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N.C. Utilities Commission

From: Oliver L. Canaday, 713 Camellia Ave, Panama City, FL. 32404

- (-pertains to my small farm located 909 Parker Town Road, Four Oaks, N.C.)

To: Attorney General Josh Stein, Department of Justice, 9001 Mail Service Center,

- Raleigh, N.C. 27699-9001

→ Chief Clerk, N.C. Utility Commission, 4325 Mail Center, Raleigh, N.C. 27699

Ref: (a) Docket No. E-2, Sub 1150 (Application) (179 pages)

- (b) BioInitiative 2012, (<http://www.bioinitiative.org/>) ("Human beings are bioelectrical systems. Our hearts and brains are regulated by internal bioelectrical signals.") -

- (c) Routing Study and Environmental Report, prepared for Duke Energy, Cleveland-Matthews Road 230kV Transmission Tap Line Project, Raleigh, N.C., Project No. 92394 of 06/2/2017, prepared by Burns & McDonnell Engineering Company, Inc. Kansas City, Missouri; (Docket No. E-2, Sub 1150, pages 10-153 of 179)

- (d) Direct Testimony of Timothy J. Same for Duke Energy Progress, LLC; (Docket No. E-2, Sub 1150, pages 154-174 of 179)

- (e) Appendix B – Agency Correspondence, (Docket No. E-2, Sub 1150 via e-mails, pages 85-97 of 179) (N.C. DEQ does not address EMF pollution)

- (f) Power Lines and People Concern at- www.electricsense.com/4637/emfs-from-power-lines-the-facts

- (g) 30 Jun/ 5 Jul 2017, Using Gauss Master Meter No. X000918K5N, I took EMF readings on Parker Town Road about (o/a) 50 meters from 230kV Line crossing; at 1710 hrs/1455 hrs, both reading -mill gauss (mG) 10. (ROW to be 125' -half each side is 62.5', 50 meters is o/a 165', ROW is not EMF safe)

- (h) 30 Jun 2017, Using Radiation Meter: Model CDV-717 No.1, SerNo.44472, I took radiation readings at hours: 1015, 1200, 1440, 1530, 1710; each reading .2r/hr. -On 5 Jul 2017, I took a reading at 1500 hrs, -was .2r/hr; see enclosure (4) for dose limits via U.S Nuclear Regulatory Commission (NRC). (I believe same readings can be duplicated in Raleigh area o/a 50 meters from any 230kV line with mG reading or r readings.)

- (i) Direct Testimony of James Umbdenstock for Duke Energy Progress, (Docket No. E-2, Sub 1150 pages 175-178 of 179)

- (j) Electric and Magnetic Fields: An EPA Perspective on Research Needs and Priorities for Improving Health Risk Assessment (google site)
-
- Encl: (1) Page 39 of 179 of reference (a); - 4.3.2 Public Information Workshop heading
- (2) Page 59 of 179, reference (a); -5.0 ENVIRONMENTAL IMPACTS OF THE PROPOSED PROJECT, (5.1...5.5) (not 1-item mentioned about EMF)
-
- (3) WHAT DO THE STUDIES SAY ABOUT EMFS FROM POWER LINES? (p.3 & 4/excerpt) see entirely at www.electricsense.com/4637/emfs-from-power-lines-the-facts
-
- (4) U. S. Nuclear Regulatory Commission (NRC), NRC Occupational Dose Limits
- (5) Electric and Magnetic Fields (EMF) Affect Milk Production and Behavior of Cows; via Michigan State University
-
- (6) Info, Snap Shot –Pages: -EMF Health Effects/BioInitiative Report 2012; -Table of Contents; -List/BioInitiative Participants/Contributing Authors (27 Doctors/ PhDs,- (-all these professionals in their fields cannot be wrong)
-
- (7) Electric and Magnetic Fields: An EPA Perspective...-(3-page excerpt)

Subj: Fraud in Application for Duke Energy Progress, LLC for Certificate of

- Environmental Compatibility and Public Convenience and Necessity to Construct
- Transmission Line in the Cleveland Area of Johnston County, N.C. Docket No. E-2, Sub 1150 of 14 Jul 2017

1.- Attorney General Josh Stein, I have discovered Fraud reading reference (a) pertaining to subject. I will list items of Fraud discovered.

a. Reference (c), page 39 of 179 contains following fraud statements, Burns & McDonnell Engineering: (see enclosure (1))

1. "An Informational letter and small-scale map...was mailed to all property owners within 500 feet of the alternative routes 2 weeks prior to workshops". I am a property owner, **I never received this letter. This is fraud.** (First letter I received from Duke Energy about new transmission line was via certified mail No. 7016 2710 0000 2201 7004, signed for 17 May 2017; (about o/a) 6-months later).

2. "...Duke held two open forum workshops on November 16 and 17, 2016,..." – Notification of workshops -2-weeks prior would be on/about o/a 2 Nov. 2016. I did not attend workshop, nor represented there, as Duke never informed me of workshop. Reference (a) and (c), the way presented, insinuates Duke notified all property owners'

2-weeks prior to dates of workshops. I was not informed, which leads me to believe other property owners were not notified. **This is fraud.**

b. Reference (d), lines 1, 2, 3. (Direct Testimony); -States; -"An informational letter and small scale map,...was mailed to all property owners within 500 feet of the alternative routes two weeks prior to workshops." I am a property owner, I never received this letter. **This is Fraud, and under "Direct Testimony".**

c. Enclosure (2), outline content does not address dangers of environmental pollution via EMF on 230kV transmission line. (It appears Duke Energy gave two brochures to Burns and McDonnell to put in application, even has Duke Logo on them.) This is presented as if an environmental study for EMF was done. **This is fraud.** (This is in Appendix C – Public Involvement Information.) Reference (b) and enclosure (3) - electronic site, addresses dangers of EMF pollution.

d. Reference (e), (I read the e-mails), no mention of EMF pollution. I do not know if the agencies were asked for EMF pollution input. As a property owner, it seems an environmental impact study would include EMF health issues assessment for people and livestock as both are affected by EMF pollution see reference (b) and enclosure (5). This indicates Application, Docket No. E-2, Sub 1150 is incomplete, -request –be stopped until EMF pollution study is done on people/livestock. Evidence EMF Pollution/radiation exist is shown via references (f), (g), and (b), see enclosure (3)

e. Reference (h), page 177, lines 17 – 20, states: "There are currently no transmission lines or substations in this area of Johnston County, which is roughly bounded by Interstate 40 (I-40) on the west, Highway 70 Bypass on the north, Highway 70 on the east and Interstate 95 (I-95) on the south." **This testimony statement is Fraud** -reason, -there is a transmission line shown via reference (a), page 103-map. This transmission line crosses Hwy-42 east of I-40, it crosses Hwy-1010/Cleveland Road east of I-40, and the line is east of I-40 before it crosses Middle Creek. This shows 3- reference points of a transmission line in this area of Johnston County, N.C. **This testimony statement is Fraud.** - (This transmission line, 500kV can have a tap line come off it to new substation. -There is a way for 500kV line to be tapped for use via distribution lines to homes and businesses; why else build one. Two examples: tap lines off 500kV line for distribution line use -Knightdale, N.C. (pop.14,794) and Fayetteville, N.C. (pop.204,759).

1 Long term effects from reference (f); mG 10 per hour reading over time: 10 mG X 24 hrs = 240 mG per day, X 365 days = 87,600 mG per year, X 40 years = 3,504,000 mG. The question to N.C. DEQ is; -What are health effects receiving 3,504,000mG on people for 40 years and livestock 87,600mG per/yr. for 5/10/20 years?.....


2 Long term effects from reference (g); .2r per hour reading over time: .2r/hr X 24 hrs = 4.8r/h, X 365 days = 1752r/yr, X 40 years = 70,080r over 40 years? The question to N.C. DEQ is; -What are health effects receiving 70,080r on people over 40 years and livestock receiving 1752r per/yr. over 5/10/20 years?...

2. Reading/studying about EMF relationship to health of people/livestock indicates health issues develop over period of time. (Some peoples' immune systems perform better than others, example would be: in kids, in teens, the 20s/30s,.....or wait until 60s/70s. EMF is indicated via references (b), (f), (g), (h), (j) and enclosures (3), (5), (6), and (7). See enclosure (6) for snapshot of report. I do not believe all these Doctors/PhDs are wrong. ---- (I object to subject transmission line crossing my property. Cleveland area has space for a new ROW or use existing ROWs for 230kV line. Cleveland area has created need for increase of electrical power by: -Property owners selling land at a profit to developers; -Developers partition land into lots/cut roads/sold lots to builders at profit; -Builders built home to sell at profit to buyer. -Growth/progress created by Cleveland area & profits should sustain itself with electrical infrastructure without infringing on property owners 12-miles south.)

3. Connecting the dots of reference (a) – (j) and enclosures (1) – (7) demonstrates the application under Docket No. E-2, Sub 1150 has Fraud and incomplete EPA study. **This Fraud is not frivolous.** Implementation of Duke Energy application – Docket No. E-2, Sub 1150 will bring hardship to my small farm: **-first-**via destruction of o/a an acre of almost mature timber (one tenth) of timber land on farm - (reason I bought a portable sawmill to saw my own lumber), **-second-** now I know it will effect it's use for small cow/calf farming being done year round on farm. When EMF effects dairy cow's milk production, it means it will affect milk going to calf. The calves is what pays the land rent and I pay the property taxes with land rend and make repairs. **-Third** -Reference (j), U. S. EPA Perspective; convinces me EMF contributes to health issues of people and live- stock. Duke Energy Progress has not shared their research with U.S. EPA that clarifies EMF does not contribute to health issues of: cancer, Alzheimer's & etc. If shared, I cannot find it. –Conclusion; -my gut instinct is Duke/all electric utilities nor EPA is publishing all they know about EMF due to economic cost to fix.

4. Request Attorney General Josh Stein stop reference (a), **Until Fraud is removed** from application in Docket No. E-2, Sub 1150, & EPA study is approved with impact of EMF pollution on people and livestock. –Reply requested.

Sincerely,


Oliver L. Canaday

Cc: N.C. DEQ Administration, 1601 Mail Service Center, Raleigh, N.C. 27699-1601;
-Request your office compute health dangers to people and livestock via EMF pollution
and Radiation via reference (f) and (g). -See paragraphs 1., d., 1 & 2. Please forward
computations to N.C. AG Josh Stein. Please feel free to contribute any known EMF
information to N. C. Utility Commission and N. C. AG Stein. Many health issues
shown in reference (b) take years to surface; (as happened with Agent Orange & Camp
Lejeune Water Pollution, I have first-hand experience with both). Request reply, cc: for
O. L. Canaday

The primary concern discussed during the agency scoping meeting was related to the presence of a federally protected mussel species (dwarf wedgemussel) and other federal aquatic species of concern within the study area. The USFWS and NHP provided Duke with information on streams and their tributaries that had differing levels of sensitivity based on the known existence or potential to support aquatic species of concern. This information was incorporated into the route evaluation factors. Copies of agency correspondence are included in Appendix B.

4.3.2 Public Information Workshops

The intent of the public information workshops was to provide potentially affected landowners near the alternative routes an understanding of the need for the Project, the decision-making process used to select a preferred route, and a forum to voice concerns about the proposed Project.

An informational letter and small-scale map describing the Project and advertising the workshops was mailed to all property owners within 500 feet of the alternative routes 2 weeks prior to the workshops.

Additionally, a news release was issued to the public 7 days prior to the workshops. Information about the Project and a map of the study area and routes were also available on the Duke website throughout the duration of the route selection phase. The Project website is updated as the development and construction of the Project progresses. Copies of the news release, letters, and website information are included in Appendix C.

To gather public input on the route alternatives, Duke held two open forum informational workshops on November 16 and 17, 2016, at the C3 Church in Clayton, North Carolina, and the Johnston County Community College in Smithfield, North Carolina, respectively. A total of 149 people signed in to the workshop in Clayton, and 61 people signed in to the workshop in Smithfield. On both evenings, there were additional attendees observed that did not sign in.

The public workshops included displays with information on Project need, engineering, route alternatives, environmental management, and ROW requirements. Representatives from Duke and Burns & McDonnell were present to address the public's questions and take comments. Potential routes for the proposed transmission line were depicted on aerial photographs. No preferred route had been selected at the time of the workshops. Photographs and drawings showing the types of structures that would be used for the Project were displayed. Duke staff was also present to discuss ROW acquisition and maintenance, and electric and magnetic fields associated with transmission lines.

Participants at the workshop received a written questionnaire to communicate their opinions on the routing criteria, the segment locations, and issues of concern regarding the Project. The public was asked

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100XE The Best
EMF Meter?

Cordless Phones:
Even More
Dangerous Than
Cell Phones?

EMFs in Your
Home – My
Protection Tips

Power Lines and People Concern



WHAT DO THE STUDIES SAY ABOUT EMFS FROM POWER LINES?

Powerline EMFs have been linked to:

- leukemia (especially in children)
- breast cancer
- brain cancer
- reproductive problems and birth defects
- – depression,
- blood disorders,
- heart disease, sleeping complaints and a host of other ailments.

Dozens of studies have found links between living near power lines and poor health:

- as far back as 1979 the Wertheimer and Leeper study found that children living near ordinary power lines had 3 times the likelihood of developing cancer....large gauge transmission lines are worse.
- the Savitz study (1980s) concluded 10-15 percent of all child cancers resulted from magnetic field exposure from powerlines.
- the Wall Street Journal reported in 1993 that the real estate resale value of homes decreased by as much as 30%, if exposed to electromagnetic fields
- according to a 2005 study published in the British Medical Journal, babies who live near high-voltage power lines are almost twice as likely as others to develop leukemia during childhood

And yet despite this evidence people are still being subjected to EMFs from power lines which are installed too close to people's homes.

What Kind of EMFs do Power Lines Create?

There are two types of electromagnetic field produced by powerlines.

– an **electric field** is always present when the powerline is switched on. It strength depends on the voltage.

– a **magnetic field** is caused by the electric current flowing in the line when people use electricity. This can vary considerably and is considered the most dangerous.

Analog is Safe



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Electricity is stopped by most building materials. The real problem with power lines are the magnetic fields.

Magnetic fields penetrate practically everything. The main factor that reduces magnetic fields is distance from the source. In other words the further away you can get from these powerlines the better. But if its your home that is situated too close to a power line this is not easily resolved.

Are Underground Power Lines Safer?

The EMFs from underground powerlines are slightly different. The electric fields will usually be negligible because they are screened by soil, concrete, sand etc. But because underground cables tend to be buried close to the surface the **magnetic fields at ground level can be high**, except for the fact that the cables tend to be closer together than for overhead cables so the magnetic fields cancel out.

Can I Tell if a Power Line is Dangerous By Looking At It?

The width and size of the cables is a good indication of the voltage. But you can't know the current flowing (what electricity people are drawing). And you can't tell the configuration.

What's the configuration? In your home, if your house wiring is not balanced, that's to say the phase and neutral wires are not run together, this creates high magnetic fields. Similarly with powerlines, if the current on one side of the line cables is very different to the current on the other, this leads to much higher electric and magnetic fields than if both sides carried equal currents.

How Can I Know The EMFs Being Emitted From A Power Line?

The only way to know for sure what EMFs are being emitted by a powerline is to measure with an EMF meter. Your power company may be willing to do this testing for you. Then again your request may fall on deaf ears. In which case you can quite easily test your exposure by purchasing an EMF meter.

Measure the EMFs indoors and outdoors. Take measurements at different times of the day. Measure where you sit, and where children play.

Test with your electricity switched off at the mains, then again with it turned on, so you can determine how much of the EMFs are coming from the power line and how much from your own house wiring and electrical appliances.

What Are Safe Levels of EMFs From Power Lines?

The BioInitiative Report recommends safe limits for EMFs. For ELF's (low frequency EMFs) the BioInitiative Report recommends **1 milliGauss (0.1 microTesla) limit** for habitable space adjacent to all new or upgraded power lines.

If you are electrically sensitive this may still be much too high -the Building Biology guidelines recommend a much lower limit.

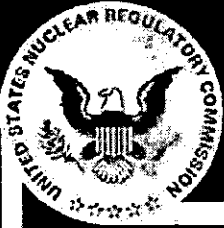
What To Do If Your Home Is In Close Proximity To A Power Line

The first thing to do is to obtain reliable readings with an EMF meter (as described above). There may be no cause for concern. You may live in very close proximity to a power line but the EMFs may be negligible. Then again you may live at good distance but your exposure may be significant because of the very high voltages in the cables. Obtaining EMF meter readings is the *only* way to know for sure.

If your readings are high then you have two options. You can either shield or you can move out. Shielding will not be easy. Yes, shielding does work easily and well for the electric field element. Practically any sheet of metal, metal screen, or metal fencing, provided the metal is grounded will do the job.

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ENCL: (3)



NRC Occupational Dose Limits

Whole Body (TEDE)	5,000 mrem/yr
Any Organ (TODE)	50,000 mrem/yr
Skin (SDE)	50,000 mrem/yr
Extremity (SDE)	50,000 mrem/yr
Lens of Eye (LDE)	15,000 mrem/yr
Embryo/Fetus of DPW	500 mrem/yr
Member of the Public	100 mrem/yr

Note: 1,000 mrem = 1 rem

Briefing for Media

ENC (4)



Electric and Magnetic Fields (EMF) Affect Milk Production and Behavior of Cows; Results Using Shielded Neutral Isolation Transformer



By Donald Hillman, Ph.D., Charles L. Goeke, M.S., and Richard Moser, EE

12th International Conference on Production Diseases in Farm Animals, Michigan State University

Published by: *Shocking News*, 750 Berkshire Lane, East Lansing, MI 48823 -- donag1@aol.com

July 2004

SUMMARY

In 2002 we reported that behavior, health, and milk production of cows were impaired by transients and by the 3rd, 5th, 7th, and triplen harmonic electrical currents from utility power lines. Kaune et al., concurred in that 180 Hz currents and the 3rd, 5th, and 7th harmonics in the living areas of homes were associated with cancer deaths of former residents in Denver, CO. Subsequently, our investigations revealed that a cellular telephone signal generator located at the base of an antenna tower, was charging the neutral-ground with 10+ V and the 3rd, 5th, 7th and other harmonics were on the neutral conductors and water lines of homes, schools, and workplaces in the area, causing harmonic distortion of the power supply. Primary neutral voltage and 3rd, 5th, 7th and other harmonics on dairy farms were reduced to near zero when a shielded neutral isolation transformer was installed between the utility and the dairy. Animal behavior improved immediately, and milk production which had been depressed for 3 years, gradually returned to normal within 18 months after installation of the shielded transformer. Shielding prevents transients and harmonics on the utility primary from induction onto the user neutral and likewise prevents user harmonics and transients from getting onto the utility electrical line. Changes in concentrations of several blood and cerebrospinal fluid components, energy and fat metabolism, and reduced milk have been reported for cows exposed to EMF from overhead powerlines in Canada. Consequences are related to the time and intensity of exposure to EMF.

INTRODUCTION

Farm investigations revealed that transient and harmonic voltages and currents were related to animal behavior, health, and milk production of dairy cows on 12 farms. Details of methods and materials were reported previously (Hillman 2003) and results are in the DVD presentation that accompanies this article.

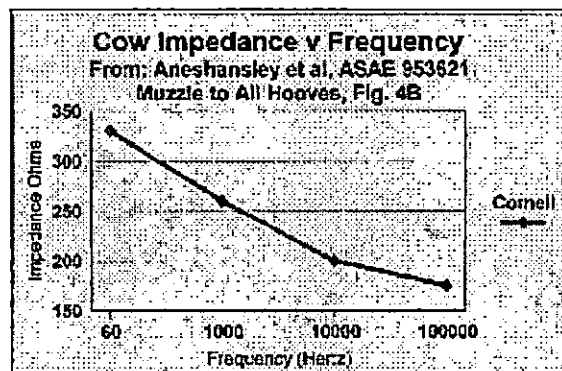
Briefly, the farm studies revealed that:

- Transients and harmonics were prevalent on rural electric power lines and were commonly called "noise" or "dirty" electricity in the electrical industry.
- Neutral-to-ground distorted non-sinusoidal transients averaged 280 ± 60.2 V on 3 farms for 165 days, and 79.9 V on five farms for 385 of 515 days as recorded by Fluke® EventRecorder VR-101.
- The concentration of transients and harmonic impulses varied greatly from farm to farm, day to day, and time of day.
- Milk per cow/d decreased as the number of transient events, hot-to-neutral and neutral-to-ground, transients (oscillations, spikes on the power supply) increased daily.
- Milk was negatively correlated with phase-shift degree angle

of transients.

- Step-potential oscilloscope voltage readings from the floor of milking stalls averaged 0.0628 V ($62.8 \text{ mV} \pm 39.8 \text{ mV}$) and ranged from 0 to 0.1516 V (151.6 mV) on five farms for 515 days.
- Cow movement (steps/min) increased as the voltage differential (minimum - maximum) increased from 0.9 to 6.0 millivolts during the same minute and as the voltage standard deviation increased..
- Milk per cow/d decreased as the number of 3rd, 5th, 7th, 21st, 28th, and 42nd, harmonics increased/d. Harmonics were correlated with the number of transients per day.
- Milk decreased as the sum of triplen harmonics (3rd, 9th, 15th, 21st, 33rd, and 39th) increased/d ($P < 0.003$).
- Cow impedance decreased as frequency increased.
- Current in the cow increased as frequency increased.
- Public Utility Commission (PUC, PSC) standards and use of 500-ohm resistors in test circuits adopted in Wisconsin and some other states underestimate effects on cow behavior, health, and milk production of non-sinusoidal, inferior-quality power on rural power lines.
- IEEE 519, 1992 recommended 5% Total Harmonic Distortion (THD%) on the utility side of the meter, and 5% Total Distortion Demand (TDD%) on the end-user side of the meter, limits that were set for protection of electrical and electronic equipment must be applied for protection of livestock and humans as well.
- The Grounded-Y distribution/transmission system uses the earth as a return conductor for neutral current resulting in earth currents that could be avoided by hard-wiring the neutral back to the substation.

Relationships between frequency of voltages and current passing through the cow were reported by Aneshansley et al. (1990, 1995) and are illustrated below. Voltage at harmonic frequencies increases amperage two to three times compared to sinusoidal 60 Hz voltage because of the reduced impedance of the cow at higher frequencies.



ENCL: (5)



Everyone always asks me – whether they’re skeptics or not – where can I read peer-reviewed, published studies about EMF health effects? “Are there really studies linking magnetic fields and radio frequency radiation to cancer?” Well... this is it! Here is a big dose of reality for all the naysayers.

(<http://healthybuildingscience.com/wp-content/uploads/sites/85/2013/01/EMF-Health-Effects.png>)



(<http://www.bioinitiative.org/>)

EMF Health Effects – BioInitiative Report 2012

EMF Health Effects – BioInitiative Report 2012

This excerpt from the updated BioInitiative Website (<http://www.bioinitiative.org/>):

“PUBLICATION DATE: December 31, 2012

WHERE: The BioInitiative 2012 Report will be published at www.bioinitiative.org (<http://www.bioinitiative.org/>). Free download.

WHAT IS IT: A report by 29 independent scientists and health experts from around the world* about possible risks from wireless technologies and electromagnetic fields. It updates the BioInitiative 2007 Report.

WHAT IT COVERS: The science, public health, public policy and global response to the growing health issue of chronic exposure to electromagnetic fields and radiofrequency radiation in the daily life of billions of people around the world. Covers brain tumor risks from cell phones, damage to DNA and genes, effects on memory, learning, behavior, attention; sleep disruption and cancer and neurological diseases like Alzheimer’s disease. Effects on sperm and miscarriage (fertility

Milligauss mG

Gauss measurement

BioInitiative 2012

A Rationale for Biologically-based Exposure Standards for Low-Intensity Electromagnetic Radiation

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ELECTRIC AND MAGNETIC FIELDS: AN EPA PERSPECTIVE
ON RESEARCH NEEDS AND PRIORITIES FOR
IMPROVING HEALTH RISK ASSESSMENT

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that EMF affects melatonin synthesis should be the focus of studies to determine the sites and mechanisms of interaction. Related research should better define the role of melatonin in suppression of cancer in animals. A primary goal of research on EMF and the nervous system is to define causative exposure conditions; particular attention should be given to the possible differential effects of electric versus magnetic fields.

E. IMMUNE SYSTEM EFFECTS

E.1. HUMAN

The immune system defends against cancer and other diseases. Environmental agents that compromise the effectiveness of the immune system could potentially increase the incidence of cancer and other diseases. No research recommendation is given for the human studies category because of the lack of data on immune system effects in human beings and the preliminary state of knowledge of such effects in both in vitro and in vivo laboratory studies (see below).

E.2. ANIMAL

A series of comprehensive investigations in the United States on the effect of 60 Hz electric fields on the immune system of laboratory animals found no effect of chronic exposure of rats and mice. Thus, it was concluded that power frequencies have small or no effects on the immune systems of exposed animals. However, the role of magnetic fields was not investigated.

→ In vitro tests have also been used to investigate the effect of EMF on the immune system. The results suggest that the magnetic field alone or in combination with an electric field can affect immune function. Magnetic fields have been reported to inhibit the proliferation of immune cells, inhibit killing of abnormal cells by the immune system, and to change the proliferative capacity of cells in culture. Independent confirmation of the in vitro immune results would open a promising research approach to investigate the possible link between exposure to EMF and cancer. In addition, these tests would help to define effective exposure parameters because some immune effects are reported to be frequency-specific and to have a nonlinear exposure-response relation. Also, work with modulated high-frequency radiation indicates that the low frequency of modulation is the biologically effective frequency.

RECOMMENDATION: Research should attempt to replicate independently the reported in vitro immune effects. In addition, immune responses in laboratory animals exposed chronically to magnetic fields warrants investigation.

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CHAPTER III

BIOPHYSICAL MECHANISMS

Studies of biophysical mechanisms are important because the research examines both stages of the interaction process: (1) the nature of the initial physical/chemical interaction of EMF with biological systems and (2) the expression of the physical/chemical change as a biological response. This information is needed to identify field parameters and biological responses important for health research.

There is a substantial body of literature upon which the investigation of biophysical mechanisms can be based. It is apparent from this literature that EMF should not be considered a single entity, but rather a generic class of physical agents, similar to classes of chemicals. Because of the infinite number of potential combinations of exposure parameters, such as frequency, intensity, modulation, etc., it is possible that more than one mechanism may account for the variety of EMF effects. Examples of reported biological responses to electric and magnetic fields include: (1) alteration of melatonin synthesis in the pineal gland, (2) response of brain tissue, e.g., ion flux changes and behavioral changes, (3) intervention in biochemical signalling across the plasma membrane, including second-messenger systems and protein-kinase action pathways that are important in hormone-induced responses, (4) alterations in circadian rhythms, (5) effects on developmental and immune processes, (6) bone fracture healing, and (7) alterations in gene regulation that are implicated in tumor production.

The biological effects of EMF can be best understood by a three-step paradigm: transduction, amplification, and expression. In the first step, energy in electric or magnetic fields must be converted, or transduced, into a biochemical or biophysical change to affect a biological system. The second step, amplification, is needed to boost the initial biophysical changes triggered by the field. Amplification would then lead to the third step, expression of the effect as an observable entity in the laboratory; expression could occur through a constellation of both intra- and extra-cellular biological changes.

There are known and predicted physical constraints on the transduction step. It is known that the photon energy of frequencies in the 0 to 500,000 Hz range is very small; there is insufficient photon energy to break chemical bonds even if the transduction step were 100% efficient. A second constraint is predicted by a simple physical model describing how lower frequency electric fields interact with an isolated small spherical cell. The model predicts that electric fields do not affect the cell because the electric current flows around and not through the cell. These two physical constraints, the low energy of EMF and the physical model prediction, contribute to the controversy on the biological plausibility of EMF interactions with living systems.

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