	03W

NDB name	Hdg/Dist	Freq	Var	ID	
GROSSE ILE	314/11.1	419	07W	RYS	.-. -.-- ...
GOLF	267/13.7	398	05W	G	--.
HOWELL	137/37.8	243	05W	OZW	--- --.. .--
ADRIAN	064/38.3	278	06W	ADG	.- -.. --.

There are about 37 frequencies in use at DTW for communication, plus another 9 locally for navigation. This does not include the frequencies used for instrument approaches for each runway.
If cancer rates near air force bases and airports were elevated prior to the 1980s, I wonder what they are today and how is this radiation affecting those on board aircrafts, especially the crew?

Radio frequency radiation on airplanes
A few years ago I was returning from the US and, while the plane was loading, I asked the pilot and co-pilot if they knew what levels of radiation they were exposed to in the cockpit. The co-pilot frowned and told me that the airline industry monitored the levels a few years earlier but they were never provided with the results, which wasn't good news. Wonder what happened to that study?
On that flight I gave the pilot my RF meter and he did measurements in the cockpit during the flight. The values were below FCC guidelines but were well above Russian levels of 10 micoW/cm2. I measured the levels of radiation in the cabin during flight and found they decreased from the front to the rear of the plane. The highest reading I measured was around 35 microW/cm2.

Magnetic fields on airplanes
A few years ago I measured low frequency magnetic fields on an airplane. Instead of 50 or 60 Hz, airplanes operate at 400 Hz. The lowest levels of magnetic fields were at the rear of the plane (around 3 to 5 mG) and the highest readings were in first class (around 20 to 30 mG). On this particular flight (it was prior to 911) I was allowed into the cockpit and measured the magnetic fields while the plane was in flight. High readings (over 100 milliGauss) came from conduits that carried the electrical wires behind the pilot and co-pilot. The magnetic field near the window was also high (over 100 mG) and I was told that the window was heated to keep it flexible. When the pilot turned off the heating element the magnetic field dropped sharply.
The pilot thought for a moment and said that many of his colleagues, who had retired at age 55, developed cancer and didn't live long after retirement.
According to the scientific literature, levels of 2 to 4 mG for residential exposure have been associated with increased incidence of childhood leukemia; levels of 2 to 12 mG have been associated with breast cancer, brain tumors and adult leukemia from occupational exposure; and levels of 16 mG with miscarriages during the first trimester.

WiFi on airplanes and at airports
The most recent change on airplanes is the introduction of WiFi. A friend who recently flew on a commercial flight with WiFi complained of feeling unwell.
Flying is a dangerous business and it is become more dangerous with all of this additional exposure to radiation at the airport and on the aircraft. Wonder how long it will take for the airline industry to recognize that the lower the levels of radiation the safer the flight for the crew and passengers alike?

5 Why the Double Standard?

Inglis, L.P. 1970. Why the double standard? – A critical review of Russian work on hazards of microwave radiation. IEEE International Symposium on Electromagnetic Compatibility, July 14-16. 1970.

Summary
Continued interest in the determination of appropriate national levels of exposure to microwave fields has directed attention to Soviet work in this field. The vastly different standards adopted in the two countries have aroused much speculation as to the reasons. In this paper the Russian work is reviewed, and the major individuals identified. An explanation for the different exposure limits is offered, based partly on the difference in national organization.

Comments
This document is written by Leo P. Inglis, who worked for Atomics International Division, North American Rockwell Corp.– a company involved with the early development of nuclear technology for commercial and government applications.
In "*Why the double standard?*" Inglis tries to tease apart the reasons for the much lower radio frequency standards used in the USSR compared with those used in the USA.
A much quoted paragraph, and the focus of this document, is the following:
"*In the U.S., the thermal effects are generally believed to be the only ones of significance; other contentions are usually dismissed as lacking a provable basis. In the USSR, non-thermal effects are considered the most significant and are overwhelmingly the ones most studied.*"
Several interesting concepts are presented based on Russian research.

1. Biological effects of radio waves are reduced with an increase in wavelength (i.e. at lower frequencies) and that this might be true when comparing different regions of the spectrum, but within the microwave band this general regularity may not exist.
2. There is a possibility of resonant absorption of microwaves by complex protein molecules, particularly enzymes. The result of such absorption could change molecular structure and when protein structure changes so does its function.
3. Pulsed and modulated radiation are more harmful than continuous waves and may stimulate the nervous system as shown by studies with rabbits that document changes in brain wave activity as measured by EEG, occurring within 10 seconds of microwave exposure (in the absence of heating) and lasting 10 to 15 minutes after irradiation ended.

The results that I found most intriguing were those by Drogochina and Sadchikova (1965), who studied, for several years, individuals exposed to microwave radiation in the course of their work. They investigated the development of various symptoms (which we would today call electrohypersensitivity or EHS) resulting from exposure to radio frequencies in the centimeter wavelengths (high MHz and low GHz frequencies similar to mobile phones and WiFi). These symptoms fell into three stages.

The **initial stage** symptoms usually appeared within 3 to 5 years of exposure. Most characteristic is the asthenic syndrome [note: Asthenic syndrome describes a person characterized by low energy, susceptibility to physical and emotional stress, and a diminished capacity for pleasure], which develops because of the exhausting action of the radio frequencies on the central nervous system, and results in increased fatigue, headaches, and sleepinessduring work hours. Among the biological effects that occur are bradycardia [heart rate less than 60 bpm], changes in heart conduction on the electrocardiograph, weak development of dermographia [development of welts where someone scratches the skin], and hyperhydrosis [excessive perspiration] of the wrists. Often there is a slight enlargement of the thyroid gland and a tendency towards increase in the leukocyte [white blood cell] count and histamine content of the blood. All these changes are unstable and can be eliminated by a brief interruption of the work involving exposure.

The **second stage** develops if exposure continues. Patients suffer prolonged headaches, pain in the region of the heart, bradycardia, increased blood pressure, pronounced changes in the appearance of the electrocardiogram, a lowered olfactory response, and often such trophic disturbances as loss of hair and brittleness of the nails, and a decrease in sexual potency [Does the surge in the use of Viagra and other drugs to enhance male performance relate to microwave exposure?]. Some medical treatment is required and temporary transfer to other work is mandatory.

The **third stage** is poorly described in the article. Symptoms include strong recurring headaches, vertigo and fainting, heart pains, shivering and trembling, gastrointestinal disturbances, pronounced dermographia and hyperhydrosis. Symptoms can remain even a year after the individual had changed jobs, although at a reduced level.

In the *discussion*, Inglis quotes from testimony presented by Dr. Charles Susskind (UC Berkeley) before the Senate Committee hearings on "Radiation Control for Health and Safety Act of 1967."
Dr. Susskind recommends that much basic research at lower power densities should be performed before *". . . we can decide whether we should adopt the much stricter safety level of the Soviet Union.*" He also suggests that "*non-ionizing radiation might ultimately prove to be a greater problem than ionizing radiation.*"
According to Inglis, "*If that prophecy should prove correct, I am sure the Russian literature will one day be weighed more carefully than it is at present* [i.e. 1970]." We are fortunate that Dr. Glaser kept these documents.

Others have also expressed concern about the proliferation of microwave radiation.
In a 1973 report submitted by JA Tanner from the Division of Mechanical Engineering and co-authored by faculty in the Department of Anatomy at Queen's University in Kingston, Ontario, the authors conclude:
"*In view of the expected proliferation of MW [microwave] devices in many different applications, a substantial increase in MW background activity is feared that may endanger human health. On this basis strict control of the use of these devices must be introduced while present safety standards are revised and extensive research is conducted into long term effects of exposure to low intensity MW radiation. In particular, a study of the possible accumulative effects of MW radiation (directly or indirectly) through sensitization must be conducted*."

A few years later, Robert O. Becker (MD) stated the following:
"*I have no doubt in my mind that at the present time, the greatest polluting element in the earth's environment is the proliferation of electromagnetic fields. I consider that to be far greater on a global scale, than warming, and the increase in chemical elements in the environment*.''

Inglis (Rockwell Corp.), Susskind (UC Berkeley), Tanner (Mechanical Engineering, Queen's University) and Becker (Orthopedic Surgeon and Professor SUNY, Syracuse) can't all be wrong. So why weren't they listened to?

It is now 2010. Forty years have passed yet the thermal debate is alive and well in many developed countries. The symptoms of asthenia or electrohypersensitivity are becoming more prevalent in society as is our exposure to microwave radiation. When once this was an occupational illness it has become a societal illness and one that is likely to get worse as we continue to install smart meters on homes, Wi-Max in communities and WiFi in schools.
As I write this biblical images come to mind.

I image the sea level rising as Noah gathers his family and the animals on his boat. It rained for 40 days and 40 nights and we have had at least 40 years of knowing this technology is harmful.

Today, instead of water, levels of microwave radiation are rising and many have already suffered from exposure. Complaints of insomnia, chronic fatigue, chronic pain, allergies, depression, anxiety, heart problems, cancers, reproductive problems, neurological disorders, diabetes are on the rise and studies show these are the symptoms associated with electrosmog. Countless people will die as the technology invades our homes, schools, and communities. The Noah equivalents call themselves *electromagnetic refugees*. They find safe havens and ensure their homes and communities are electromagnetically clean.

I also image Moses descending from Mount Sinai seeing his people dancing around a calf made of gold, a false god. Is the thermal standard not a false god that governments have fabricated and are worshipping? What will it take for the blind to see and the deaf to hear what governments and industry have been hiding and negating for the last 40 years? Moses didn't live to see the promised land and many of my colleagues wonder if they will see what happened to cigarettes also happen to wireless technology during their lifetime.

What we need is labelling and awareness raising of the hazards of this type of radiation. We need more protective guidelines in those countries still falsely worshiping the golden calf and stating that heating is the only effect of microwave exposure. We need a shift to wired technology, especially fibre optics that is much faster, more secure, and safer than wireless. We need to change behaviour and limit places where wireless is allowed. We can all built a boat to carry us to safety or we can have the levels of microwave radiation recede to levels that are tolerable to the most sensitive in our society.
The choice is ours but it will take a monumental effort to achieve.

6 Clinical & Hygienic Aspects of Exposure to Electromagnetic Fields

Dodge, CH. 1969. Clinical and Hygienic Aspects of Exposure to Electromagnetic Fields: A Review of the Soviet and Eastern European Literature. Biological Effects and Health Implications of Microwave Radiation, Symposium Proceedings, Richmond, Virginia, September 17-19, 1969 (BRH/DBE 70-2) (PB 193 898).

Christopher Dodge, affiliated with the Library of Congress, wrote the first comprehensive review of the world (especially the Soviet and Eastern European) literature on the biological effects of microwaves in 1964. The current document was written 5 years later during which time the author was with the Biosciences Division, U.S. Naval Observatory, in Washington, D.C. This

document concentrates on human clinical studies and occupational hygiene surveys of microwave exposure and is well worth reading.
What is clear is that by the late 1960 the Soviet and Eastern European scientists had conducted numerous studies on the effects of microwave radiation on humans, that biological and health effects were documented for a range of frequencies at non-thermal levels, and that this information was available to the U.S. military. Why this science was not taken more seriously, why guidelines were not influenced by this research, and why we are still debating thermal vs non-thermal effects is a mystery that I leave for historians and philosophers to debate.
Here are a few gems from this document:

1. By 1933 Soviet scientists recognized that electromagnetic fields affected the human nervous system. Indeed changes to the **central (CNS) and autonomic (ANS) nervous system** attributed to radio frequency radiation were frequently documented, as were additional effects as shown in Table 1. Frequencies from 30 MHz to 300 GH at both thermal (greater than 10 mW/cm^2) and non-thermal (microW/cm^2 to milliW/cm^2) intensities were known to affect the CNS.
2. The most disappointing aspect of the literature cited was the **absence of information** on the specific circumstances of the irradiation, characteristics of the environment and the conditions of the body exposed, which makes repetition of the studies difficult.
3. Panov et al. (1966) proposed **three chronological stages** of human response to microwaves (Table 2).
   – The **first stage** is not marked by severe episodes such as fainting or dramatic changes in pulse or blood pressure and the subject responds to outpatient treatment.
   – The **second stage** is called the “syndrome of autonomic and vascular dystonia” and the key features include altered pulse including bradycardia (slow) and tachycardia (rapid), either high or low blood pressure, altered ECG and general neuro-circulatory asthenia. Severe episodes (fainting) may occur and the subject requires hospitalization of unspecified nature or duration.
   – The **third stage** is called diencephalic syndrome in which visceral dysfunctions and crisis are observed. Typical episodes include apathic embolic disorders, hypersomnia, hypokinesis, hypothalamo-pituitary-suprarenal weakness, and inhibition of sexual and digestive reflexes. Panov claims these changes are not always reversible and that subjects require hospitalization.
4. The general **subjective complaints** resulting from EMR exposure shown in Table 3 resemble symptoms associated with electrohypersensitivity (EHS).
5. Edelwejn (1966) found that the **symptoms** (Table 3) experienced by Polish personnel exposed to microwave radiation for up to six hours/day **depended on the length of employment and degree of exposure**. During the first three years, a dramatic response to microwave exposure accompanied by neurotic symptoms was reported. This was followed by a gradual adaption phase and then, many years later, by the reappearance of neurologic symptoms. Soviet workers exposed to electric and magnetic fields near hydroelectric stations also complained of symptoms in Table 3. Ospiov (1965) concluded that most subjective symptoms were reversible and that pathological damage to neural structures was insignificant.
6. In one study, a larger percentage of subjects exposed to **weak** (1 to 100s microW/cm^2) and **moderate** (100s microW/cm^2) levels of EMR experienced symptoms than those who were sporadically exposed to **intense**levels (3000 to 4000 microW/cm^2) (see Figure 1 below, note this figure is based on Table 4 of the original document).
7. Pulsed ultra high frequency (UHF) fields [0.3 to 3 GHz] could be used as a form of contactless **electrosleep**, which was called **radio-sleep**.

8. Numerous changes were documented in the **blood** including altered blood sugar, cholesterol and lipids; altered levels of pyruvic acid, lactic acid, and creatinine; as well as hematopoietic [blood forming processes] and biochemical responses to electromagnetic radiation (see Tables 8,9, 10).
9. Effects on the functioning of and damage to the **eyes** were mostly documented at either acute or chronic thermal levels of exposure (see Table 11).
10. Major **endocrine responses** included altered functioning of the pituitary, thyroid and adrenal glands. Damage to sex glands and functions have been frequently documented after chronic exposure to primarily thermal intensities (Table 12). Decreased spermatogenesis, altered sex ratio at birth (excess females), changes in menstruation, retarded fetal development, congenital effects in newborns, decreased lactation in nursing mothers have been documented as result of thermal exposure (greater than 10,000 microW/cm^2).

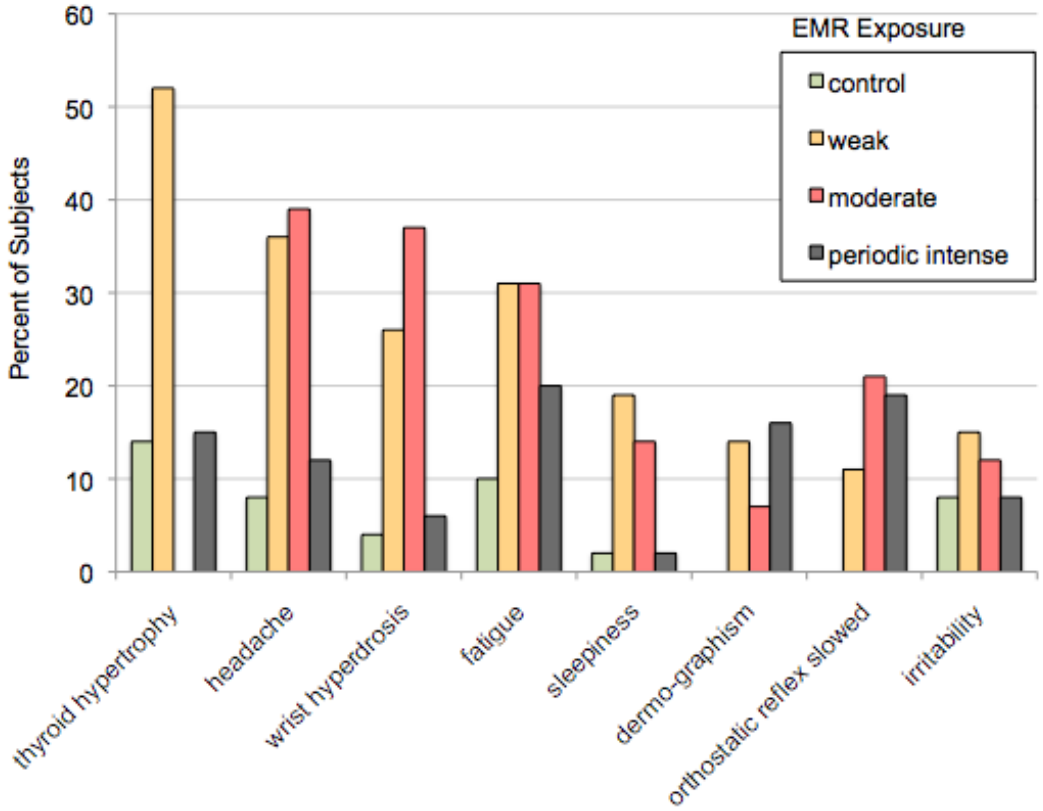


Figure 1. Percentage of subjects who responded to weak (1 to 100's microW/cm2), moderate (100's microW/cm2), and periodic intense (3,000 to 4,000 microW/cm2) levels of microwave radiation. Based on data in Table 4, Dodge, 1969. [*Note*: U.S. and Canadian guidelines are 1,000 microW/cm2 so the weak and moderate exposures are well below these guidelines.]

7 Hazards of Microwave Radiations – Review from 1960

Hazards of Microwave Radiations – A review gives us some insights into what was known 50 years ago (1960).
Kuo-Chiew Quan. 1960. Hazards of Microwave Radiations – A Review. Industr. Med. Surg. 29:315-318, July 1960 and reprinted in Occupational Medicine, Medical News Letter, Vol. 36, No. 10. November 18, 1960, pp 29-34.

This document, written 50 years ago, discusses the hazards associated with relatively high levels of microwave exposure that might be experienced by those who work near radar installations, as radio frequency heat sealers, or with medical diathermy machines. *Note this also applies to those who repair both broadcast and cell phone antennas.*

The author makes several statements about energy absorption and thermal effects of microwave radiation.
Statement 1: "any biological effects, beneficial or harmful, produced by microwaves can result only from absorption of energy by the tissues."
Statement 2: "It is not clear whether all biologic effects of microwaves can be attributed solely to temperature increases that result from energy absorption or whether these effects are produced in part by mechanisms other than simple thermal elevation."
Statement 3: "at this time it is impossible to rule out completely the possibility of athermal effects of microwaves."

So the thermal vs athermal debate was well underway in 1960.
The concept that microwaves can kill has been known for decades. Rabbits exposed to a constant 300-watt field were killed after 75 seconds. The same power level killed a rat in 22 seconds and a hamster exposed to 400 watts died after a 20-second exposure. Death was attributed to thermal paralysis of the respiratory center. This makes microwaves considerably more lethal than x-rays.

Note: The power of the transmitter, measured in watts (W), and the signal intensity (power per unit area) influence exposure. In the examples above, exposure from 300 to 400 watt fields can kill laboratory animals within seconds. How does this compare to the power of transmitters used today?
Typical combined radiated radio frequency (RF) power of microwave oven is 1000 W although they seldom work at 100% efficiency. Good thing the microwave generator is in a metal (faraday) cage with minimal leakage! Typical maximum output RF power from ham radio transceiver is 10 W. Remote uplink trucks use 120 watts pointed towards satellites and transmitters for cell phone antennas use approximately 10 watts of power although this depends

on their range. Maximum output from a mobile phone ranges from 2 W (power class 1) to 0.125 (power class 4). The older bag mobile phones were more powerful with 4 watts of power.

Exposure of body parts elevates temperature of selected organs that are unable to thermoregulate. Testis are damaged without any damage to the skin. Cataracts occur optimally when exposed to 10 to 12 cm wavelengths (3 to 2.5 GHz frequency). *Note: WiFi and microwave ovens as well as some digital cordless phones use 2.4 GHz frequencies.* Lower power levels, at the same frequency, produce cataracts over a longer period of time so recurring exposures at lower intensities have the same effect as fewer exposures at higher intensities. Cataracts are repeated reported by radar repair workers.

Metal implants can magnify the intensity of the microwave exposure by forming standing waves and those with such implants may be vulnerable to tissue damage from microwave exposure. Swelling and pain associated with metal implants have been reported with the symptoms disappearing when exposure was stopped. Those with metal implants should be excluded from working with microwave emitting equipment.
In 1957 a fatal exposure, attributed to microwave irradiation, was still debated 3 years later.

To prevent injury it is important to point the radar beam away from people, to use metal screens to restrict the radiation beam, to use lights to indicate radar is operating, to indicate shape of radar beam with signage. And finally those who work near radar installations should be supplied with photographic flash bulbs to warn them when they are exposed to intense microwave fields.
Note: These precautions (minus the flash bulb) should also be applied to cell phone antennas that are placed on buildings or on towers near buildings since people are exposed to this radiation 24/7 for many years, especially since cumulative chronic exposure may have similar effects to short-term acute exposure.
Medical diathermy, which uses microwave radiation, should have certain precautions to minimize exposure of the eyes and testis and it should be used cautiously on those with metal implants.

Acute thermal exposure can kill quickly (in a matter of seconds to days) while repeated non-thermal exposure contributes to chronic ill health (as previous reports have documented).

8 Repacholi Revises Safety Code 6

Dr. Michael Repacholi, prior to becoming the Coordinator of the Radiation and Environmental Health Unit at the World Health Organization, was involved in formulating Canada's Safety Code 6 Guideline for microwave radiation. In 1977, he and Maria Stuchly gave a talk at the I.E.E.E. meeting in Toronto entitled "Emission and Exposure Standards for Microwave Radiation."

In this presentation Repacholi and Stuchly proposed a Canadian maximum permissible level (MPL) for microwave radiation that was between the then U.S. guideline (10 mW/cm^2) and the Russian guideline (0.01 mW/cm^2). The recommended MPL was 1 mW/cm^2 for occupational exposure and 0.1 mW/cm^2 for public exposure. These proposed guidelines are much lower than what we currently have (5 mW/cm^2 for occupational exposure and 1 mW/cm^2 for unlimited public exposure).

Here are a few key statements in this document:

1. "The fact that maximum permissible exposure levels are recommended indicates that confirmed biological effects have been found, and that definite health hazards exist."
2. " . . . there is increasing dissatisfaction in the U.S. with the 10 mW/cm^2 figure since it does not contain sufficient safety factors to allow for the increased effects observed with pulsed beams . . . (Note WiFi and mobile phones have a pulsed beam.)
3. The USSR allows its workers to be exposed to 1 mW/ cm^2 (current 24-hour public exposure limit for Canada and U.S.] for only 20 minutes a day and to 0.1 mW/ cm^2 for only 2 hours a day (proposed guideline for public exposure that was NOT adopted).
4. Although most of the non-thermal effects have not yet been confirmed in the West, this does not mean the effects do not exist.
5. The general public represents a much larger population than the radiation workers and so one cannot accept as high a risk probability.

Unfortunately the recommended lowering of Safety Code 6 was not accepted in 1977.
Today we have a much **larger population** exposed to even **higher levels of microwave radiation** and we are exposing this population to an even **higher probability of risk**.
What is most **disturbing** is that on August 31, 2010 Health Canada issued a statement on their website that . . . *"As long as exposure is below these established limits* [i.e. Safety Code 6], *there is no **convincing** scientific evidence that this equipment* [WiFi] *is dangerous to schoolchildren or to Canadians in general*."
If this radiation is so safe then why did Dr. Repacholi recommend a reduction in existing guidelines more than 30 years ago?
The truth is that we have no scientific evidence that this equipment (WiFi) is safe or dangerous to students as the **studies with children have not been conducted**! Instead we are in the middle of one of the **largest human experiments** ever and we are using **children as guinea pigs**. It will take a few years until we learn what the short-term effects are and possibly generations to learn what the long-term effects are of this technology.
What Health Canada should be saying is "*There are no scientific studies of the effect of WiFi on children and we have no **convincing** scientific evidence that microwave radiation at levels below Safety Code 6 is **safe**."*

9 0.95 and 2.45 GHz most Lethal Microwave Frequencies

Why are we using some of the most lethal microwave frequencies for WiFi and digital cordless phones?
Polson, P, DCL Jones, A Karp, and JS Krebs. 1974. Mortality in rats exposed to CW microwave radiation at 0.95, 2.45, 4.54, and 7.44 GHz. Final Technical Report Prepared for U.S. Army Mobility Equipment Research and Development Center, Fort Belvoir, Virginia, Contract DAAK02-73-C-0453. 105 pp.

Dose-response (lethality) data have been obtained for rats exposed frontally to CW [continuous wave] microwave radiation in the frequency range 0.9 to 8 GHz. Approximately 1400 male rats of the Sprague-Dawley strain have been exposed in equal groups to four separate frequencies:

0.95, 2.45, 4.54, and 7.44 GHz. Power density levels have ranged from approximately 0.2 W/cm^2 to 12 W/cm^2[note: US/Canada guidelines are 0.001 W/cm^2] and lethal exposure durations from approximately 10 sec to 300 sec. Gross and histologic evaluation of selected tissues from some 20 animals has been obtained. The cause of death has been established as congestion, hemorrhage, and obstruction of nasal passages and/or congestion, hemorrhage, and often edema of the lungs. The lethality data have been subjected to a probit analysis, yielding LD_{50} curves for each of empirically fitted the four frequencies, and the LD_{50} values have been with a mathematical model. The LD curves very closely approximate the shape of rectangular hyperbolae.

Research conducted at Stanford Research Institute, Menlo Park, California in 1974, showed that experimental exposure to high levels of microwave radiation, well above U.S. and Canadian guidelines killed rats within a matter of seconds to few minutes.
The higher the power density (intensity of the radiation) the more quickly the rats died. Of the four frequencies tested, the two most lethal frequencies (0.95 and 2.45 GHz) are commonly used for analog mobile phones (0.8 to 0.9 GHz); microwave ovens (2.45 GHz); and both digitally pulsed cordless phones and wireless routers (2.4 GHz). The least toxic of the frequencies was 4.54 GHz (near 5.0 GHz also used for some WiFi systems).

The primary site of damage appears to be the blood vessels of the lung and respiratory tract with edema and hemorrhage representing changes in permeability of vessel walls.
Rats exposed to 0.95 and 2.45 GHz felt warmer than non-irradiated rats but there was no correlation between rectal temperature and mortality. At the two highest frequencies, the rats did not feel abnormally warm to the technicians handling them. This is interesting as harmful effects are often attributed solely to heating, which, even at these very high intensities, may not be the case.
While this study showed the most lethal frequencies (at very high intensities) are 0.95 and 2.45 GHz, it is not clear if the order to toxicity for these frequencies is the same at lower intensities.

So why are the most lethal frequencies used for common household appliances? Because this frequency range is not licensed.
Cell phone antennas, radio and TV broadcast antennas, radar, and other types of long distance wireless communication technologies require a license from the federal government to minimize interference of the signals in any one location. But, you do not need a license to operate your microwave oven, your WiFi, or your cordless digital phone. These frequencies are unlicensed and hence popular for common household and office equipment. That is why wireless gadgets in this frequency range are proliferating

10 Navy Tested Microwaves on Military Volunteers

Among Zory Glaser's documents, I found a newspaper article entitled: *Navy Testing Microwave Risk* (United Feature Syndicate, 1972).
The article starts: "*The Navy is exposing 50 volunteers to potentially harmful microwaves to find out what these mysterious rays do to the human body*." It goes on to say that Americans and military specialists are exposed to increasingly high levels of microwave radiation. Medical reports link these rays to cataracts, damage to male reproductive organs, cardiovascular changes, and psychological problems.

Dr. Dietrich Beischer, a German scientist, who exposed his own body to frequency microwave doses along with military personnel, headed the "human guinea pig" study. This was a long-term study since "*microwave effects may show up years afterwards . . . Genetic damage might not show up until the second generation*." Dr. Beischer said he would make his results public by mid-1973.
A previous study was cancelled when monkeys exposed to "heavy microwave exposure" became ill.

Not having heard of Dietrich Beischer before, I did a search. I learned that his early research in the 1950s on the effect on animals of being upside down was featured in Life Magazine. I found several studies on the biological effects of null geomagnetic fields (ultra low magnetic fields that one might experience in space or on the moon for example) and the biological effects of extremely low frequency magnetic fields (45 Hz). While I was unable to find any of his studies on the biological effects of microwave exposure on human volunteers, I did find one studythat documents how microwave radiation is altered by the presence of a human body, with standing waves produced on the illuminated side and a pronounced shadow effect on the opposite side. This research is important if dosimeters are used to measure microwave exposure, as these dosimeters may provide false readings depending on the direction of exposure.

Dr. Andrew Marino (who studied with Robert O. Becker and is currently a Professor at Louisiana State University Health Sciences Center) refers to Dietrich Beischer and the work he did with low frequency electromagnetic fields in his Amicus Curiae Brief on Exceptions. More information about Dietrich Beischer's extremely low frequency (ELF) research can be found at Powerline Electrosmagnetic Fields and Human Health.
While I was unable to find the results of the human microwave experiments that Beischer conducted, I was able to find other microwave studies with humans that I will share in future issues of "Pick of the Week."
In the meantime, I wonder what happened to Dr. Dietrich Beischer's research on microwave radiation?

11 Potentially Harmful Radio Frequencies used in the Packaging and Food Industry

Few people realize that radio frequencies (RF) are currently used in the manufacturing industry to mold plastics for car parts, vinyl fabrics, and food packaging. In fact this industry used the first incarnation of the "microwave" oven that we all enjoy today.

Our home microwave oven works on radio frequencies to heat food. Similarly, radio frequencies, which are much more energy efficient than thermal energy production by fossil fuels, are used to mold and seal plastics. These machines are called RF heaters.
Are these machines safe and who sets the safety standards?

After leaving the U.S. Navy, Dr. Zory Glaser worked for NIOSH (National Institute for Occupational Safety and Health) and helped formulate our current guidelines with the Canadian government for radio frequency radiation. He passed along a document that I would like to share with you that demonstrates the reasons for establishing the "thermal effect" guidelines.

Radio frequency (RF) heaters are known to leak radiation. Dr. Glaser was shocked to see that machine operators had taped large fluorescent light tubes to the outside of the machines to determine when they were operating. What worried him was that there were no wires connected to the lights. The leaking radiation was so intense it would light up the tube. These observations resulted in a study by Canadian government officials to determine if these machines were safe to use.

Stuchy, Repacholi and Mann (1980) conducted this survey (click here) to determine the radiation exposure of those working near dielectric (RF) heaters in Canada. RF heaters and microwave ovens operate between 1 MHz and 2.4 GHz and operate from a few hundred to 100,000 Watts of power. The heat, at the point of contact of the plastic and hearter, is intense but drops off rapidly a few feet away. If the machine is not properly shielded, the radiation will leak and be absorbed by the workers.

At the time of this study the maximum allowed exposure measured at the human body was 1 mW/cm^2. This level is called the "thermal effect" based on the heating of human tissue. It was assumed (and still is, incorrectly) that if the radio radiation isn't powerful enough to heat the body there would be no adverse health effect.
To their horror, 38% of the machines exceeded the Canadian safety guidelines. What happened to these machines? Were the output levels lowered (like we are asking be done for WiFi in schools)? Did we ship them to third world countries? Or, are we still using them today?

According to Dr. Glaser, this industry is largely responsible for the safety guidelines that we currently have in place based on the "thermal effect" — a guideline set to limit the amount of leakage of radiation from your microwave oven so it does not heat your body.
The conundrum we now face is that if we lower the guideline (below 1 mW/cm^2) to account for "biological effects" such as increased permeability of the blood-brain barrier, increased calcium flux, changes in enzyme activity, among others — will these limits shut down our packaging and food processing industries?

Perhaps the protection of this industry is one reason, among many others, why health protection agencies are unable to lower the existing guidelines for RF radiation.

12 Why Pulsed Microwave Frequencies are More Harmful

As I read the documents from Dr. Glaser's archives, I can't help but think that we are being "dummified". It seems we know less about microwave radiation than was known decades ago. "*Standing on the shoulder of giants*," a quote attributed to Sir Isaac Newton, refers to the fact that scientists build on the work of other scientists but this can be done ONLY if information is shared. If information is not shared, then we run the risk of discovering things *de novo* at great expense of time and money. If this information relates to the health of environments or people then we run the risk of delaying action that could protect the environment and save lives.

This document, *Some considerations concerning the use of magnetron generators in microwave biological research*, written by Vernon R. Reno at the Department of the Navy, Aerospace Med Research Laboratory clearly shows that the waveform, as well as the type of instrumentation used to both create and measure the waveform are important when considering the biological effects of microwave radiation. Reno clearly states that "average" power density is an inadequate metric for assessing the effects on animals in experimental studies. By extension, it should be inadequate for monitoring exposure of human populations as well.

So why do federal authorities continue to rely on average power density as the metric for guidelines? In Canada exposure to radio frequency radiation is averaged over a 6-minute period and in the U.S. it is averaged over a 30-minute period for public exposure. Clearly, this is inadequate based on a document written more than 35 years ago! So why are we still using this metric?

Have government scientists become dummified? Are they unaware of this literature? While this might be the excuse in Canada, I'm quoting from a U.S. military document so the U.S. government at least should be aware of this and related research.

The literature from the Eastern European countries including the former Soviet Union repeatedly report that **pulsed** radio frequency radiation is more harmful than **continuous wave** radiation at the same carrier frequencies. This may be due to the pulse carrying information to the cells and thus disrupting internal communication as suggested by Dr. Ross Adey when he said that "cells whisper to each other" using electrochemical signals. Or it may be due to a higher "maximum" exposure, which occurs with pulsed radiation that is underestimated when "averaging" is used. Either way, there is little dispute that pulsed frequencies are more harmful and, as a result, some countries have more stringent guidelines for pulsed than for CW frequencies. In the former Czechoslovakia, for microwave radiation (frequencies between 300 MHz to 300 GHz) the guideline is 2.5 microW/cm^2 for continuous wave and 1 microW/cm^2 for pulsed frequencies.
So why should we care? Because WiFi and digital cordless phones CONSTANTLY pulse the 2.4 frequency that is used to carry the wireless digital data – even when not is use. Measuring exposures can be much higher than indicated by an "average" value and, as such, our exposure to this technology may be under estimated.

13 Microwave studies with human subjects, 1966

Schwan, HP, A Anne, and L Sher. 1966. Heating of Living Tissues, Aerospace Crew Equipment Laboratory, U.S. Naval Air Engineering Center, Philadelphia, Pennsylvania, U.S.A., NAEC-ACEL-534. 38 pp.

Abstract
A central forehead area of 4 subjects was exposed to free-field, 10 cm microwave irradiation and the reaction time to onset of warmth sensation measured. Subjective awareness of warmth was found to be only a rough indication of personal hazard based on the currently accepted safety standards of 75 mW/cm^2 for 2 min.

The U.S. Air Engineering Center did studies on 4 human subjects to determine how quickly they could perceive changes in temperature when exposed to high levels of microwave radiation. They irradiated the forehead of these subjects using 10 cm wavelength (3 GHz frequency) at a power density of 74 and 54 mW/cm^2. Each of the 4 subjects was irradiated 30 times over a period of 5 days.

What is amazing about this study is not the time it took for these subjects to react (which was a matter of seconds) but the high levels to which they were exposed and the lack of follow-up studies to determine long-term effects or indeed to determine any changes other than heat perception. The Americans were so certain that the only effect of microwave radiation was heating that they didn't bother to determine any other responses to this radiation. If you don't look you can't find!

The authors concluded that it might be better to choose some other part of the body than the forehead to determine heating effect of microwave radiation at such high power densities. One reason for this is that the thickness of the skin affected heat perception. Another reason provided is that this would "remove [the] fear of brain damage."

Great effort went into designing a room and exposure of these subjects and one very interesting aside is the material used to absorb microwave radiation. Three layers were used to protect parts of the body not exposed to microwave radiation. This involved an absorbing material (Eccosorb), a second thinner absorbing layer (Teledeltos paper), and just in case some microwaves penetrated both layers, a sheet of copper to reflect the remaining radiation back into the absorbing layers.

Currently we have material (film, fabric, paint) that will reflect microwave radiation but what we need is material that will absorb this energy and, indeed, research on such material is actively being conducted.

14 Proposal for Legislation: Non-ionizing Radiation (1979)

This article is based on a thoroughly researched and carefully crafted document (*The Challenge of Non-Ionizing Radiation: A Proposal for Legislation*) written by Karen A. Massey (Project Attorney for Natural Resources Defense Council) and published in the Duke Law Journal (Volume 1979, No. 1, 86 pp). This paper will be of interest to policy analysts, lawyers, member of Congress, and all the agencies that currently have pieces of the electromagnetic puzzle in the United States and elsewhere.

Massey identifies the key departments and agencies that have influence on the science and policy of non-ionizing radiation, including: Department of Health, Education and Welfare (HEW); Department of Labor (DOL); Occupational Safety and Health Administration (OSHA); Department of Defense (DOD); Federal Communication Commission (FCC); Department of Transport (DOT); Federal Aviation Administration (FAA); Department of Energy (DOE); National Regulatory Commission (NRC; Environmental Protection Agency (EPA); Food and Drug Administration (FDA); Central Intelligence Agency (CIA) as well as selected state and municipal authorities. With so many "authorities" involved, one might feel confident that appropriate steps are being take to protect public health and the heath of the environment from the potentially harmful effects of non-ionizing radiation. Nothing could be further from the truth!

Massey outlines the key issues that need to be addressed from both a scientific and public policy perspective.
She writes, this article " *…makes a plea for a legislative solution and offers some suggestions for dealing with what may be the most complex yet in a line of pollution problems that tax the individual talents of both the scientists and the policymakers, as well as their ability to bridge the gap between their two spheres of action.*"

What is disturbing is that so little progress has been made in the intervening 30 years. Indeed, today there is much less research on non-ionizing radiation than there was decades ago despite the fact that we have many more devices emitting microwave radiation and our levels of exposure are increasing exponentially.
One of the key impediments to progress is the ongoing debate about thermal vs non-thermal effects. This is a red-herring that has received much more attention than it deserves.
This is what Massey writes about thermal vs non-thermal effects.
"I*t has been said that present physical laws do not account for any 'nonthermal' effects and unless new laws are discovered, there can be no possible effects of electromagnetic radiation on biologic systems. This statement is slightly contrary to good science.*"[71]
She goes on to say that *"It may be more than 'slightly' contrary to good science. Knowledge of mechanisms or physical laws explaining phenomena is obviously very important, particularly for its predictive value. But to say that there are no effects when effects are in fact observed, simply because the effects cannot be explained, is like saying no apples fell until Newton discovered the law of gravity. For a long while American scientists could not have observed such effects because, believing only thermal mechanisms had biologic effect, they did not experiment at below-thermal levels. Their Soviet counterparts, believing they had discovered such effects, set their exposure standard accordingly.*[72]

While some things have changed since 1979, not all of the changes have been for the better. For example, Section 704 of the Telecommunications Act of 1996 bars state and local governments from regulating the placement, construction, and modification of cell phone and other personal wireless service facilities on the basis of the environmental effects of radio frequency emissions to the extent that such facilities comply with the FCC regulations concerning such emissions. This certainly can't be called "progress"!

15 Russian Translations on Biological Effects of Magnetic Fields and Radio Frequency Radiation

These articles were originally designed to provide individual documents from Zory's Archives to anyone interested in the early studies on microwave radiation until we had enough documents scanned for distribution.

I would now like to make these documents available in larger groupings.
The first set consists of a collection of translations from the former USSR provided by the Joint Publications Research Service (JPRS). In this collection there are five documents consisting of three books and two shorter studies dealing with both radio frequency radiation and low frequency magnetic fields. These documents are intended for a scientific audience as they are specialized and highly technical in nature.
I am providing a table of contents for the books and for one book abstracts for each chapter. If anyone with experience in this field would like to write a short review highlighting what is novel information in any of these translations, please contact me. The documents are listed chronologically below.
1. Kulikovskaya, Ye.L., 1971. Protection from the Effect of Radio Waves, JPRS 52622, 15 March 1971, 155 pp.

Content

Radio Wave Irradiation
Chapter IX: Protective Measures Against the Effect of Electromagnetic Waves of Marine Radar
Chapter X: Medical Measures for the Effects of High-Frequency and Superhigh-Frequency Electromagnetic Radiation on the Organism
BIBLIOGRAPHY

2. Troyanskiy, M.P. 1972. Hygienic Problems of the Effect of Microwave Electromagnetic fields on the Body. JPRS 57209, 19 October 1972. 12 pp.
Abstract: T he article studies the harmful effects of microwave fie lds on the human body, the determination of maximum permissible human exposure levels , and the development of preventive and protective measures.

3. UHF Irradiation and the Worker in Industry, JPRS 57711, 7 December 1972, 15 pp. This is a translation of two articles from the Russian-language journal *Gigiyena Truda I Professional'nyye Zabolevaniya*, No 9, 1972, Moscow.
Abstract: The report contains two studies on cerebral and peripheral blood circulation in radiowave disease according to rheographic research results and on the immunological reactivity of animals in prolonged irradiation by ultra-high frequency radiowaves.

4. Kholodov, Yu.A. (Ed.). 1974. Influence of Magnetic Fields on Biological Objects. JPRS 63038, 24 September 1974. 228 pp.

Abstract
The report contains information on the influence of sufficiently intensive constant, alternating, and pulsed magnetic fields on various biological objects.

Content
A Introduction to the Problem (Yu. A. Kholodov)
B Physical Phenomena Occurring in Live Objects Under the Effect of Constant Magnetic Fields (Ya. G. Dorfman)
C Influence of Magnetic Fields on Enzymes, Tissue Respiration, and Some Aspects of Metabolism in an Intact Organism (M. A. Shishlo)
D The Influence of Magnetic Fields on Microorganisms (S. t… Pavlovich)
E The Mechanism of Biological Effects of a Constant Magnetic Field (A. B. Kogan, et al.)
F The Influence of Constant Magnetic Fields on the Growth of Plants (Yu. I. Novitskiy, et al.)
The Influence of Magnetic Fields on Radiation-Induced Chromosomal Aberrations in Plants (A.A. Pozolotin)
G Pathologoanatomic Characteristics of Changes in Experimental Animals Under the Influence of Magnetic Fields (I. V. Toroptaev, et al.)
H Magnetic Fields, Infection, and Immunity (N. V. Vasil 'yev, et al.)
I Effects of Magnetic Fields on the Nervous System (Yu.. A. Kholodov)
J Effect of Magnetic Fields on Experimental Tumors (Direct and Through the Nervous System) (M. A. 'Uk.olova, Ye. B.. Kvakina)
K Clinico-Hygienic and Experimental Data on the Effects of Magnetic Fields Under Industrial Conditions (A. M. Vyalov)
L Peculiarities of Methods and Methodology of Magnetobiological Experiments (A. A. Shul 'pekov)
Bibliography
List of Abbreviations
Abstracts of Articles

Abstracts of articles: The influence of magnetic fields on biological objects, 1971

A "Introduction." Kholodov, Yu. A. THE INFLUENCE OF MAGNETIC FIELDS ON BIOLOGICAL OBJECTS, 1971, 1-14.

The article gives a brief historical survey of magnetobiological works on the effects of artificial magnetic fields, fluctuations in the intensity of the geomagnetic field, and the weakened field of the earth on biological objects. It is pointed out that the influence of magnetic fields has been discovered at all levels of biological organization: from the molecule to the population. A hypothesis on the ecological significance of the geomagnetic field is stated.

B "Physical Phenomena Occurring in Live Objects Under the Effect of Constant Magnetic Fields." Dorfman, Ya. G. THE INFLUENCE OF MAGNETIC FIELDS ON BIOLOGICAL OBJECTS, 1971, 15-23.

The article· describes three principal physical effects occurring under the influence of artificial CMF on biological objects. They include: 1) magnetohydrodynamic inhibition of the movement of the blood and other biological fluids, 2) elastic oscillations of nervous, muscular and plant fibers during the propagation of bioelectric pulses in them (these oscillations may cause distortion and inhibition of the pulses), 3) orientational and concentrational changes in biologically active macromolecules in solutions which reflect on the kinetics of biochemical reactions and other physicochemical processes.

C "Influence of Magnetic Fields on Enzymes, Tissue Respiration, and Some Aspects of Metabolism in an Intact Organism." Shishlo, M. A. THE INFLUENCE OF MAGNETIC FIELDS ON BIOLOGICAL OBJECTS, 1971, 24-40.

The author discusses the published and his own data on the influence of magnetic fields on the metabolic processes of various biological objects and expresses his opinion regarding the nonspecific nature of this phenomenon. Emphasis is placed on the changes in the aging rate of enzymes *in vitro*, changes in the ratio of free and phosphorylation oxidation, intensification of glycolysis, stress reaction of the entire organism, etc. It is probable that magnetic fields, by changing the energy of weak interactions, influence the supramolecular organization of live structures, which can again result in quantitative changes in chemically specific reactions. It is not ruled out that magnetic fields may influence biological objects through the changes in the properties of water.

D "The Influence of Magnetic Fields on Microorganisms." Pavlovich, S. A. THE INFLUENCE OF MAGNETIC FIELDS ON BIOLOGICAL OBJECTS, 1971, 41-55.

It is shown that magnetic fields can influence the processes of vital activity in microorganisms. The effect depends on the nature of the magnetic field, its intensity, and biological peculiarities of the test objects. The latter is particularly clear in short exposures to magnetic fields. The differences in the nature of the obtained data are sometimes due to the differences in the experimental conditions. Prolonged exposure to a magnetic field results in a clear manifestation of the biological effects. Specific influence of various fields levels out and the observed changes have the same directivity. These studies indicate that the changeability of microorganisms is, probably, the result of the influence of magnetic fields on the enzymal systems and RNA. This may account for the influence of magnetic fields on the nature and rate of growth of microorganisms and increased thermo-tolerance of "magnetic" cultures. However, magnetic fields also cause other changes in the metabolism of microorganisms, which is exemplified by the phenomenon of phage induction.

E "The Mechanism of Biological Effects of a Constant Magnetic Field." Kogan, A. B., Sachava', T. S., Dorozhkina, L. I., Pavelko, V. M., and Go1'tseva, I. N. THE INFLUENCE OF MAGNETIC FIELDS ON BIOLOGICAL OBJECTS, 1971, 56-68.
The authors studied the influence of constant magnetic fields on the organisms of various evolutionary levels. In their experiments on *infusoria*, they observed changes in the movements, redistribution and decrease of RNA (protoplasmic), and increase in aerobic glycolysis under the effect of a constant magnetic field. In the cells of *Nitella*, they discovered a decrease in the rest potential during the action of the magnetic field by using the method of intracellular registration of the biopotentials. The effect depended on the intensity of the field and on the seasonal conditions of the experiments. It was established by the study of an individual cell of the stretching receptor of a crayfish that a magnetic field of 500 oersteds, after exposure of 30 minutes, caused an inhibitory reaction of neurons whose intensity depended on the season of the year. Structural changes in neurons were characterized by disintegration of RNA lumps and its accumulation in the perinuclear region. The physiological activity of adrenalin changed after the magnetic treatment when it was checked on an isolated heart of a frog by Straube's method

F "The Influence of Magnetic Fields on Radiation-Induced Chromosomal Aberrations in Plants." Pozolotin, A, A. THE INFLUENCE OF MAGNETIC FIELDS ON BIOLOGICAL OBJECTS, 1971, 69-97.
Studies on the influence of pulsed and constant magnetic fields on radiation induced chromosomal aberrations in the meristematic tissue of the pea revealed changes in the yield of aberrations caused by gamma-irradiation of the ends of roots. The effect was observed only since the stage when the soaking of the irradiated seeds had ended and depended on the dose of the preliminary irradiation. The effect was not well-defined during the first mitosis, which meant that the magnetic field influenced the restoration rate of the initial potential injuries of the chromosomes. The obtained results confirm the conclusion that the magnetic field is a weak biological stimulus.

G "Pathologoanatomic Characteristics of Changes in Experimental Animals Under the Influence of Magnetic Fields." Toroptsev, I, V" Garganeyev, G. P., Gorshenina, T, I., and Teplyakova, N. L. THE INFLUENCE OF MAGNETIC FIELDS ON BIOLOGICAL OBJECTS, 1971, 98-107.
Comparison of all studied morphological changes in the organs and tissues of laboratory animals revealed that male gonads were the most sensitive to magnetic fields. This physical factor disturbed mitosis, which resulted in the appearance of giant multinuclear cells in a number of organs (testes, liver, kidneys, suprarenal glands, epithelium of the crystalline lens), The aggregate of the morphological changes caused by a magnetic field in the entire organism makes it possible to speak of the specificity of the pathologoanatomic picture. A study of the dynamics of morphological changes revealed a marked tendency toward normalization of the disturbed structures in the organs and tissues after the termination of the action of magnetic fields. The biological effectiveness of pulsed and alternating magnetic fields was higher than that of constant magnetic fields. Pathological changes in a number of organs and systems occurring under the conditions of the tested magnetic fields were not catastrophic in their nature.

H "Magnetic Fields, Infection, and Immunity," Vasil'yev, N. V., Shternberg, I. B., and Boginich, L. F. THE INFLUENCE OF MAGNETIC FIELDS ON BIOLOGICAL OBJECTS, 1971, 108-123.
The article gives the results of studies carried out in various laboratories, primarily by the authors, on the influence of magnetic fields on the immunobiological reactivity of the organism. It is shown that the magnetic field is a physical factor which is undoubtedly active with respect to the mechanism of immunobio1ogica1 reactivity, both in its nonspecific and specific aspects. The influence of magnetic fields on the formation of antibodies has similarities with the effects of

ionizing radiation. It was established that the magnetic field itself, without immunization, was capable of causing changes in the lymphoid tissues which were similar to immunomorphologica1 changes. It is not ruled out that this is connected with the stress effect of both the immunization and the magnetic field. Basic directions of research in this area are suggested.

I "Effects of Magnetic Fields on the Nervous System.. " Kho1adov, Yu. A. THE INFLUENCE OF MAGNETIC FIELDS ON BIOLOGICAL OBJECTS, 1971, 124-146.
It is shown that constant magnetic fields increase the motor activity of vertebrates, inhibit conditioned reflexes developed by them to other stimuli, and can themselves serve as conditioned stimuli for carps and rabbits. Electrophysiologica1 studies revealed that magnetic fields caused a synchronization reaction in the EEG of the rabbit which developed with a latent period of 10-20 seconds. The electrographic reaction to the magnetic field in a preparation of an isolated brain and in neuronally isolated strip of the cortex of the cerebral hemispheres of a rabbit occurred more intensively and with a shorted latent period than a similar reaction of an intact brain. The author concludes that magnetic fields have direct influence on the brain tissues. This is confirmed by microelectrode studies on the spike activity of neurons and by morphological studies on the glioneural complex. The lowering of the stability of mice against oxygen want after exposure to a magnetic field compels the author to assume that magnetic fields influence the oxidizing metabolism of the brain. He stresses the nonspecific nature of reaction of the CNS to the magnetic field, because this reaction is detected after the exposure to radio-frequency electromagnetic fields and ionizing radiation.

J "Effects of Magnetic Fields on Experimental Tumors (Direct and Through the Nervous System)." Uko lova , M. A. and Kvakina, Yeo B. THE INFLUENCE OF MAGNETIC FIELDS ON BIOLOGICAL OBJECTS, 1971, 147-164.
The effects of constant and alternating (low-frequency) magnetic fields on the development of transplanted and induced tumors were studied in experiments on rats. The authors exposed either the tumor directly, or the head of the animal to a magnetic field, or combined these two methods. The application of the magnetic field often caused the experimental tumor to resolve. The effect was stronger with additional administration of Undenfriend's reagent or adrenalin. The action of a magnetic field on the head intensified tissue respiration, aerobic glycolysis, phosphorylation, and excitability of the hypothalamus. Moreover, the cholinesterase level in the blood rose, the total amount of the SH-groups decreased in the suprarenal glands and increased in the thyroid gland. Histological studies also revealed hypersecretion in the thyroid gland caused by the magnetic field. Thus, the activation of the vegetative and endocrinic sections of regulation performed by the hypothalamus is one of the mechanisms of the influence of magnetic fields on the development of tumors.

K "Clinico-Hygienic and Experimental Data on the Effects of Magnetic Fields Under Industrial Conditions." Vyalov, A. M. THE INFLUENCE OF MAGNETIC FIELDS ON BIOLOGICAL OBJECTS, 1971, 165-177.
Analysis of the clinicophysiological data obtained in studying workers subjected to the effects of magnetic fields made it possible to isolate two principal syndromes: peripheral vasovegetative and asthenovegetative. The central place in both syndromes usually belonged to the functional vascular and cardiovascular changes. Vasovegetative changes occurred more frequently and were expressed more clearly in the distal parts of hands than in other parts of the body. Experimental laboratory data indicate the same directivity of the process under the influence of magnetic fields. Physiological reactions to this factor are based on the intensification of the vagotonic effect, which is most frequently connected with the decrease in the tonus of sympathetic innervation. It should be considered that the action of magnetic fields above certain

levels of intensity can have unfavorable effects on human organisms. At the present time, the maximum permissible levels are being determined more precisely. Recommendations for therapeutic and preventive measures have been developed.

L "Peculiarities of Methods and Methodology of Magnetobiological Experiments." Shul'pekov, A. A. THE INFLUENCE OF MAGNETIC FIELDS ON BIOLOGICAL OBJECTS, 1971, 178-189
In magnetobiological experiments, a physical reality in the form of a magnetic flux is actually used as a stimulant. Therefore, it is expedient to use units characterizing the value of the magnetic flux — weber and its intensity — tesla, since these units have been accepted in the International System of Units (IS) for measuring magnetic fluxes. It is methodologically wrong to stress the difference in the biological effects of the north and south magnetic poles. If there is such a difference, then it is possible to speak of different quantitative levels of the effect resulting from the considerable magnetic field gradients near the poles and inaccurate reproduction of the coordinates. The works of the magnetobiologists confirm the materiality of magnetic fields and broaden our knowledge not only regarding biological processes, but also regarding the nature of electromagnetic fields.

5. Gordon, Z.V. 1974. Biological Effects of Radiofrequency Electromagnetic Fields. JPRS 63321, 30 October 1974. 247 pp.

Abstract

The Report contains results of studies of hygienic standards at industrial sites. Data is also presented on in-depth studies of the mechanism of action of electromagnetic fields.

Content

Investigations on the Susceptibility of Animals to Microwave (MW) Irradiation Following Treatment With Pharmacologic Agents (Ye. A. Lobanova)
Principles of Neurophysiological Investigations of Microwave Bioeffects and Changes in Elementary Excitable Structures on Exposure to Very Low Intensity Irradiation (M. S. Bychkov)
The Problem of Glio-Neuronal Relationship in the Rat Cerebral Cortex During Long-Term Exposure to Microwaves (I. M. Kazbekov, Yeo A. Lobanova)
Studies on the Reproduction and Testicular Microstructure of Mice Exposed to Microwaves (A. N. Bereznitskaya, I. M. Kazbekov)
Embryotropic Effects of Microwaves (A. N. Bereznitskaya, T. Z. Rysina)

Commonwealth Club 11-18-10. Panel I – Magda Havas, PhD from ElectromagneticHealth.Org on Vimeo.

16 Russian Translation Microwave Radiation influence on Man and Animals (1970)

Russian Translation Microwave Radiation influence on Man and Animals.
Petrov, I.R. (Ed). 1970. Influence of Microwave Radiation on the Organism of Man and Animals. Academy of Medical Sciences of the USSR, Translation of "Vliyaniye SVCh-Izlucheniya na Organizm Cheloveka i Zhivotnykh. II "Meditsina" Press, Leningrad, 1970, NATIONAL AERONAUTICS AND SPACE ADMINISTRATION, NASA TT F-708. For sale by the National Technical Information Service, Springfield, Virginia 22151 $3.00

Abstract

The book deals with problems of the effect of the microwave field on the organism, which are becoming more pressing with each passing year, since the power outputs of microwave generators are being increased and more and more persons are being exposed to this factor.
The monograph consists of three parts.
The Introduction deals with the biological bases of the action of microwave electromagnetic radiation on the organism. Parts I and II set forth experimental material on the influence of high and low microwave intensities on the animal organism, characterizing the functional changes of the organism's basic systems and its metabolism. Also considered is the question of damage due to microwaves combined with other factors and changes in the organism's immunological reactivity, the properties of bacteria, viruses, and simple animals.
Part III of the book is devoted to the influence of microwaves on the human organism and sets forth data acquired as a result of observations on volunteers as to the influence of low microwave intensities on the healthy human organism; it sets forth the symptomatology, stages, reversibility of changes, and a classification for the pathological processes that arise under the influence of microwaves in persons working with microwave generators.
The book examines problems in the etiology and pathogenesis of sequelae to exposure to microwave radiation, characterizing the significance of microwaves and factors operating concurrently with them in the appearance of pathological changes, and indicating the basic pathogenic mechanisms of the pathological changes that arise under the influence of microwaves. It also presents material characterizing the application of microwaves to treat patients.
The last chapter is devoted to protection from and prevention of detrimental effects of microwaves on the human organism. It cites the maximum permissible microwave radiation levels, characterizes means for individual and collective protection from the harmful effects of microwaves, and presents experimental material on the use of drugs to prevent detrimental after effects of microwave exposure.
The Conclusion sets forth concisely the basic premises of the problem of microwave effects on the organism as reflected in the monograph and takes note of problems that require further study.
The book contains 24 illustrations, 36 tables, and a bibliography of 521 citations.
Click here to read the Conclusions (10 pages).
Commonwealth Club 11-18-10. Panel I – Magda Havas, PhD from ElectromagneticHealth.Org on Vimeo.

17 Power Frequency Electromagnetic Fields

Most of the documents in Zory's Archive are concerned with the biological effects of radio frequency radiation. This week we have one that focuses on the biological effects of low frequency electric and magnetic fields.

Nair, I, MG Morgan, and HK Florig. 1989. **Biological Effects of Power Frequency Electric and Magnetic Fields**, Background paper as part of OTA's assessment of *Electric Power Wheeling and Dealing: Technological Considerations for Increasing Competition*, Department

of Engineering and Public Policy, Carnegie Mellon University, Pittsburgh, PA, Congress of the United States, Office of Technology Assessment, 110 pp.

Introduction and Overview

Electric and magnetic fields produced by electric power systems have recently been added to the list of environmental agents that are a potential threat to public health. This paper describes peoples' exposures to fields from power systems and other sources (Section 2), reviews existing scientific evidence on the biological effects of these fields (Sections 3 through 7), presents a history of research support and of regulatory activity (Sections 8 and 9), and discusses problems and alternatives in regulatory action (Section 10).

The electric power that is used in our homes, offices and factories uses AC or alternating current. This is in contrast to the DC or direct current that is produced by batteries. An alternating current does not flow steadily in one direction. It alternates back and forth. The power used in North America alternates back and forth 60 times each second. This is called 60 hertz (Hz) power. In Europe and some other parts of the world the frequency of electric power is 50 hertz rather than 60 Hz.

There are electric and magnetic fields wherever there is electric power. This means that there are fields associated with large and small powerlines, wiring and lighting in homes and places of work, and all electrical appliances. These fields are created by the electric charges that are pumped into the power system by electric power generating stations. Electric fields arise from the amount of that charge and magnetic fields result from the motion of that charge. Taken together, these fields are often referred to as electromagnetic fields. The electric and magnetic fields created by power systems oscillate with the current. That is why fields around power systems are called power-frequency or 60 hertz fields. A more complete description of the electromagnetic fields from power systems is presented in Section 2.

Public concerns about power-frequency fields first emerged in the late 1960s as power companies turned increasingly to extra high voltage (EHV) transmission lines to handle large increases in electricity use. EHV lines carry electric power with lower energy losses and with smaller land usage than multiple lower-voltage lines with the same power-delivery capacity. Public attention to EHV transmission lines focused first on the aesthetic impact of their large towers, on the aesthetic and ecological impacts at their rights-at-way, and on various nuisance effects created by their strong electric fields. These nuisance effects include audible noise, TV/radio interference, and induced shocks that can occur when a person standing beneath an EHV line touches a large ungrounded metal object such as a truck or farm vehicle. By the early 1970s, the American National Standards Institute had issued voluntary standards to address nuisance effects. The first evidence that power-frequency fields might have a direct effect on human health appeared in 1972 when Soviet investigators reported that workers in Soviet EHV switchyards suffered from a number of nonspecific ailments [Korobkova 72]. Although these reports were greeted with much skepticism by western scientists, they served to stimulate public concern. By the mid-seventies, health effects had become a central issue in transmission line siting hearings in several states.

There are two reasons why conventional wisdom has until recently held that the fields associated with power systems could pose no threat to human health. First, there is no significant transfer of energy from power-frequency fields to biological systems. Unlike X-rays (i.e. ionizing radiation), powerfrequency fields do not break chemical bonds. Unlike microwaves (i.e. non-ionizing radiation), powerfrequency fields cannot cause significant tissue heating. Second, all cells in the body maintain large natural electric fields across their outer membranes.

These naturally occurring fields are at least 100 times more intense than those that can be induced by exposure to common power-frequency fields.

However, despite the low energy of power-frequency fields and the very small perturbations that they make to the natural fields within the body, studies over the last fifteen years have demonstrated unequivocally that under certain circumstances, the membranes of cells can be sensitive to even fairly weak externally imposed low frequency electromagnetic fields. Extremely small signal changes can trigger major biochemical responses critical to the functioning of the cell [Adey 81, Adey 84, Adey 87]. This should perhaps have come as no surprise, as cells, especially those in the nervous system, make use of complex electrochemical processes in their normal function. The ability of some animals including eels, sharks, and pigeons to detect extremely weak ELF fields and use them for homing and finding prey clearly demonstrates that at least some specialized cells can be exquisitely sensitive to such fields [Fessard 74, Gould 82]. Among the responses demonstrated in laboratory studies using animal cells and tissue are:

• modulation of ion flows;
• interference with DNA synthesis and RNA transcription;
• interaction with the response of normal cells to various agents and biochemicals such as hormones, neurotransmitters, and growth factors;
• interaction with the biochemical kinetics of cancer cells.

Even when effects are demonstrated consistently on the cellular level in laboratory experiments, it is hard to predict whether and how they will affect the whole organism. Processes at the individual cell level are integrated through complex mechanisms in the animal. When a process in the cell is lightly perturbed by an external agent such as an ELF field, other processes may compensate for it so that there is no overall disturbance to the organism. Some perturbations may be within the ranges of disturbances that a system can experience and still function properly. This difficulty in extrapolating cellular level effects to predict the existence or severity of possible public health effects, together with the absence of any large-scale and obvious public health effect associated with electrification, are two arguments advanced during the last decade in support of the claim that there is no need for concern about possible public health effects from exposure to power-frequency fields.

Another problem in deducing possible health effects from cellular level effects has been the lack of a theoretical model to explain and understand the detailed mechanism of interaction. ELF fields affect the cell via the cell membrane. Cell membrane biology is still in its infancy although this area of molecular biology has made great strides in the past few years. Until recently, there was not enough understanding to even advance hypotheses on the potential mechanisms by which ELF fields may cause significant perturbations in cell and organ functions. Hypotheses are now being advanced but are still at a speculative stage [Adey 86, Smith 87, Liboff 86].

As we discuss in Section 3, findings at the cellular level display considerable complexity including resonant responses (or, “windows”) in frequency and field strength, complex time dependencies, and dependence on the ambient DC magnetic field created by the earth. For these reasons, ELF fields appear to be an agent to which there is no known analog. Many lessons learned from environmental hazards such as chemical agents (PCB, vinyl chloride, benzene, etc.) or physical agents (ionizing radiation, asbestos etc.) may not directly apply to ELF fields. This is because in the case of fields it is not yet clear what measures of exposure or “dose” are relevant. In contrast to more familiar environmental agents where “if some of it is bad, more of it is worse”, it may not be safe to assume that if ELF field exposure leads to health risks, exposure to stronger fields or exposure for longer periods is worse than exposure to weaker fields or brief periods.

In addition to cellular studies, whole animal and human experiments have examined five general categories of effects:

1. General effects such as detection, avoidance and behavior response and development and learning of animals, and moods of humans;

2. Effects on externally measured physical parameters such as growth and birthweight, respiration, heartbeat rate, and temperature rhythms;
3. Effects on specific biochemicals such as hormones that are responsible for the maintenance, regulation and control of general physiological and psychological functions; for response to environmental stressors; for growth and development; and, for triggering special responses such as sexual function, and fetal and newborn nourishment;
4. Effects on circadian rhythms of animals and humans, and,
5. Effects in the epidemiology of cancer, particularly leukemia and brain cancer.

Several authors and scientific advisory panels have reviewed the effects literature [Adey 86, Adey 87, AIBS 85, Carstensen 87, Florida 85, Grandolfo 86, lee 86, NYSPIP 87, Sheppard 83, West 86, WHO 84]. In summary, the results are complex and inconclusive. There have been many "negative" experiments, that is, experiments that have looked for effects but not found any difference between biological systems that have been exposed to fields and those that have not. However, the growing number of positive findings have now clearly demonstrated that under specific circumstances even weak low-frequency electromagnetic fields can produce substantial changes at the cellular level, and in a few experimental settings, effects have also been demonstrated at the level of the whole animal.

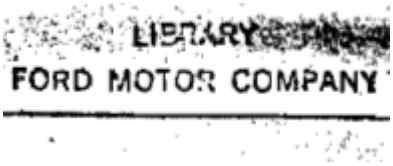
Epidemiological evidence, while controversial and subject to a variety of criticisms, is beginning to provide a basis for concern about risks from chronic exposure. Some observers find this epidemiological evidence more persuasive in light of the clear evidence of effects that is available at the cellular level, but others insist on treating the evidence from these two areas as separate.

As recently as a few years ago, scientists were making categorical statements that on the basis of all available evidence there are no health risks from human exposure to power-frequency fields. In our view, the emerging evidence no longer allows one to categorically assert that there are no risks. But it does not provide a basis for asserting that there is a significant risk.

If exposure to fields does turn out to pose a health risk, it is unlikely that high voltage transmission lines will be the only sources of concern. Power-frequency fields are also produced by distribution lines, wall wiring, appliances, and lighting fixtures. These non-transmission sources are much more common· than transmission lines and could play a far greater role than transmission lines in any public health problem.

Commonwealth Club 11-18-10. Panel I – Magda Havas, PhD from ElectromagneticHealth.Org on Vimeo.

18 Effect of Microwaves on the Central Nervous System 1965 – German translation



Effect of Microwaves on the Central Nervous System, German Translation, 1965.
Bergman, W. 1965. The effect of Microwaves on the Central Nervous System. Translation from the German for Research and Scientific Laboratory, Ford Motor Company by the Technical Library Research Service. 82 pp.

Abstract

The autonomic nervous system is affected by the microwaves of the centimeter wavelength band. These waves affect circulation, respiration, temperature control, water balance, albumin and sugar concentration in the cerebro-spinal fluid, hydrogen ion concentration, EEG. GSR,

sleep, conscious awareness, etc. Depending on the applied dosage, these waves stimulate the sympathetic or parasympathetic system. Very small dosages produce analgesic effects; however, very large dosages are fatal. An undamped or modulated frequency is more effective than damped waves. The biological effect of these waves results from the resonance absorption in the ganglia. There are indications that only higher harmonics, and not the fundamental frequency, produce biological effects. The shielding of the test subject by metal screens increases these effects; however, magnetic fields remove them. Higher harmonics producing these biological effects have physical properties which are similar to those of the bio-electrical energy generated by the human body. The mechanism of hypnosis is explained by the transmission of this energy.

Contents

Introduction

The present study demonstrates that short electromagnetic waves can have an extensive influence on the central nervous system. This involves a direct influence of high-frequency

energy on the autonomic nervous system and the influence on the somatic nervous system takes place by the control of its readiness to function from the vegetative sphere. Such a process otherwise takes place only under hypnosis.
The human body has been found to be the generator of a wave energy which is propagated in the surrounding atmosphere in the form of electromagnetic waves. In its transmission to other persons, this energy influences the central nervous system in a manner similar to short electromagnetic waves. The hypothesis used for an explanation of suggestion is based on the transmission of this wave energy. It has been found that neither the entire electromagnetic field of a short-wave transmitter nor the entire electrical field in the environment of the human body can influence the central nervous system. Rather, the central nervous system is influenced by certain wave components contained in the electromagnetic waves generated by a short-wave transmitter as well as in the electrical field surrounding the human body. Since these Wave components of short electromagnetic waves as well as those of the electrical field around the human body exhibit similar physical characteristics and exert similar influences on the central nervous system, it can be assumed that the same energy is involved in both cases. The possibility results to produce the energy which is effective in hypnosis by engineering methods. In this connection, the development of the instruments which are to produce this energy is to be based on guidelines which differ fundamentally from those presently utilized in the development of transmitters for short-wave diathermy.
In short-wave diathermy as it is used today, the heat generated in the patient is primarily utilized. The development of short-wave transmitters consequently followed the design of highly efficient instruments which produced a maximum heat generation in the patient. It was found that heat produces an effect opposite to that of the energy which influences the central nervous system. Consequently, the effective action of the energy influencing the central nervous system is considerably reduced by the heat formed in the patient. A further attenuation of the energy influencing the central nervous system was produced by the introduction of oscillators which generate undamped oscillations. For undamped waves produce much less prominent reactions of the central nervous system than damped waves or pulses. The introduction of transmitters built on this basis for short-wave diathermy together with the new dosage method which I have proposed and which is based on the principle of measuring the reaction of the autonomic nervous system to the electromagnetic energy absorbed by the body. will provide the practising physician with a new effective instrument permitting the treatment of patients by direct stimulation of the central nervous system.

19 Index of Publications on Biological Effects of Electromagnetic Radiation (0-100 GHz)

James Kinn with the U.S. Environmental Protection Agency (EPA) and Elliot Postow with Naval Medical R&D Command compiled a list of 3627 publications on the biological effects of electromagnetic radiation from 1 to 100 GHz. This 574 page document has been scanned and converted into a searchable pdf document that is available here. The references in this document are listed by title and author.

Abstract

Considerable research effort has been made into the biological effects of electromagnetic radiation over the frequency range of 0-100 GHz. This work intensified since 1966 when occupational exposure guidelines were made by the American Standards Institute – C95.9. During this period and especially in the last several years it has become clear that a cumulative bibliography of peer reviewed publications reporting this research was needed.
This publication lists 3627 articles published in world literature dealing with the biological effects of electromagnetic radiation over the frequency range of 0-100 GHz. The contents have been compiled from the data bases of the U.S. Environmental Protection Agency and the Navy Department. The bibliography covers the published work that was available to March 1980.

20 Early Research on the Biological Effects of Microwave Radiation: 1940-1960

The early research on biological effects of microwave radiation between 1940-1960 is reviewed by Cook and colleagues and is available here for download as a pdf.
Cook, H.J., N.H. Steneck, A.J. Vander, and G.L. Kane. 1980. Early Research on the Biological Effects of Microwave Radiation: 1940-1960. Annals of Science 37:323-351.

Summary
Two overriding considerations shaped the development of early research on the biological effects of microwave radiation-possible medical application (diathermy) and uncertainty about the hazards of exposure to radar. Reports in the late 1940s and early 1950s of hazards resulting from microwave exposure led to the near abandonment of medical research related to microwave diathermy at the same time that military and industrial concern over hazards grew, culminating in the massive research effort known as 'the Tri-Service program' (1957-1960). Both the early focus on medical application and the later search for hazards played important roles in dictating how this field of research developed as a science.

Contents

21 Physical Basis of Electromagnetic Interactions with Biological Systems

A workshop sponsored by the Office of Naval Research, the Naval Medical Research and Development Command, and the Bureau of Radiological Health, Food and Drug Administration was held at the University of Maryland in 1977. The Proceedings of that workshop are available here as a pdf document.

Taylor, L.S. and A.Y. Cheung (editors). The Physical Basis of Electromagnetic Interactions with Biological Systems. Proceedings of a workshop held at the University of Maryland, College Park, Maryland, June 15-17, 1977. 410 pp.

Foreword

This volume contains the proceedings of a Workshop on the Physical Basis of Electromagnetic Interactions with Biological Systems held at the University of Maryland on June 15-17, 1977. The workshop was sponsored by the Office of Naval Research, the Naval Medical Research and Development Command and the Bureau of Radiological Health, Food and Drug Administration.

The wide application of industrial, commercial and military devices and systems which radiate frequencies in the radiofrequency and microwave portion of the electromagnetic spectrum plus numerous only partially understood indications of microwave effects upon living organisms have raised important questions of the physical basis of the interactions of electromagnetic fields with biological systems. These questions must be answered if the development of regulatory standards and of methods and techniques for controlling radiofrequency and microwave exposure is to be achieved. The same questions must be answered in connection with present and proposed therapeutic applications of these waves. The rapid increase in the use of these frequencies makes these questions matters of imperative concern, particularly in view of the possibilities of cumulative or delayed effects of exposure.

The study of electromagnetic interactions with biological systems brings together diverse specialties in the fields of physics, engineering, biology and chemistry in a highly interdependent way. Progress towards practical solutions of the problems involved will depend upon the development of experimental techniques and instruments and of a sufficient general theoretical base to inform and react with the experimental investigations. The purpose of the Workshop on the Physical Basis of Electromagnetic Interactions with Biological Systems was to bring together the leading investigators in the field to present the results of recent research, to determine the present status of the field and the priority of significant problem areas, and to critically evaluate conflicting theoretical interpretations and experimental techniques. These proceedings contain

the formal papers prepared by the invited speakers plus a number of contributed papers given by other participants in the Workshop. Transcriptions were made of the discussion periods following each paper and edited versions of these are included; the editors bear the responsibility for any misquotation.

Table of Contents

22 A Very Important Symposium!

Janet Healer reviewed studies of people occupationally exposed to radio frequency radiation. Below are some excerpts from her document presented at the "Biological Effects and Health Implications of Microwave Radiation" symposium. These are direct quotes with the numbered citations removed and my comments provided in square [ ] brackets. I have tried to restrict quotes to studies that were conducted at or below our current guidelines of 1 mW/cm^2, although in many instances exact exposure conditions are not provided. Emphasis added. Link to proceedings is available at the end of this document.

1. page 90. "There is increasing evidence that radio-frequency radiations can affect biological organisms, even at relatively low intensities, particularly under conditions of chronic exposure [WiFi in schools, offices and homes for example]. A substantial number of observations have been made at intensity levels below those presently accepted as tolerable for continuous exposure in the United States and most of Western Europe. To date, the deleterious effect of radio-frequency fields, particularly of microwaves, at relatively high intensities, e.g., 50 mW/cm^2 or greater, has been recognized and attributed to heating. However, biological hazards may exist at lower levels, extending well below 10 mW/cm^2, and effects at both high and low intensities may be attributable to more complex modes of interaction. **At low intensities effects may be subtle, impairing performance; chronic, affecting general mental and physical health and longevity; and may also be mutagenic, affecting succeeding generations.**"

2. page 91: ". . . the Moscow Institute conducted a 10-year study of over 1000 individuals exposed in various occupations over periods from months to as long as 20 years. The study included investigation of symptoms associated with chronic, long-term low-level exposures that "do not produce a thermal effect." Effects of various frequency bands were compared from below the high-frequency (HF) [3 to 30 MHz] band up through the superhigh frequency (SHF) [3 to 30 GHz, wavelength 1 to 10 cm] band. A large portion of the work was done in the centimeter range with reported exposure intensities of 1 mW/cm^2 and below [note 1 mW/cm^2 is the current guideline in the U.S., Canada, and is recommended by both ICNIRP and the World Health Organization]. Even at these low intensities, systematic, long-term exposures were reported to produce symptoms. Similar observations have been made at these and lower frequencies extending into the ELF [extremely low frequency] region.

3. page 92: "The symptomatology associated, in the Soviet literature, with prolonged exposure most commonly includes **headache, increased fatigability, diminished intellectual capabilities, dullness, partial loss of memory, decreased sexual ability, irritability, sleepiness and insomnia, emotional instability, sweating, and hypotension**. **Shortness of breath** (dyspnea) and **pains in the chest region** are also reported. [Note: these are similar to symptoms of electrohypersensitivity]. Symptoms of disturbance of the vegetative nervous system including sinus arrhythmias, a tendency toward bradycardia [slowed heart beat], and other vagotonic changes are common observations." [Note: vagotonic changes refer to over

excitation of the vagus nerve–a nerve that supplies the throat, voice box, lung, heart, and stomach–adversely affecting function of the blood vessels, stomach, and muscles resulting in dizziness, sweating, constipation, and pain].

4. page 92: “The most commonly reported **objective physiological changes** [indicating that these symptoms are NOT *psychological*] are **neural, cardiovascular, blood compositions, and endocrine functions**.”

5. page 92: “At low intensities, neural changes, like other reported biological shifts, are typically functional, are not accompanied by distinct pathological change, and disappear after the subject is removed from the radiation environment. Nervous system response is expressed in the electroencephalogram (EEG) and by altered response times. Commonly, responses are characterized by initial excitation followed by subsequent inhibition.”

6. page 93: “Various biochemical, neurohumoral and metabolic disruptions have been observed which can affect neural and other body functions. Changes in **histamine** [leading to inflammation] in the blood (generally increases) have been reported.
Decreased **cholinesterase** [enzyme affecting nervous system and immune system] levels are frequently reported in exposed people and also in animals where they have been observed in connection with altered neural response. **EEG** [brain wave activity] changes have been observed in some occupationally exposed people at microwave and lower frequencies. These changes are reported to be early occurring and often appear before other changes are detectable in the organisms. They are frequently reported to persist after the cessation of irradiation.

7. page 93: They [Czechoslovakian scientists] regard EEG shifts as a kind of early-warning system for detection of organism response to radio frequency radiation on a very subtle level.

8. page 94: “Numerous Soviet studies cite **cardiovascular disturbances** which they widely regard as the predominant vegetative response to radio-frequency irradiation. In general, cardiovascular responses are characterized by hypotension, dystonia [neurological movement disorder causing sustained muscles contractions leading to twisting or repetitive movements of the body], and vagotonic reactions. Electrocardiographic (EKG) studies of exposed people and of animals, report a predominance of bradycardia, arrhythmia, and particularly sinus arrhythmias. Depressed intracardial conduction, commonly intraventricular, and lowered EKG waves, particularly T-waves, are also reported. Shifts are reported more often in persons with long histories of occupational exposure. Some examinations suggest a heightened susceptibility of persons with predisposition to, or a history of, cardiovascular disease. In the interest of occupational hygiene, many Soviet investigators (and at least one U.S. researcher) have recommended that **cardiovascular abnormalities be used as screening criteria to exclude people from occupations involving radio-frequency exposures**. [Note that we have anecdotal evidence that children in schools with WiFi or with WiFi in their home experience a racing or irregular heart beat that normalizes when they are not exposed.]

9. page 94: “An extensive examination program was conducted by the Institute of Labor Hygiene and Occupational Diseases, Moscow, involving over 500 individuals, periodically exposed for periods up to approximately10 years to cm and longer wave radiations at low intensities (e.g., below 1 mW/cm^2, and up to several mW/cm^2). This program revealed a variety of cardiovascular shifts predominant among which were bradycardia and vascular hypotension [low blood pressure]. Differences in responses to acute exposures of higher intensities and longer term chronic exposures at lower intensities were noted. Although these effects are

generally reported to be reversible, a few exceptions are noted for certain individuals chronically exposed over many years, who showed pronounced pathological conditions."

10. page 94: "In the **blood**, alterations have been reported in the protein fractions, ions, histamine content, hormone and enzyme levels, and immunity factors, but most frequently reported are changes in cellular composition."

11 page 94: "Increased **thyroid** gland activity and sometimes enlargement is the most commonly reported endocrine response of exposed people. **Adrenal** changes are also reported."

12. page 94: "A few occupational studies have suggested possible disturbances in some r**eproductive system**functions. Several foreign low-intensity animal studies report reproductive system disturbances and cases of adverse effects on progeny, although contradictory evidence has also been reported. Of particular significance are possible **genetic changes** which might occur in large populations over long periods of time. Very little genetic data exists, although one U.S. study suggested a possible relationship between paternal radar exposure and mongoloidism.

13. page 94: "A 1967 Polish paper discussing **ophthalmological aspects** of safety standards for workers during operation of electromagnetic-field generators in military installations, indicates concern for workers with some eye ailments when working in microwave 'fields as low as 0.01 mW/cm^2." [Note: This value is 1% of the current WHO guideline!]

14. page 94. "There is general agreement among Soviet and Eastern European investigators that systematic chronic exposure to low-intensity radiations (around 10 mW/cm^2 and lower) can have an adverse effect on health. Their standards are more restrictive than those of the United States by several orders of magnitude (e.g., 0.01 mW/cm^2 for continuous daily microwave exposure). Furthermore, separate standards exist for various frequency ranges below the microwave region (e.g., 60 kHz-30 MHz, and 30-300 MHz). In Czechoslovakia maximum permissible exposures distinguish between **pulsed** and **continuous-wave radiations** and are **more restrictive for the pulsed case** (0.025 mW/cm^2 vs 0.01 mW/cm^2)." [Note: WiFi and mobile phones use the more harmful pulsed radiation.]

15. page 95: "In summary, considerable investment of time, money and talent have been made in foreign programs to study the effects of low-intensity occupational radio-frequency exposures in man. These studies have resulted in the accumulation of a large body of research data, which in aggregate cannot be ignored even though in many details it must be substantiated."
[Note: So why has it been ignored and why are federal and international health authorities denying that a problem exists below the thermal guidelines currently at 1 mW/cm^2 in many countries?]
A total of 119 references were cited.
Can anyone guess when this was published? Would you believe 41 years ago in 1970!!!
Cleary, S.F. (Editor). 1970. Biological Effects and Health Implications of Microwave Radiation, Symposium Proceedings, Richmond Virginia, September 17-19, 1969. Sponsored by Medical College of Virginia, Virginia Commonwealth University with the support of Bureau of Radiological Health, U.S. Department of Health, Education, and Welfare, Public Health Service, Environmental Health Service. 275 pp.
Click here to download this document as a searchable pdf (7.1 MB).
This was a very important symposium with more than 30 additional papers presented. The panel discussions alone are illuminating.

Content

23 Research on Biological Effects of Radio Frequency Radiation in Eurasian Communist Countries, 1976.

The Defense Intelligence Agency of the United States released a document referenced below that had a security classification as “confidential” and has since been “unclassified”. This document may help us better understand why the U.S. military is interested in opposing a more protective guideline for microwave radiation.

Adams, R.L. and R.A. Williams. 1976. Biological Effects of Electromagnetic Radiation (Radiowaves and Microwaves) – Eurasian Communist Countries (U). Prepared by U.S. Army Medical Intelligence and Information Agency Office of the Surgeon General and was released by the Defense Intelligence Agency. 34 pp. Unclassified.

Abstract
This study was undertaken to provide a review and evaluation of the current Eurasian Communist country state-of-the-art in the area of the effects of radiowaves and microwaves. It generally covers the 1968-1975 period. The major topics include discussions of the effects on humans and animals. The study provides information on the genera1 trends of research with special attention to possible military applications. Where appropriate, information on safety standards and research personalities and facilities is provided.

The section dealing with biological significance of radiowaves and microwaves include the following topics for which there is considerable research: blood, cardiovascular system, cells, central nervous system, digestive system, glands, metabolism, reproduction, visual systems, internal sound perception as well as miscellaneous effects.

There are two disturbing paragraphs in this document that clearly indicate the U.S. military’s perspective opposing more stringent guidelines for microwave radiation.
“If the more advanced nations of the West are strict in the enforcement of stringent exposure standards, there could be unfavorable effects on industrial output and military function. The

Eurasian Communist countries could, on the other hand, give lip service to strict standards, but allow their military to operate without restriction and thereby gain the advantage in electronic warfare techniques and the development of antipersonnel applications." [page vii]
"Should subsequent research result in adoption of the Soviet standard by other countries, industries whose practices are based on less stringent safety regulations, could be required to make costly modifications in order to protect workers. Recognition of the 0.01 mW/cm^2 standard could also limit the application of new technology by making the commercial exploitation of some products unattractive because of increased cost, imposed by the need for additional safeguards." [page 24]

Note that the "less stringent safety regulations" refers to U.S., Canada, Great Britain and several European countries as well as to the guidelines recommended by ICNIRP and WHO. It seems that the authors of this document value military and commercial financial considerations above worker health. There is little doubt that the U.S. military played a key role preventing safer and more protective U.S. guidelines for microwave radiation.

Microwave weapons are outside the scope of this document, although there is reference to antipersonnel applications of microwave technology including inducing neurological effects, metabolic diseases, heart seizures and neurological pathologies resulting from breaching the blood-brain barrier, as well as intracranial production of sounds and possibly words at very low average power densities. On page 26, a section dealing with microwave weapons seems to have been removed.

This document clearly reflects the U.S. military's resistance to lowering the guideline and their distrust of research conducted in the Eastern Block Countries. That distrust and the power wielded by the U.S. military is largely responsible for the status of the current guidelines, which fail to protect public and worker health.

Click here to down load this document as a pdf (1.8 MB).

24 Microwave Radiation Affects the Heart

During the past year I have become increasingly interested in the effects of microwave radiation on the heart. This interest is based on a number of observations.

Some people who are electrically sensitive complain that they have a rapid or irregular heart beat and feel chest pressure or pain (Eltiti, 2007). We conducted a "proof of concept" study to determine if we could measure heart rate changes caused by microwave radiation with real-time monitoring. We found that some individuals developed a rapid or an irregular heart beat when exposed to pulsed microwaves (from a cordless phone base station) at levels considered safe by the WHO, FCC, and Health Canada (Havas et al. 2010).

During the past year I have heard stories that children who attend schools with WiFi are complaining of a racing heart while in school (link to video). Two of these students in the Barrie area (Canada) were given heart monitors to wear and one young girl was scheduled for heart surgery because her cardiologist couldn't figure out what was wrong. Her parents postponed the operation, removed the WiFi in their home, and her symptoms did not return during the summer when she wasn't attending school.

During the past few years two different students, also in the Barrie region, experienced exercise-related sudden cardiac arrest. Fortunately they got help quickly and survived. Schools have now installed defibrillators as a consequence.
Is it normal for young people to complain of heart problems and for two students in a relatively small community to experience sudden cardiac arrest?

I began to research this subject and learned that sudden cardiac arrest is the leading cause of death among athletes (Drezner et al. 2008) and appears to be increasing among adolescents and young adults (Maron et al. 2009; Zheng et al. 2005). Sudden death among athletes increased slowly from 1980 to 1995 and then rose suddenly in 1996 and continued to increase up to 2006, when the study was terminated (Maron et al. 2009) (See figure 1). Coronary heart disease and blunt trauma to the chest during competition have been identified as the cause in some cases but other cases remain a mystery.

Maron et al Sudden Death in Young Athletes 1087

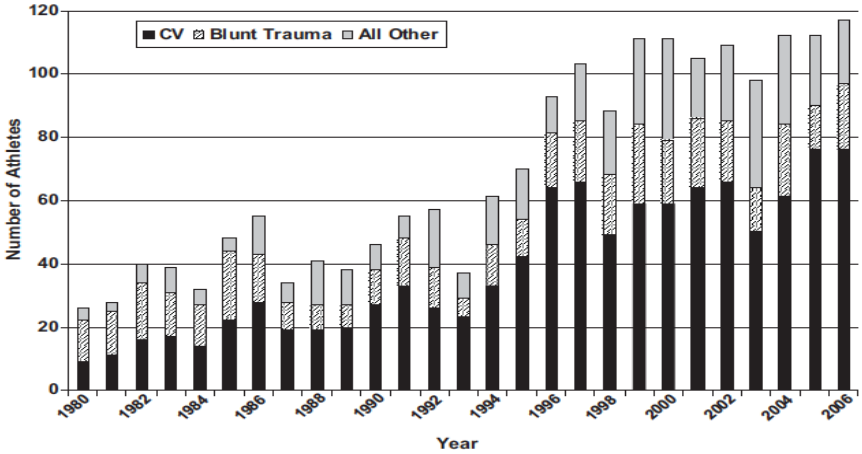


Figure 1. Number of cardiovascular (CV), trauma-related, and other sudden death events in 1866 young competitive athletes, tabulated by year.

Doctors do not know the reason for this disturbing trend and according to one study (Dencheve et al. 2010), medication for children diagnosed with attention deficit hyperactivity disorder may increase the risk for sudden cardiac death.

One aspect that has not be considered is the increasing exposure to microwave radiation from mobile phones, cell phone antennas, and wireless technologies in the home and school environment. Could it be that our low level exposure to microwave radiation is placing undue stress on the nervous system of these children and is contributing to heart irregularities that become exacerbated with exercise resulting in sudden cardiac arrest? If microwaves at low intensities (as shown in our study) can affect adult hearts then this radiation can certainly affect the hearts of children.

In November 2010, two schools in the Barrie area were monitored for microwave radiation. What is particularly disturbing about the results obtained is that of the 20 rooms measured 17 of the classrooms had levels at or above the levels that caused heart irregularities among adults in our heart rate variability study (0.003 milliwatts/cm^2). But even more disturbing is that levels of microwave radiation exceeded Health Canada's Safety Code 6 guideline near a computer in one classroom (1.342 vs 1 milliW/cm^2)! I will write more about this in a separate report.

We know that pace makers can malfunction if they are exposed to interfering microwave frequencies and people with pace makers are told to stay away from microwave ovens and other microwave emitting devices. The newer pace makers have shielding to prevent interference. But the human heart comes without a shield. So it is not only the child or adult with a pace maker that needs to be careful about their exposure to microwaves, all of us need to be aware that this radiation may affect the heart.

This concept is supported by the early research on microwave radiation. Cardiovascular problems seem to be common among microwave workers. In (#22: A Very Important Symposium), Healer (1970) stated that:
"*In the interest of occupational hygiene, many Soviet investigators (and at least one U.S. researcher) have recommended that cardiovascular abnormalities be used as screening criteria to exclude people from occupations involving radio-frequency exposures.*"
Glotova, KV, Sadchikova MN. 1970. Development and clinical course of cardiovascular changes after chronic exposure to microwave irradiation, Effect of Microwave Irradiation, Arlington, VA, Joint Publication Research Service, (JPRS 51238), 3 pp. Click here to download pdf of study.

The authors of this publication were with the Institute of Labor Hygiene and Occupational Diseases, USSR Academy of Medical Sciences, Moscow. This is just one in a series of study from the Soviet Union that examines the effect of microwave radiation on the nervous and cardiovascular system. My comments are in square brackets [ ].

The purpose of this report was "*to describe the nature, severity, and clinical course of the cardiovascular changes that follow chronic exposure to microwave irradiation. This information was derived from long-term [3 to 6 years] clinical observations on 130 patients. The data pertain to 105 (90 males and 15 females) patients. Those with chronic tonsillitis, organic neurologic lesions, and cranial trauma were excluded.*"

The patients had been working with microwaves in the one-centimeter range waves for at least 5 years and were exposed to fairly intense levels especially in the early years (at and below several milliW/cm^2). Intensities above 1 mW/cm^2 would now be considered high exposure. Subjects were placed into two groups. Subjects in **group one** had asthenia (weakness and low energy), and complained of headache, fatigue, insomnia and pains in the heart region. A number of these persons had arterial hypotension (low blood pressure) and bradycardia (slow heart rate).

Subjects in **group two** complained of fatigue, irritability, headaches, nausea, and vertigo. Some experienced autonomic-vascular crises with severe headaches, chills, tremor, loss of consciousness, pallor or reddening of the face, constricting pain in the heart, labored breathing followed by great weakness. Subjects in this group were more likely to experience tachycardia (a rapid heart rate) and high blood pressure, autonomic-vascular dysfunction and hypothalamic insufficiency. The hypothalamus, a small portion of the brain just above the brain stem, links the nervous system to the endocrine system and controls body temperature, hunger, thirst, fatigue, sleep and circadian cycles. A hypothalamic insufficiency could affect any of these functions.

The authors concluded the following:
"*Thus, long-term observations showed that the nature and intensity of the cardiovascular reactions to prolonged exposure to microwaves are closely related to neurologic changes, especially those in the autonomic nervous system. They also vary with the individual. Some*

exhibit for a long time only mild asthenic symptoms with sinus bradycardia and arterial hypotension with no signs of general or regional hemodynamic disturbances.
Others develop autonomic-vascular dysfunction, often with symptoms of hypothalamic insufficiency and angiospasm [spasmodic contraction of the blood vessels with increase in blood pressure] *which sometimes impair the cerebral* [brain] *and coronal* [heart] *circulation*."

The early literature showing cardiovascular dysfunction among microwave workers, our study showing heart rate irregularities with pulsed microwave exposure at a fraction of international microwave exposure guidelines; the complaints of electrically hypersensitive individuals of heart irregularities; student complaints of heart flutters and a racing heart; and the increase in the rate of sudden cardiac arrest among young people to the point that schools are installing defibrillators cannot be ignored.

Just as workers ought to be screened if they are going to work with microwave radiation,students ought to be to screened each year at school to ensure that they do not have an underlying heart condition that may be exacerbated with WiFi exposure.
A heart flutter may be an early warning that something more serious can happen. Anyone who experiences a rapid or irregular heart rate that comes on suddenly with mild or no physical exertion when they are exposed to wireless technology should heed the warning, minimize their exposure as quickly as possible and visit a cardiologist.

25 Review of International Microwave Exposure Guidelines from 1957 to 1968.

A Review of International Microwave Exposure Guides

G1

JON R. SWANSON, Ph.D.,* VERNON E. ROSE, and CHARLES H. POWELL, Sc.D.
International Labour Office, Geneva, Switzerland, and the Bureau of Occupational Safety and Health, Public Health Service, 1014 Broadway Cincinnati, Ohio 45202

Swanson and colleagues from the International Labour Office (Geneva, Switzerland) and the Bureau of Occupational Safety and Health, Public Health Services (Cincinnati, Ohio) reviewed guidelines for microwave radiation and published their review in the American Industrial Hygiene Association Journal, Vol. 31: 623-629 (1970). Click here to download a pdf of this article.

Below is some information from this article. My comments appear in square brackets. To convert from mW/cm^2 to $microW/cm^2$ multiple by 1000.

United States

1. From 1940s to 1970s the use of microwave emitting equipment had increased considerably.
2. In the United States radio frequencies (RF) from 10 to 10,000 MHz were classified as microwave radiation, while in Europe the range was from 300 to 300,000 MHz. [NOTE: We now use the European range to delineate the microwave part of the radio frequency spectrum.]
3. By 1970, scientists recognized that parts of the body that are unable to dissipate heat are the most vulnerable to microwave radiation. This includes the lens of the eye (cataracts) and the reproductive organs (sterility or degenerative changes).
4. Depth of penetration of radiation into tissue is a function of frequency with greater penetration at lower frequencies.
5. In the United States the first guidelines were established during the Tri-Service conference, held in 1957. Below is a quote about the guidelines:

It was the opinion of those participating in the Conference that there were not sufficient data to determine safe exposure levels for each frequency, or ranges of frequencies, within the microwave region; therefore, a level of 10 mW/cm^2 [10,000 microW/cm^2] was selected for all frequencies. The U.S. Air Force, in adopting this exposure level in May 1958, applied it to the frequency range of 300 to 30,000 MHz and established it as a maximum permissible exposure level, which could not be exceeded. The only factor considered in this criterion is the power density level. Such factors as time of exposure, ambient environmental temperatures that could have an increased or decreased effect on the body's thermal response, the frequency of the microwave energy, effects of multifrequency exposures, differing sensitivity of various body organs, and effect of air currents on cooling the body are not considered, although they are all recognized as factors that might affect biological response.

[NOTE: It was clear in 1970 that the US guidelines were somewhat arbitrary, were based on thermal effects only, and did not include other factors that influence biological and health consequences. This guideline has since been lowered from 10 to 1 mW/cm^2 but is still 100 to 1000 times higher than guidelines in other countries.]

UK, West Germany, France and Netherlands

6. Guidelines in the UK and in West Germany allowed citizens to be exposed to 10 mW/cm^2 (same as in U.S).
7. In France only military personnel during working hours were allowed to be exposed to 10 mW/cm^2. In rest areas and in public areas the guidelines were 1 mW/cm^2.
8. In the Netherlands the guidelines were at 1 mW/cm^2.

Poland, USSR, Czechoslovakia

9. Guidelines in the eastern European Block countries were much more protective than those in western countries.

Poland

10. Polish guidelines, established in 1961 and 1963, were as follows:

- 10 microW/cm^2 [0.01 mW/cm^2] – no limitation for time of work or sojourn in this field.
- 10 and 100 microW/cm^2 [0.01 and 0.1 mW/cm^2]- cumulative time of work or sojourn not to exceed 2 hours in every 24 hours
- 100 and 1000 microW/cm^2 [0.1 and 1 mW/cm^2]- cumulative time of work or sojourn not to exceed 20 minutes in 24 hours.

11. The Polish regulation requires an annual medical examination for exposed workers including neurological and ophthalmological examinations; safe placement of microwave generating installations; protective screening; personnel protection; site surveillance; and safety education.

12. The Polish regulation forbids work with microwave radiation for young people (age not provided), pregnant women, and other people suffering from certain diseases, which are listed in the regulation.

USSR

13. The USSR standards were based on time of exposure as follows:

- 10 microW/cm^2 [0.01 mW/cm^2] for a working day
- 100 microW/cm^2 [0.1 mW/cm^2] for 2 hours daily
- 1000 microW/cm^2 [1 mW/cm^2] for 15 minutes daily [so at 1000 microW/cm^2 the Soviets could be exposed for only 15 minutes, the Poles for only 20 minutes but the Americans could be exposed for 24 hours each day!

14. The U.S.S.R. is also one of the first to propose exposure standards for intermediate-frequency electromagnetic radiation [dirty electricity], which heretofore had been considered as having no effect on the human body. These levels are:

- Medium wave (100 kHz – 3 MHz) – 20 volts/ meter [29 microW/cm^2]
- Short wave (3 MHz- 30 MHz)- 5 volts/ meter [1.8 microW/cm^2]
- Ultra short wave (30 MHz- 300 MHz)- 5 volts/ meter [1.8 microW/cm^2]

[NOTE: The WHO has recently recognized the importance of intermediate frequencies (IF) and the information they provide is severely limited].

15. Medical examinations are regulated in the Soviet Union for persons exposed to electromagnetic radiation. Medical counter indications are enforced so that workers are not allowed to be exposed to microwave radiation if specified diseases exist. Heavy emphasis is placed on blood disorders, neurological disturbances, and chronic eye diseases.

16. Preventive measures of an engineering nature are used by Soviet health and epidemiological centers to ensure compliance with their health regulations. Decreasing the amount of radiated energy, reflective and absorptive screening, and personnel protection measures are widely used for personnel operating microwave equipment.

Czechoslovakia, 1965, above 300 MHz:

17. The following values are considered for the **general population** and other workers not employed in generation of electromagnetic energy as tolerable doses of radiation not to be exceeded at the person's location during one calendar day :

- for **continuous generation** in the microwave frequencies- value = 60 where the energy is expressed in microwatts per square centimeter and the time in hours [(microW/cm^2) X t (hours) < 60 ; therefore twenty-four hours exposure time corresponds to an average energy flow of 2.5 microW/cm^2].
- for **pulsed generation** in the microwave frequencies- value = 24 where the energy is expressed in microwatts per square centimeter and the time in hours [(microW/cm^2) X t(hours) < 24; therefore twenty- four hours exposure corresponds to an average pulsed energy flow of 1 microW/cm^2].

18. The final point that is worth noting is the authors' recommendation that "*in applying the concept of a time-weighted exposure the health specialist must consider how far the dose- time relationship can be extrapolated*."

Extrapolation of the dose-time relationship.

Both cell phones and WiFi routers use pulsed microwave radiation and it is well known that pulsed microwave radiation is more harmful than continuous wave radiation. If we apply the Czech time-weighted concept for pulsed radiation we get the following (see last four rows in table 1). These values begin to approach the Salzburg recommended guidelines for outdoor (0.1 microW/cm^2) and indoor (0.01 microW/cm^2) exposure.

Table 1. Comparison of time-weight exposure guidelines in selected countries.

Guideline	Exposure Time	Guideline (microW/cm^2)
UK, US ('57), Germany ('70)	24 h/day	10,000
France	military, working hours	10,000
France, Netherlands, Canada, US (current)	24 h/day	1,000
USSR	15 minutes	1,000
USSR	2 hours	100
USSR	24 hours	10
Czech (continuous)	1 hour	60
	6 hours	10
	24 hour	2.5
Czech (pulsed)	1 hour	24
	6 hours (school day)	4
	8 hours (work day)	3
	24 hours	1
Time-Weighted (pulsed)	week of school (30 h)	0.8
	month of school (120 h)	0.2
	1 year of school (1200 h)	0.02
	1 year constant exposure	0.003

Clearly guidelines that differ 4 orders of magnitude (from 10,000 to 1 microW/cm^2) need to be addressed.