OFFICIAL COPY

11 Oct. 2017

From: Oliver L. Canaday, 713 Camellia Ave, Panama City, FL. 32404
- (pertains to farm on 909 Parker Town Rd., Four Oaks, N.C.)

To: N.C. Utility Commission, Chairman Finley, 430 N. Salisbury St., Dobbs Building,
- Raleigh, N.C. 27603-5913

Christopher J. Ayers, Executive Director Public Staff, 4326 Mail Service Center,
- Raleigh, N.C. 27699-4300

Ref: (a) North Carolina General Stature 62-102. Application for Certificate, para(s)
- (a), (4), a., b., and c.

(b) Application of Duke Energy Progress (DEP), LLC for a Certificate of
- Environmental and Public Convenience and Necessity to Construct
- Transmission Line in Cleveland Area of Johnston County, North Carolina
- Docket No. E-2, Sub 1150 (179 pages)

(c) Duke Energy Progress, LLC verified Response to 25 Sept. 2017 Order
- Requiring Additional Information, Docket No. E-2, Sub 1150 of 9 Oct. 2017

Encl: (1) Electric Power Research Institute (EPRI) (member funded, most members
- are electric utilities)

(2) Physician asks N.C., Will you ignore EMF/RF health risk as you did with
- tobacco?, via Dr. Larry Burk MD; source - News & Observer

(3) Plant Responses to High Frequency Electromagnetic Fields, number – 2
- contributor – North Carolina State University, Dept. of Plant and Microbial
- Biology; by BioMed Research International (extract – 1 page)

(4) Developmental Instability as a Means of Assessing Stress in Plants: A Case
- Study Using Electromagnetic Fields and Soybeans , a contributor was Wayne
- State Univ., Detroit, MI., by The University of Chicago Press Journals, via
- International Journal of Plant Sciences (extract -1- page)

(5) Effects of magnetic field on the antioxidant enzyme activities of suspension-
- cultured tobacco cells, by journal – Bioelectromagnetics, via, Wiley-Liss, Inc.

(6) MAGNETISM AND PLANT GROWTH: ILL. EFFECT ON GERMINATION
- AND EARLY GROWTH OF CORN AND BEANS, by NRC Research Press,
- via Canadian Journal of Plant Science (extract -1- page)

(7) Evaluation of the Potential Carcinogenicity of Electromagnetic Fields, draft review, by U.S. EPA, (circulated for comment on tech-accuracy & policy implications) (**for public interest, eye opening information EPA/Fed-Govt /Congress has known about EMF health issues /people/livestock/plant issues since Oct. 1990; -27 years no-action) (extract -5-pages/-393 Page document). (Encourage N.C. Utility Commission read this EPA draft prior to approval of future transmission lines.) (pull up on line)

(8) MAGNETIC FIELDS BIOLOGICAL EFFECTS, source –Microwave News

Subj: Request Utility Commission Issue a Cease & Desist Order for Docket No. E-2, Sub1150 for Stated Reasons

1.- **Reason, -reference (b) does not comply with reference (a), paragraphs (a), (4), a., b., c.** -Case In Point, reference (a) states: "An applicant for the certificate described in G.S. 62-101 **shall file** an application with the Commission containing the following information:" – addressed below, information & reasons-.

a. Reference (a), paragraph (a), (4); -**requires an environmental report setting forth:** -by the applicant, Duke Energy. Duke Energy does not show an environmental report with Electric Magnetic Field (EMF) pollution in application Docket No. E-2, Sub 1150. The application section for environmental Impacts are 5.0, 5.1...5.5.; pages 59...68, no information addresses EMF pollution via preferred route 31. There will be EMF pollution on preferred route 31, as I have taken several readings of (mG)-10 about 50 meters from 230kV line; (same hook-up line for preferred route 31); crossing Parker Town Road about 500 meters east of I-95. Therefore reference (b) does not comply with N.C. General Statute G.S. 62-102; reason for request -Cease and Desist Order for Docket No. E-2, Sub 1150.

b. Reference a, paragraph (a), (4), a.; **-requires an environmental impact of the proposed action**; -by applicant Duke Energy. Duke Energy does not show an environmental impact of EMF pollution in application Docket No. E-2, Sub 1150. (The impact studies I have seen are usually a ream of paper/more). Therefore reference (b) does not comply with N.C. General Statute G.S. 62-102; reason for request -Cease and Desist Order for Docket No. E-2, Sub 1150.

c. Reference (a), paragraph (a), (4), b.; **-requires any proposed mitigating measures that may minimize the environmental impact;** -by applicant Duke Energy. Duke Energy does not show any proposed mitigating measures to minimize EMF environmental impact for the following:

1. Minimize EMF pollution on farm workers (health issues) working under the 230kV lines. (Working cropland is how business farmer & farm workers make their

living and pays their bills; -the lines mostly run length & middle of fields from I-95 north thru Old School Road; (section/community of main concern)).

2. Minimize EMF pollution on livestock health issues when grazing under 230kV lines.

3. Minimize EMF pollution on plant crops: tobacco, corn, soybeans, wheat, etc., EMF pollution effects production/yield per acre, example: bushel, pound, ton, etc.

d. Reference (a), (4); c. requires alternatives to the proposed action; by Duke Energy. Reference (b) does not show an alternative to proposed action, building a new 230kV transmission line Preferred Route 31. Therefore reference (b) does not comply with N.C. General Statute G.S. 62-102; reason for request –Cease and Desist Order for Docket No. E-2, Sub 1150.

2. Reason, reference (c). Q-4. -reply pertaining to EMF pollution is not an environmental report setting forth environmental impact of proposed action as stated in reference (a). These EMF brochures are not environmental impact studies. One is by Electric Power Research Institute (EPRI) -funded by members, (mostly electric utilities), see enclosure (1). The other brochures have Duke Logos by Duke Energy & are not EMF pollution environmental impact studies. Enclosures (2) thru (8) are attached for information pertaining to EMF pollution. **There is no environmental impact pertaining to EMF pollution in reference (c).** I believe reference (c) is Fraud via it being presented to Commissions as environmental impact for EMF pollution.

3.- Reason, reference (c), page 3/63 response/reply to notification of public meetings concerning potential paths of 230kV transmission line is Fraud. This Fraud information is in reference (b) and (c) to N.C. Utility Commission for decision making. This fraud has some identification now: -DEP Contractor Burns & McDonnell;- Duke Public Engagement Specialist, Drew Gilmore, & -Timothy J. Same – Manager, Site Design & Permitting for Duke Energy. I am a property owner, -first letter received from Duke Energy was via certified mail, signed for 17 May 2017; -my understanding of process of notification started in early Nov. 2016 and public meetings were 16 & 17 Nov. 2016; -my notification was mid-May 2017, on/about (o/a) 6 months after the fact. This is how I know this is Fraud: I inherited property from mother o/a July 2001, went thru process of deed transfer at county court house & Johnston County Tax Collector introduced me to property tax process, my mother owed 6-months tax & I owed 6-months tax. The Johnston County Tax Collector has mailed me property tax notices like clock-work each year since then; -this is how I know Fraud is in reference (b) & (c). **I believe Fraud information in reference (b) & (c) is justification to issue a Cease & Desist Order for Application E-2, Sub 1150.**

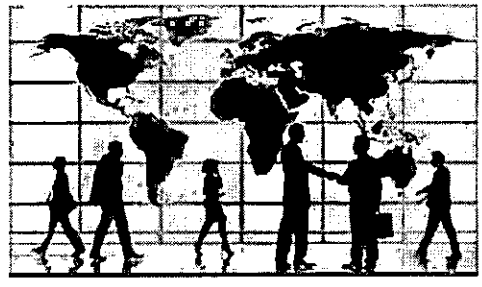
4. - Reason, reference (c), page 5/63; last paragraph addresses; "serving the area "directly from that 500kV line," DEP has never allowed a load connection to its 500kV bulk transmission system." -Examples given for doing a tap line off a 500kV line was Knightdale, N.C. (pop.14,794) & Fayetteville, N.C.(pop. 204,759) –There are tap lines off 500kV lines at these two locations, (not mentioned in reply). I do not know requirements for tapping a 500kV line; -I know it exist at Knightdale & Fayetteville, N.C. –I do not know "term connection" but (makes sense) coming off a 500kV line would require stepping it down to 230kV, to 115kV kV, ect until you can use service in homes & business. –I request the Commission **order Duke do a comprehensive study (as stated)** to shorten the 230kV transmission line from 11.5 miles/cost about $28 million. to o/a 4-miles for about cost $9.74 million; -(Cost is about $2.4 million per mile). I believe cost of new transmission line will show-up in billing statements; similar to increase proposed to clean-up coal-ash-pits. A shorter line will save consumers the difference in cost of long line about $18.26 million. **I believe Fraud information in reference (b) & (c) is justification to issue a Cease & Desist Order for Application E-2, Sub 1150.**

Sincerely,

Oliver L. Canaday

EPRI | ELECTRIC POWER RESEARCH INSTITUTE

Our Members



The worldwide membership that supports EPRI's work and mission comprises more than 1,000 organizations. While most members are electric utilities, many are firms, government agencies, corporations, or public or private entities engaged in some aspect of the generation, delivery or use of electricity.

Members work collaboratively in advisory councils that help inform the development of our annual research portfolio. These advisors are fundamental to identifying the critical and emerging electricity industry issues that our research will address.

Each year, our members, along with executives, innovators and thought leaders from the electricity sector, convene at EPRI's Summer Seminar to discuss industry challenges and opportunities. Over the years it has played a crucial role in shaping EPRI's research portfolio and the future of electricity worldwide.

Member Funding

Because members pool their resources to fund research, development and demonstration programs (RD&D), they can realize as much as $10 worth of RD&D for each dollar invested. This creates financial and intellectual momentum that cannot otherwise be achieved by a single company's effort.

Members choose from different funding options. "Base membership" offers access to all base programs in the annual research portfolio while "partial membership" allows members to select specific EPRI programs or projects for participation. In addition, non-member organizations may offer supplemental funding for projects or programs that are not offered in the annual portfolio but are tailored to a specific need. To address longer-term issues, we allocate a portion of membership funds to focus on longer-term research opportunities, and look for breakthrough technologies and innovations that can be applied in the electricity industry.

The Value of an EPRI Membership

EPRI members realize the value of their membership through successful applications of the more than 1,000 research products we produce in a single year. Whether it is a resourceful new method for repairing a crack in a turbine or the improvement of a treatment process for power plant wastewater, EPRI's work intends to help our members not only benefit the electricity industry, but the customers that they serve. Learn how EPRI's work has made meaningful differences in its applications throughout the industry.

Exelon.

Exelon
EPRI study analyzed the potential benefits and consequences of providing upstream passage for the American eel at hydroelectric facilities, providing Exelon with information to evaluate eel transport options in relicensing its Conowingo Hydroelectric Generating Station.

NewYorkPower Authority

New York Power Authority
NYPA teams with EPRI installing an Acoustic Doppler Current Profiler to measure the water flow in a channel of the Niagara River to potentially optimize operations at two Niagara Power Projects.

EXCL. (1)

Smart Meter Harm
Overbilling, fires, health problems, inaccuracy, hacking & cybersecurity, interference, privacy loss, and more....

Physician asks North Carolina, Will you ignore EMF/RF health risks as you did with tobacco?

Posted on August 5, 2016

From **News & Observer**

Comment on "Duke Energy proposes $150 opt-out fee to customers who don't want a smart meter ", August 3, 2016

By Dr. Larry Burk, MD

As a radiologist specializing in MRI, I have made my living for 30 years reading scans produced by the non-thermal effects of short-term exposure of the human body to RF and EMF. These dramatic pictures are generated from resonant interactions with the hydrogen protons at the cellular level below the thermal threshold. As a member of the National Safety Committee for MRI from 1987 to 1994, I began investigating potential health effects of these fields and determined that there is little evidence for hazard related to short-term exposures such as those experienced by patients in MRI.

However, I subsequently joined the Bioelectromagnetic Society and discovered there was an entire academic discipline devoted to studying the effects of long-term exposure to these fields which was largely unknown to most physicians and electrical engineers. These scientists, many of whom now participate in the IARC, found rigorous and repeatable evidence for non-thermal physiological effects and hazards including potential carcinogenicity. The initial data were limited to power lines and radar, but have now expanded exponentially to include cellphones, Wi-Fi, and smart meters.

The situation with smart meters reminds me of the early days of radiation safety when the short-term clinical use of X-rays for patients seemed to have no downside. It wasn't until the 1930s, 40 years after Roentgen's discovery, that radiologists started to report the long-term effects of chronic exposure. These early radiologists, feeling falsely reassured by the lack of apparent effects on patients, would focus the beam by putting their own hands in it. When enough radiologists lost fingers due to radiation damage and developed leukemia and other blood diseases, radiation protection policies were implemented.

I'm afraid we are in serious danger of making a similar mistake with regard to RF/EMF long-term exposure safety issues. This analogy is particularly pertinent now that actual DNA damage has been documented by Dr. Henry Lai in the Bioinitiative 2012 report. For that reason the systematic review below by Anke Huss et al. in 2007 showing that the studies funded by industry were far less likely to find evidence of hazard that those funded by public agencies or charities is particularly important.

North Carolina is no stranger to the concept of industry influence and bias with regard to research results, as the denial of tobacco health hazards is still a shameful legacy. It was made very clear that tobacco executives were quite aware of potential lethal risks due to their products and actively covered them up, and I think there is reason

ENCL. (2)

to believe that the same holds true for this industry. Let's make a more responsible choice here in our state this time and prevent Duke Energy from charging a fee to people who refuse smart meter installation or who wish to replace their smart meter with an analog meter.

Larry Burk, MD, CEHP
http://www.larryburkmd.com
<http://l.facebook.com/l.php?u=http%3A%2F%2Fwww.larryburkmd.com%2F&h=GAQE7pkhL>

President, Healing Imager, PC
Durham, NC

Anke Huss, et al., "Source of Funding and Results of Studies of Health Effects of Mobile Phone Use: Systematic Review of Experimental Studies," Environmental Health Perspectives 115 (2006): 1-4.http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1797826/

http://www.newsobserver.com/news/business/article93551722.html

Related

EU Appeal: Scientists and doctors call for moratorium on 5G, warn of serious health risks; RF-EMF proven harmful
In "4G"

Microwave frequency electromagnetic fields (EMFs) produce widespread neuropsychiatric effects including depression
In "causality"

Insurance exclusion and litigation risks: a coming storm for wireless?
In "AM Best"

This entry was posted in Uncategorized and tagged MRI, non-thermal, North Carolina, radiation, tobacco industry. Bookmark the permalink.

BioMed Research International
BioMed Research International

BioMed Research International
Volume 2016 (2016), Article ID 1830262, 13 pages
http://dx.doi.org/10.1155/2016/1830262

Review Article

Plant Responses to High Frequency Electromagnetic Fields

Alain Vian,[1] Eric Davies,[2] Michel Gendraud,[3] and Pierre Bonnet[4,5]

[1]Université d'Angers, Campus du Végétal, UMR 1345 IRHS, CS 60057, SFR 4207 QUASAV, 49071 Beaucouzé Cedex, France
[2]Department of Plant and Microbial Biology, North Carolina State University, P.O. Box 7612, Raleigh, NC 27695, USA
[3]Université Blaise Pascal, 24 avenue des Landais, 63177 Aubière Cedex, France
[4]Institut Pascal, Université Blaise Pascal, BP 10448, 63000 Clermont-Ferrand, France
[5]CNRS, UMR 6602, 63171 Aubière, France

Received 25 November 2015; Accepted 17 January 2016

Academic Editor: Yan-Bo Hu

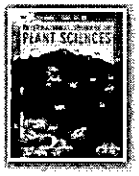
Abstract

High frequency nonionizing electromagnetic fields (HF-EMF) that are increasingly present in the environment constitute a genuine environmental stimulus able to evoke specific responses in plants that share many similarities with those observed after a stressful treatment. Plants constitute an outstanding model to study such interactions since their architecture (high surface area to volume ratio) optimizes their interaction with the environment. In the present review, after identifying the main exposure devices (transverse and gigahertz electromagnetic cells, wave guide, and mode stirred reverberating chamber) and general physics laws that govern EMF interactions with plants, we illustrate some of the observed responses after exposure to HF-EMF at the cellular, molecular, and whole plant scale. Indeed, numerous metabolic activities (reactive oxygen species metabolism, α- and β-amylase, Krebs cycle, pentose phosphate pathway, chlorophyll content, terpene emission, etc.) are modified, gene expression altered (calmodulin, calcium-dependent protein kinase, and proteinase inhibitor), and growth reduced (stem elongation and dry weight) after low power (i.e., nonthermal) HF-EMF exposure. These changes occur not only in the tissues directly exposed but also systemically in distant tissues. While the long-term impact of these metabolic changes remains largely unknown, we propose to consider nonionizing HF-EMF radiation as a noninjurious, genuine environmental factor that readily evokes changes in plant metabolism.

1. Introduction

High frequency electromagnetic fields (HF-EMF, i.e., frequencies from 300 MHz to 3 GHz, wavelengths from 1 m to 10 cm) are mainly human-produced, nonionizing electromagnetic radiations that do not naturally occur in the environment, excluding the low amplitude VHF (very high frequency) cosmic radiation. HF-EMF are increasingly present in the environment [1] because of the active development of wireless technology, including cell phones, Wi-Fi, and various kinds of connected devices. Since living material is not a perfect dielectric, it readily interferes with HF-EMF in a way that depends upon several parameters, including (but not restricted to) its general shape, the conductivity and density of the tissue, and the frequency and amplitude of the EMF. The interaction between the living material and the electromagnetic radiation may (or not) induce an elevation of the tissue temperature, thus defining the thermal (versus nonthermal) associated metabolic responses. In the case of a thermal response, the resulting heat dissipation is normalized with the specific absorption rate (SAR) index. This has led to considerable research efforts to study the possible biological effects due to exposure to HF-EMF. While the vast majority of these studies have focused on animals and humans because of health concerns, with contradictory or nonconclusive results [2], numerous experiments have also been performed on plants. Plants are outstanding models compared to animals to conduct such investigations: they are immobile and therefore keep a constant orientation in the EMF and their specific scheme of development (high surface area to volume ratio) makes them ideally suited to efficiently intercept EMF [3]. It is also quite easy in plants to achieve genetically stable plant lines through the selection of species that favor asexual reproduction [4] or self-pollination [5]. Furthermore, metabolic mutants are easily available for several species and constitute invaluable tools to understand the way the EMF signal

Encl (3)



International Journal of Plant Sciences

Volume 160, Number S6 | November 1999 (Volume Supplement)

Developmental Instability as a Means of Assessing Stress in Plants: A Case Study Using Electromagnetic Fields and Soybeans

D. Carl Freeman,[1,]* John H. Graham,† Mary Tracy,* John M. Emlen,‡ and C. L. Alados§

*Wayne State University, Department of Biological Sciences, Detroit, Michigan 48202, U.S.A.; †Berry College, Department of Biology, Mount Berry, Georgia 30149, U.S.A.; ‡Northwest Biological Science Center, 6505 NE 65th Street, Seattle, Washington 98115, U.S.A.; and §Instituto Pirenaico de Ecologia, Avda. Montanna 177, Aptdo. 202, 50080 Zaragoza, Spain

RECEIVED: Mar 1999 **REVISED:** July 1999

Abstract

Developmental instability is often assessed using deviations from perfect bilateral symmetry. Here, we review the literature describing previous studies, suggest mechanisms that may account for both the generation and disruption of bilateral symmetry, and examine the influence of electromagnetic fields on the asymmetry of soybean leaves. Leaves from plants under high-voltage power lines generating pulsed magnetic fields of <3 to >50 mG were more asymmetrical for two parameters (the terminal leaflet widths and lateral rachilla lengths) than leaves of plants even 50 or 100 m away from power lines. This asymmetry could not be attributed to either size scaling or measurement error.

Keywords: developmental instability, fluctuating asymmetry, soybean, electromagnetic fields.

ENCL. (4)

Bioelectromagnetics *Explore this journal >*

Go To

View issue TOC
Volume 28, Issue 1
January 2007
Pages 42–47

Research Article

Effects of magnetic field on the antioxidant enzyme activities of suspension-cultured tobacco cells

Hassan Sahebjamei, Parviz Abdolmaleki, Faezeh Ghanati

First published:
20 September 2006 Full publication history

DOI:
10.1002/bem.20262 View/save citation

Cited by (CrossRef):
41 articles Check for updates | Citation tools

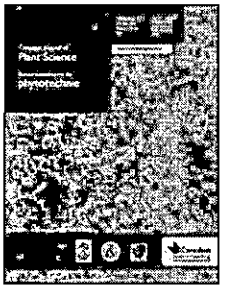
Abstract

Effects of magnetic fields (MFs) on the activities of antioxidant enzymes of suspension-cultured tobacco cells were investigated. Compared with the control cells, exposure of the cells to static MF with the magnitudes of 10 and 30 mT for 5 days, 5 h each day, increased the activity of superoxide dismutase (SOD). In contrast, the activity of the catalase (CAT) and ascorbate peroxidase (APX) was decreased by MF, compared with those of the control cells. Level of lipid peroxidation was also increased by MF. It suggests that MF could deteriorate antioxidant defense system of plant cells. Bioelectromagnetics. © 2006 Wiley-Liss, Inc.

REFERENCES

Related content

ENCL (5)



Browse the journal
List of issues
e-First articles
Just-IN articles
Current issue
Special issues
Most read articles
Most cited articles
Sample issue
Author index

For authors
About the journal
Open Access
Benefits and services
Instructions to authors
Submit a manuscript
Permission forms
Reprints & permissions to reuse content

Article

« Previous TOC Next »

MAGNETISM AND PLANT GROWTH: III. EFFECT ON GERMINATION AND EARLY GROWTH OF CORN AND BEANS

U. J. Pittman

PDF (447 K)
PDF-Plus (493 K)
Citing articles

Canadian Journal of Plant Science, 1965, 45(6): 549-555, https://doi.org/10.4141/cjps65-106

ABSTRACT

Speed of germination and seedling growth of corn *Zea mays* L. and beans *Phaseolus vulgaris* L. were affected by pregermination exposure of the dry seed to an introduced magnetic field. Seed orientation and duration of pregermination exposure as well as temperature and seed orientation during germination affected total visible seedling growth. An endogenous, non-circadian growth response is indicated.

Cited by

View all 17 citing articles

BIOMAGNETIC RESPONSES IN KHARKOV 22 M.C. WINTER WHEAT

U. J. Pittman

Canadian Journal of Plant Science, 1967, 47(4): 389-393, https://doi.org/10.4141/cjps67-070 » Abstract

PDF (392 K) PDF Plus (229 K)

ENCL. (6)

United States
Environmental Protection
Agency

Office of Research and
Development
Washington, DC 20460

EPA/600/6-90/005B
October 1990
External Review Draft

EPA

Evaluation of the Potential Carcinogenicity of Electromagnetic Fields

Review Draft

(Do Not
Cite or Quote)

Notice

This document is a preliminary draft. It has not been formally released by EPA and should not at this stage be construed to represent Agency policy. It is being circulated for comment on its technical accuracy and policy implications.

-ON LINE; EPA/600/6-90/005B
several come up, click on topic: Evaluation of the Potential Carcinogenicity

P. 1 / 393

P. 1/5

ENCL. (7)

P. 376/393

Ontario Hydroelectric Power Company

ELF exposure

CONTENTS

In conclusion, several studies showing leukemia, lymphoma, and cancer of the nervous system in children exposed to magnetic fields from residential 60-Hz electrical power distribution systems, supported by similar findings in adults in several occupational studies also involving electrical power frequency exposures, show a consistent pattern of response which suggests a causal link. Frequency components higher than 60 Hz cannot be ruled out as contributing factors. Evidence from a large number of biological test systems shows that ELF electric and magnetic fields induce biological effects that are consistent with several possible mechanisms of carcinogenesis. However, none of these processes has been experimentally linked to the induction of tumors, either in animals or in humans by EM-field exposure. The particular aspects of exposure to the ELF fields that cause these events are not known.

In evaluating the potential for carcinogenicity of chemical agents, the U.S. EPA has developed an approach that attempts to integrate all of the available information into a summary classification of the weight of evidence that the agent is carcinogenic in humans. At this time, such a characterization regarding the link between cancer and exposure to EM fields is not appropriate because the basic nature of the interaction between EM fields and biological processes leading to cancer is not understood. For example, if induced electrical currents were the causative factor, then exposure to electric as well as magnetic fields would be important and the effect would be more severe as the frequency increases. But if the direct magnetic field interaction were the critical factor, then the ambient static magnetic field, as well as the alternating magnetic field, would be critical, and the effect may be confined to specific frequencies, resulting in an extremely complicated dose-response relationship. In addition, if they were shown to be causative agents, these fields probably exert their effects via other chemical and environmental factors rather than directly causing events known to be causally related to carcinogenic processes, as with genotoxic chemical agents.

Because of these uncertainties, it would be inappropriate at this time to classify the carcinogenicity of EM fields in the same way as the Agency does for chemical carcinogens. As additional studies with more definitive exposure assessment become completed, a better understanding of the nature of the hazard will be gained. With our current understanding, we can identify 60-Hz magnetic fields from power lines and perhaps other sources in the home as a possible, but not proven, cause of cancer in humans. The absence of key information summarized above makes it difficult to make quantitative estimates of risk. Such quantitative estimates are necessary before judgments about the degree of safety or hazard of a given exposure can be made. This situation indicates the need to continue to evaluate the

In summary, EM fields clearly interact with genetic material, as detected by chromosomal aberrations. Effects on transcription (gene induction) have also been reported (see Section 5.3.1). However, no obvious relationship between exposure parameters and effect is apparent, and it is premature to conclude from the genetic evidence available that EM fields are or are not likely to be carcinogenic.

5.2. EFFECTS ON MITOSIS AND MEIOSIS

Many of the publications considered in this section report an effect of EM fields, particularly the magnetic component, on cell cycle progression and/or mitotic index. Although these end points are not genetic end points in the sense that gene mutations, DNA damage, and chromosomal aberrations are, they clearly demonstrate that EM fields affect DNA function.

5.2.1. Extremely Low Frequency Electromagnetic Fields

Plants have been commonly used in studies on the biological effect of ELF fields because the root meristem provides an easy to work with population of actively growing cells. Robertson et al. (1981) studied long-term exposure of pea roots in an aqueous inorganic nutrient medium [conductivity about 0.08 siemens/meter (S/m)] to 60-Hz electric fields of 140 or 430 V/m and examined growth rate and mitotic index in the root tip cells. Mitotic index in this paper was defined as the number of cells in mitosis per 1,000 nuclei. No significant effects were found at 140 V/m; however, at 430 V/m both growth rate and mitotic index were reduced. The peak reduction in mitotic index, about 55% of control, occurred at 4 hours of exposure with gradual recovery at 6 and 8 hours of exposure. Reduction of growth rate was immediate and constant after exposure started and was about 40% at 2 days of exposure to 430 V/m. Growth rate had almost returned to normal 5 days after exposure stopped. It is likely that the changes observed in this study and in the following two studies are due to membrane effects. The induced membrane potentials reported in these studies of 3 to 7 mV in a 300-V/m field (which is considered the threshold for growth effects) and 6 to 12 mV in a 490-V/m field "represent a significant fraction of the normal resting potential of most cells."

Another report from the same laboratory (Brulfert et al., 1985) examined pea root growth and mitotic index as described previously as well as cell cycle duration. Exposure in an aqueous inorganic nutrient medium (conductivity about 0.08 S/m) for 48 hours to 60-Hz electric fields of 430 V/m produced a reduction in root growth to 44% that of control roots,

In conclusion, several studies showing leukemia, lymphoma, and cancer of the nervous system in children exposed to magnetic fields from residential 60-Hz electrical power distribution systems, supported by similar findings in adults in several occupational studies also involving electrical power frequency exposures, show a consistent pattern of response that suggests a causal link. Frequency components higher than 60 Hz cannot be ruled out as contributing factors. Evidence from a large number of biological test systems shows that these fields induce biological effects that are consistent with several possible mechanisms of carcinogenesis. However, none of these processes has been experimentally linked to the induction of tumors, either in animals or humans, by EM fields. The particular aspects of exposure to the EM fields that cause these events are not known.

In evaluating the potential for carcinogenicity of chemical agents, the U.S. Environmental Protection Agency has developed an approach that attempts to integrate all of the available information into a summary classification of the overall weight of evidence that the agent is carcinogenic in humans. At this time such a characterization regarding the link between cancer and exposure to EM fields is not appropriate because the basic nature of the interaction between EM fields and biological processes leading to cancer is not understood. For example, if induced electrical currents were the causative factor, then exposure to electric as well as magnetic fields would be important and the effect would be more severe as the frequency increases. But if the direct magnetic field interaction were the critical factor, then the ambient static magnetic field as well as the alternating magnetic field would be critical and the effect may be confined to specific frequencies, resulting in an extremely complicated dose-response relationship. In addition, if they were shown to be causative agents, these fields probably exert their effects via other chemical and environmental factors rather than directly causing events known to be causally related to the carcinogenic process, having the direct property of causing cancer, as with genotoxic chemical agents.

Because of these uncertainties, it would be inappropriate to classify the carcinogenicity of EM fields in the same way as the agency does for chemical carcinogens. As additional studies with more definitive exposure assessment become completed, a better understanding of the nature of the hazard will be gained. With our current understanding we can identify 60 Hz magnetic fields from power lines and perhaps other sources in the home as a possible, but not proven, cause of cancer In people. The absence of key information summarized above makes it difficult to make quantitative estimates of risk. Such quantitative estimates are necessary before judgments about the degree of safety or hazard of a given exposure can be made. This situation indicates the need to continue to evaluate the information from ongoing studies

Create Your Healthy Home

MAGNETIC FIELDS BIOLOGICAL EFFECTS

The source of material for this review of Magnetic Fields Biological Effects is *Microwave News*, with past issues available free on-line, www.microwavenews.com. Sign up for their occasional notification of new research results, mainly now on cell phones and WIFI.

- This literature review addresses just AC magnetic fields, which started out as power line issues. AC magnetic fields are also associated with motors, transformers, heat coils, wiring errors, grounding issues, and proximity to other sources of electrical current flow.
- AC magnetic fields emanate from sources in concentric circles and pass through just about anything in their path. They are measured with a gaussmeter (available on-line and from www.lessemf.com). Because AC magnetic fields from neighborhood distribution lines (power lines) cannot be shielded, measuring a prospective home with a gaussmeter prior to signing a contract is strongly advised. The most conservative scientists look for levels of 1 mG or lower for prolonged exposure. PPlease see the tab on using a gaussmeter to screen a potential home.

A Review of Selected Studies on Magnetic Fields Biological Effects, compiled in 1999

In 1998, a National Institute on Environmental Health and Safety (NIEHS) panel classified electromagnetic fields (EMFs) as a "possible" human carcinogen in the same class as chloroform, lead, carbon tetrachloride, and DDT.

ALZHEIMER'S DISEASE

- 1996 Drs. Eugene Sobel and Zoreh Davanipour of the University of Southern California School of Medicine, Los Angeles. Medium-to-high occupational exposures result in a four-fold increase in the rate of Alzheimer's.
- 1996 Dr. Maria Feychting of the Karolinska Institute, Stockholm, Sweden. Five-times increased rate of Alzheimer's is reported with occupational exposures.
- 1996 An occupational study by the National Institute of Occupational Health and Safety and Johns Hopkins University finds higher death rates from Alzheimer's with medium-to high occupational exposures (2 mG and higher).

BREAST CANCER

ENCL (8)

- 1987 Dr. Richard Stevens, Battelle Pacific Northwest Labs, Richland, WA. EMFs reduce levels of the cancer-fighting hormone, melatonin. Lower levels are associated with breast cancer.
- 1989-1992 Epidemiological studies show an increase in male breast cancer among exposed workers, especially for those under 30 years of age. Drs. Genevieve Matanoski of Johns Hopkins University, Baltimore, MD, Paul Demers of the Fred Hutchinson Cancer Research Center, Seattle, WA, and Tore Tynes and Aage Andersen of the Cancer Registry of Norway, Oslo.
- 1992 Dr. Sabine John of the Technical University of Munich, Germany. EMFs increase the rate of breast cancer mitochondrial activity.
- 1992 Dr. Robert Liburdy of the Lawrence Berkeley Laboratory, Berkeley, CA. Low levels of EMFs decrease the amount of melatonin.
- 1993 Dr. Wolfgang Loscher of the School of Veterinary Medicine, Hannover, Germany. EMFs increase the number of mammary tumors in laboratory animals in a dose-response relationship.
- 1993 Drs. Dana Loomis and David Savitz of the University of North Carolina, Chapel Hill. Female electrical workers have twice the expected number of deaths from breast cancer.
- 1996 – 1998 The Stevens and Liburdy melatonin studies are replicated. For the first time, a mechanism is demonstrated linking EMFs and cancer, i.e., that EMFs reduce the amount of the cancer-fighting hormone, melatonin. Dr. Carl Blackman of the Environmental Protection Agency, Dr. Richard Luben of the University of California, Riverside, CA, Dr. Larry Anderson of Battelle Pacific Northwest Laboratory, Richland, WA, and Drs. Scott Davis of Fred Hutchinson Cancer Research Center, Seattle, WA and Dr. Richard Stevens of the Battelle Pacific Northwest Labs in Richland, WA.
- 1996 Dr. Patricia Coogan of Boston University School of Public Health, Boston, MA. Another occupational study links female breast cancer and EMFs.
- 1997 Dr. Maria Feychting of Karolinska Institute, Stockholm, Sweden. Women who are under 50 exposed to EMFs above 2 mG have 80% increased incidence of breast cancer. When limited to estrogen-receptor-positive women, the incidence is 7.4 times the risk of breast cancer above 1 mG.

CANCER, ADULT – OTHER THAN BREAST CANCER

- 1989 Drs. Genevieve Matanoski, Patrick Breysse, and Elizabeth Elliott, Johns Hopkins University, Baltimore, MD. An occupational study shows increased rates of prostate, colon and lung cancers, leukemia and lymphoma.
- 1992 Dr. Birgitta Floderus of the National Institute of Occupational Health, Solna, Sweden. Men exposed to 3 mG at work have three times the expected rate of chronic lymphocytic leukemia.
- 1992 Dr. Richard Lovely of the Battelle Pacific Northwest Lab, Richland, WA. Men using electric razors have twice the rate of leukemia.
- 1994 Dr. Gilles Theriault of McGill University, Montreal. Hydro-Quebec workers exposed to magnetic fields have more brain tumors and leukemia. A second study shows that workers exposed to transients (intense pulses of high frequency radiation) have ten times the incidence of lung cancer compared to 1.6 increase for those exposed to magnetic fields alone.

- 1995 Drs. David Savitz and Dana Loomis of the University of North Carolina, Chapel Hill. Utility workers with the highest EMF exposures have more than twice the expected rate of brain cancer than the least exposed workers.
- 1995 Dr. Birgitta Floderus of the National Institute for Working Life, Solna, Sweden. Individuals exposed to EMFs on the job are found to have a small, but significant, elevation in risk for many types of cancer.
- 1995 Dr. Nancy Wertheimer, Dr. David Savitz of the University of North Carolina, Chapel Hill, and Ed Leeper find quadrupled rates of leukemia in houses where ground currents at the plumbing are present.
- 1997 Drs. Carin Stenlund and Birgitta Floderus, Karolinska Institute, Stockholm, Sweden. Rates of testicular cancer are doubled for the 25% of male workers with the highest EMF exposures
- 1997 Drs. Ching-Yi Li of Fu-Jen Catholic University in Taipei, Taiwan, Gilles Theriault of McGill University in Montreal, Canada, and Ruey Lin of National Taiwan University in Taipei. A 40% greater risk of leukemia and a 70% higher risk of ALL (acute lymphocytic leukemia) are found when the exposure is 2 mG or greater. A dose-response relationship is noted.
- 1996 Dr. Anthony Miller of the University of Toronto, Canada The leukemia risk is 11 times as high for workers exposed to both electric and magnetic fields compared to 1.6 times for workers exposed to magnetic fields alone.

CELLULAR STUDIES

- Dr. Ross Adey, formerly of the Veterans Administration Hospital, Loma Linda, CA. EMFs disrupt communication between healthy adjacent cells, with potential implication for Alzheimer's. Similar findings were reported by Drs. Carl Blackman of the Environmental Protection Agency, Robert Liburdy of Lawrence Berkeley Laboratory, Berkeley, CA, Ewa Lindstrom of the University of Umea, Sweden and the National Institute of Occupational Health in Umea, Sweden.
- 1987 Drs. Craig Byus of the University of California, Riverside, and Ross Adey, formerly of the Veterans Administration Hospital, Loma Linda, CA. Weak EMFs increase the action of an enzyme linked to cell growth in tumors.
- 1995 Drs. Reba Goodman of Columbia University and Ann Henderson of Hunter College, New York City. Magnetic fields induce changes in gene expression.
- 1998 Dr. Faith Uckun of Wayne Hughes Institute, St. Paul, MN. EMFs alter the activity of protein kinases, enzymes involved in both normal cell function and cancer promotion.
- 1997-1998 Four laboratories report increased DNA breaks from power frequency EMFs, with implications for cancer. The hypothesis is that EMF-induced free radicals may lead to an increase in DNA breaks or to a disruption of an enzyme repair mechanism. Drs. Henry Lai and Narendra Singh of the University of Washington, Seattle, Jerry Phillips of the Veterans Administration Medical Center, Loma Linda, CA, Yog Raj Ahuga of Mahavir Medical Research Center, Hyderabad, India and Britt-Marie Svendenstal of Swedish University of Agricultural Sciences, Uppsala, Sweden.

CHEMICAL CARCINOGENS PROMOTED BY AC MAGNETIC FIELDS

- 1991 Dr. Chris Cain of the Veterans Administration Hospital, Loma Linda, CA. EMFs act with a known chemical carcinogen to promote tumor development.
- 1992 The incidence of breast tumors increases from both static and AC magnetic fields interacting with a known chemical carcinogen in Russian animal studies.
- 1995 Dr. Craig Byus of the University of California, Riverside. Laboratory animals treated with a chemical carcinogen develop more tumors in the presence of elevated EMFs.

CHILDHOOD CANCER STUDIES

- 1979 Dr. Nancy Wertheimer and Ed Leeper. For the first time, an increase in childhood cancer is linked with power line EMFs. This study is replicated in 1986 by Dr. David Savitz of the University of North Carolina, Chapel Hill.
- 1990 The Environmental Protection Agency drafts a report concluding that EMFs are a possible potential carcinogen.
- 1991 Drs. Stephanie London and John Peters of the University of Southern California, Los Angeles. An increased risk of childhood leukemia is found with use of electric hair dryers.
- 1992 Drs. Anders Ahlbom and Maria Feychting of the Karolinska Institute in Stockholm, Sweden. Children exposed to 3 mG magnetic fields in their homes have three times the expected rate of leukemia.
- 1994 Dr. Allen Kraut of the University of Manitoba, Winnipeg. A direct correlation is found in an epidemiology study comparing electricity usage in the provinces with the rates of childhood leukemia and brain cancers.
- 1996 Combined studies by Drs. Anders Ahlbom and Maria Feychting of the Karolinska Institute, Stockholm and Dr. Jorgen Olsen of the Danish Cancer Society, Copenhagen, show two times the rate of leukemia at exposures of 2 mG or more and five times the rate for exposures of 5 mG or higher.
- 1996 Dr. Daniel Wartenberg for the National Academy of Sciences finds consistency in eleven childhood cancer studies showing elevated risk of cancer for children living near power lines.
- 1997 Drs. Tore Tynes and Tor Haldorsen of the Institute of Epidemiological Cancer Research at the Cancer Registry of Norway, Oslo. Children exposed to magnetic fields 0.5 mG or higher for three or more years during the first four years of life have an increased risk of leukemia.
- 1997 The National Cancer Institute childhood leukemia study finds a 72% increased risk of leukemia for children exposed to 3 mG or higher.
- 1997 Drs. Jorg Michaelis and Joanchim Schuz of the University of Mainz, Germany. Children living in magnetic fields above 2 mG have twice the risk of leukemia. Children under 4 years old have a seven times increased risk.
- 1998 Dr. Chung-Yi Li of the College of Medicine at the Pu-Jen Catholic University, Taipei, and Drs. Wei-Chin Lee and Ruey Shiung Lin of National Taiwan University, Taipei. A 2.7 times risk of childhood leukemia is found near power lines in fields 2 mG or higher.

- 1998 The National Cancer Institute studies appliance use by children and finds increased childhood leukemia rates with all 25 appliances. Appliances include video games, curling irons, microwave ovens, sound systems with headsets, electric blankets, hair dryers and TVs (sitting closer than 6 feet), There was no increased risk for use of stereos without headphones.

HEART EFFECTS

- 1998 Dr. Antonio Sastre, Midwest Research Institute (MRI), Kansas City, MO. EMFs reduce the extent of heart-rate variability (HRV) and are linked to increased risk of death from arrhythmia and heart attacks among utility workers.
- 1999 Dr. David Savitz publishes "Magnetic Field Exposure and Cardiovascular Disease Mortality Among Electric Utility Workers," in the American Journal of Epidemiology, 149, pp.135-142, January 15, 1999.

LOU GEHRIG'S DISEASE (ALS – amyotrophic lateral sclerosis)

- 1997 Drs. Zoreh Davanipour and Eugene Sobel of the University of Southern California School of Medicine, Los Angeles. The most exposed workers have seven times the risk for ALS as those least exposed.
- 1997 Dr. David Savitz of the University of North Carolina, Chapel Hill. An occupational study finds two to three times the risk for ALS.
- 1998 Drs. Christoffer Johansen and Jorgen Olsen of the Danish Cancer Society. A Danish study finds two times the rate of ALS among utility workers.

NERVOUS AND IMMUNE SYSTEM ILLS

- 1998 Dr. Laurence Bonhomme-Faivre of Paul Brousse Hospital, Paris. EMF occupational exposure is linked to fatigue, depression, irritability, and diminished libido, as well as a significant reduction in white blood cells.
- 1998 Short-term memory effects are seen with power frequency exposure. A.W. Preece, K.A. Wesnes and G.R. Iwi. "The Effect of a 50 Hz Magnetic Field on Cognitive Function in Humans," International Journal of Radiation Biology, 74, pp.463-470, 1998.
- 1999 Dr. Ross Adey is to receive the 1999 Hans Selye Award from the American Institute of Stress for his work on biological effects of weak EMFs.

PREGNANCY-RELATED PROBLEMS

- 1988 Epidemiologists at Kaiser Permanente, Oakland, CA. Women using VDTs for twenty or more hours weekly during the early months of during pregnancy have more than double the rate of miscarriage.

- 1990 Dr. David Savitz of the University of North Carolina, Chapel Hill. Prenatal exposures to electric blankets results in higher risk for leukemia, brain tumors and other cancers.
- 1992 Dr. Maila Hietanen of the Institute of Occupational Health, Helsinki, Finland. Women exposed to 3 mG magnetic fields from VDTs have close to three and a half times the expected rate of miscarriage.
- 1992 Dr. Jukka Juutilainen, University of Kuopio, Finland. Women in residences where magnetic fields at the front door are 6.3 mG or greater have a five fold increase in the rate of miscarriage.
- 1995 Dr. Claire Infante-Rivard, McGill University, Montreal, Canada. Children whose mothers used sewing machines during pregnancy have up to a sevenfold increase in rates of leukemia.
- 1995 Dr. De-Kun Li of Kaiser Permanente, Oakland, CA, and Drs. Harvey Checkoway and Beth Mueller of the University of Washington, Seattle. Electric blanket usage is associated in low-fertility women with four times the rate of congenital urinary tract anomalies in their newborns.
- 1995 Dr. Jean Harry of the National Institute of Environmental Health Sciences. In neonates, EMFs are associated with an increase in gene expression and subtle changes in the neural network of the brain.
- 1998 Dr. Kathleen Belanger of Yale University, New Haven, CT. A 5-year study shows twice the miscarriage rate for women using electric blankets.
- 1998 Dr. Jukka Juutilainen of the University of Kuopio, Finland. This study designed to detect early fetal loss shows five times the miscarriage rate for women using electric blankets.
- 1998 The National Cancer Institute's childhood leukemia study shows elevated rates of leukemia in children whose mothers use electric blankets, heating pads, or humidifiers during pregnancy.

SELECTED QUOTATIONS:

"The only thing that stands in the way of general acceptance [of EMF cancer connection] is for someone to demonstrate a plausible biological mechanism, because everything else is there. And this is not a requirement for the standard methods of epidemiology. In fact, we still don't have a biological mechanism for asbestos." Dr. David Ozonoff, Chair of the Department of Environmental Health at Boston University's School of Public Health. Microwave News, Vol. XVI No. 1, January/February 1996, p.5.

Dr. Russel Reiter of the University of Texas, San Antonio. *"The wide variety of tumors represented [in the Floderus data] suggests the mechanism is a basic one – for example, involving free radicals and melatonin."* Microwave News, Vol. XV No. 5, September/October 1995, p.8.

Dr. Gilles Theriault, McGill University: *"We keep seeing smoke, but we have not identified the fire. And there is a fire out there. One day we will put our finger on it."* Microwave News Vol. XV No. 1, January/February 1995, p.8.

"The significance of the epidemiological studies is not that they point to a cancer epidemic. But they raise the question: If EMFs can cause even a small change in cancer rates, what other biological effects could they have?"

Commentary, Microwave News, Vol. XV No. 4, July/August 1995, p. 9.

Michael Herz of Pacific Gas & Electric, San Francisco, CA: "*It's incredibly important to follow up and to answer the questions [relating to EMFs and heart rhythms] that have been raised.*" Microwave News, Vol. XVIII No. 5, September/October 1998, p.4.

Dr. Imre Gyuk of the Department of Energy in Washington: "*It's getting harder and harder for skeptics to deny low-level effects.*" Microwave News, Vol. XVIII No. 4, July/August 1998, p.3.

"*...we need to look at the combined risk of EMFs with both chemicals and ionizing radiation,*" Dr. Genevieve Matanoski, Johns Hopkins University, Baltimore, MD. Microwave News, Vol. XII No. 4, July/August 1992, p. 8.

→ "*The NAS-NRC report may mislead the public into a false sense of security – for a while. But the real link*
→ *between power lines and cancer must still be addressed, as must the evidence that points to EMFs.*"
Commentary, Microwave News, Vol. XVI No. 6, November/December 1996, p.8.

→ The National Institute of Environmental Health Sciences panel finds that EMFs are "possible" human
→ carcinogens. "*Now the public will know what the members of the EMF research community have known for years,*" said Dr. Michael Marron of the Office of Naval Research in Arlington, VA. Microwave News, Vol. XVIII No. 4, July/August 1998, p.5.

Dr. Nancy Wertheimer: "*The most important aspect of our paper was that in looking at ground currents, we identified a type of EMF measurement that is significantly associated with the incidence of both childhood and adult cancer.*" Microwave News, Vol. XV No. 5, September/October 1995, p. 2.

→ Dr. Robert McGaughy of the Environmental Protection Agency: "*If this were a chemical and we had some*
→ *mechanistic data, there is no doubt that we would have classified EMFs as a B1 carcinogen – a probable human carcinogen.*" Microwave News, Vol. XVIII No. 5, September/October 1998, p.2.

→ In a draft under review, the National Council on Radiation Protection reviewed the scientific literature
→ and concluded that 2 mG would be a prudent limit not to be exceeded for prolonged exposure.
Microwave News, Vol. XV No. 4, July/August 1995, p.12.

→ Dr. David Carpenter, dean of the School of Public Health at the NYS Department of Health in Albany, said in a talk to the New York City Bar Association on March 14th: "'*In my judgment, we are 90-95% certain that there is a link between EMFs and cancer....' Setting standards can be a contentious process, but the*
→ *'logical number is 1 mG.'*" Microwave News, Vol. XIV No. 2, March/April 1994, p.2.1995
Dr. Indira Nair of Carnegie Mellon University, Pittsburgh, PA: "*Inaction is not an option.*" She "*would err on*

the side of caution :..because chil[illegible] are implicated." Microwave News, XVIII No. 5, September/October 1998, p.2.

Shirley Linde of the National EMF Advisory Committee: "*It is reprehensible that research is stopping in the U.S. at a time when the NIEHS panel has pointed to a possible cancer risk.* " "How can we walk away when children are at risk?" Microwave News, Vol. XVIII No. 5, September/October 1998, p.3.

Barbara Balaban, West Islip Breast Cancer Coalition: "*If EMFs may present a risk, then what is the harm in educating people about those measures they can take to avoid unnecessary exposure?*" Microwave News, Vol. XVIII No. 5, September/October 1998, p.2.

Now that you have reviewed Magnetic Fields Biological Effects, take a minute to sign up for the periodic news bulletins at www.microwavenews.com.

Click to return to HOME.