



## A News Report on the Health Effects of Electromagnetic Energy.

Volume 1, No. 4. Spring 1997

### In This Issue

Following the tabling of a breast cancer report in the Senate in October 1997, we have decided to dedicate the entire Spring issue to this important topic.



### IN THIS ISSUE

#### Special Issue: **The Melatonin Connection**

For the last three issues of *Electromagnetics Forum*, each issue carried many different articles on the various aspects of the health effects of electromagnetic fields/radiation. For this particular issue I have digressed from that format to examine the evidence for a connection with powerline electromagnetic fields, melatonin and breast cancer. This issue, which has for the several months taken up much of my time, has resulted in my latest report being tabled in the Australian Senate on 29 October 1997.

Since the incorporation of this report in the Senate Hansard, there have been numerous enquiries, both in Australia and overseas for this report. The most effective way to meet these requests in a "reader friendly" way is to incorporate the report, Senator Lyn Allison's speech and related information into this newsletter. Some of the information in the senate report has been printed in previous issues of *Electromagnetics Forum*, my apologies to my readers for the repetition.

The senate report, far from being unwarranted, details overseas mainstream research which unfortunately remains largely unknown to either Australian medical practitioners working with breast cancer patients or the medical fraternity in general. The relevance of this information for breast cancer treatment is clearly mentioned in the latest scientific publication reviewing this issue.

To quote from the preface of *The Melatonin Hypothesis: Breast Cancer and Use of Electric Power*, edited by Richard Stevens, Bary Wilson and Larry Anderson, from the Pacific Northwest

Laboratory, operated by Battelle Memorial Institute for the United States Department of Energy, Published by the Battelle Press in 1997.

"Our group itself has, by design, included researchers from a wide range of disciplines. From this rich diversity of experience came the "Melatonin Hypothesis." With its basis in the modest and, at the time, arcane nocturnal experiments of almost 20 years ago, this hypothesis has become one of the salient hypotheses on breast cancer etiology in the main cancer research community."

Unfortunately to date none of the research money set aside for breast cancer research in Australia is examining this topic for reasons outlined in my report. It is my hope that the tabling of this report in the senate will lead to a change in this omission.

## Breast Cancer Report Tabled in Australian Senate

*Extract from Australian Senate Hansard, Senator Lyn Allison - Breast Cancer Awareness Week (29 October 1997)*

As the Senate will be well aware, this is Breast Cancer Awareness Week. On Monday we heard a great deal about the importance of early detection. We heard that breast cancer in Australia affects one in 14 women, kills one in 27 and is growing at the rate of three per cent annually. It is this last statistic which I think should give us the greatest concern. The excellent advances in the treatment of breast cancers will be lost if we do not do the research into the cause of this insidious disease.

I want to talk today about a body of research which is emerging on the links between melatonin, Tamoxifen, 50 to 60 hertz electromagnetic fields and breast cancer. At the First World Conference on Breast Cancer held in Canada in July of this year, consultant Cindy Sage said:

"Since 1979, scientific studies have linked electromagnetic field exposure and various cancers, including breast cancer. EMF has been reported in epidemiological, laboratory and whole animal studies to be associated with increased breast cancer rates and several hypotheses have been offered, including melatonin modulation and cellular membrane (Ca) dysfunction. If EMF is even a small risk factor for breast cancer, the public health consequences will be very large given the incidence of this disease.

Decision-making on public health issues where there is a large industry presence which may suffer financial consequences with the admission of liability for a carcinogenic product creates a most difficult climate for funding, evaluating and acting on new scientific information. The state of the science becomes a battleground, where scientific uncertainty (lack of causal evidence of scientific proof) is argued as reason to defer action or take trivial or meaningless action.

Standards of evidence for triggering interim public health advisories are different than the standard for scientific certainty. A lower threshold of evidence is permissible where the weight of the evidence warrants interim action. To wait for conclusive scientific evidence as judged by purely scientific research standards is inappropriate where the weight of the existing evidence is persuasive, the trend of studies is generally positive and consistently confirmed and the consequence of taking no action has a potentially large adverse public health impact (dread

disease, high incidence, high financial and emotional cost) and where relative costs of avoidance of the risk factor may be low."

As the senate will be aware, the Democrats have, a number of times, alerted the government to the need for research. To give it its dues, \$4.5 million was set aside for research into health effects of electromagnetic radiation in the last budget. The Senate will also have noticed that the NH&MRC called this week for applications for that research money. So it is timely this week to mention breast cancer in this context.

I will seek to incorporate a discussion paper on the subject, which was been prepared by Mr Don Maisch. The paper draws on a range of research material which shows that low-level exposure to 50-60 hertz electromagnetic fields, which is the powerline frequency, may block the body's natural production of melatonin and, therefore, its ability to suppress breast cancer cells. Melatonin, for the information of the Senate, is produced by the pineal gland and it acts to clean up cancer cells.

The studies referred to in this paper have been done only in the last few years and many of them are still awaiting peer review processes. Of course, this process can take years. In most circumstances it is quite proper to wait for the peer review to be completed. We know that the telecommunications industry, for instance, often dismissed research because it has not been replicated. As we also know, research dollars are very tight and it is usually the new and the ground braking research which will be funded ahead of replication.

The argument I want to make here is that the \$4.5 million is not a lot when, firstly, it is spread over four years and when, secondly, you see it in light of the fact that research is very costly. For instance, it cost Telstra \$500,000 to conduct its research into exposing mice to mobile phone frequencies quite recently. Research costs money and it takes time but the point is that, where there is a reasonable doubt, we cannot afford to ignore the evidence and we have to take some precautionary measures.

To return to the paper that I referred to earlier, Australian exposure standards are currently designed to avoid immediate high level hazards. The guidelines that we have in this country are 1,000 milliGauss for residential and 5,000 milliGauss for occupational exposure. What these standards do not consider is the prolonged, low-level exposure of the 50-60 hertz field. Researchers have, for some time, suspected that low-level powerline frequency magnetic fields in the 50-60 hertz range may reduce the pineal gland's production of melatonin. It's ability to suppress cancer cells is referred to as the "melatonin hypothesis."

In the program bulletin of the Second World Congress for Electricity and Magnetism in Biology and Medicine, held in Italy in June this year, mention is made of this melatonin hypothesis: "A number of experimental studies have been conducted to test the [melatonin] hypothesis.

"Although the literature is still evolving and consensus is being built, it is fair to say, a) there exists credible scientific support for the hypothesis and, importantly, b) this support encompasses in vitro, in vivo, and epidemiological research. The melatonin hypothesis, thus, currently represents one of the more well documented/tested interactions in the field of bio-electromagnetics."

The question which is posed in this discussion paper is: what is the medical fraternity to do when it is presented with a significant body scientific evidence that exposure to low-level powerline frequency magnetic fields may well be a risk factor in breast cancer?

I urge senators and the public to read this discussion paper. Much of it is quite technical, but if we can get beyond questions of treatment and early detection of breast cancer, and make some inroads into that three per cent increase in breast cancer incidence, then we need to be open to exploring possible causes and we need to be prepared to take action on the remedies which arise from them. The concerns expressed in this discussion paper are not about power-lines per se. At the Italian congress, a paper was presented by the University of Tokyo which reported on a study which set out to determine whether the effects of long-term powerline frequency EMF from electric blanket exposure, for instance, suppressed melatonin in humans.

The study suggested that exposure to electromagnetic fields through frequent use of electric blankets: "could lead to changes in melatonin production and rhythm, at least in highly sensitive individuals."

The subjects in this study were healthy young male volunteers. The authors wrote of a need for more research into the effects on immune systems that are already under strain. For example, chemotherapy patients.

*\*Correction: In my discussion paper it is not the authors of the above mentioned study that call for more research into the effects on immune systems that are already under strain. It is a point that I raise for further research. Ed*

Long-term employment trends for women point to an urgent need for research into occupational EMF exposure. Through part - and full-time work in service industries and offices, women are increasingly engaged in work involving a high degree of VDU use.

A Boston University study on breast cancer rates found that a 43 per cent increase in breast cancer was apparently amongst women with a high potential for occupational exposure to magnetic fields; namely, women working with mainframe computers.

Several studies have detected little, if any, change in melatonin levels overnight and on weekends in office workers, suggestion that electromagnetic frequency exposure is a persistent entity. It seems the reduction in melatonin levels from a full week in the office cannot be counteracted by a weekend break or by spending the occasional day at work away from the computer.

With breast cancer prevention high on our research agenda, we cannot afford to neglect the possible role of EMF exposure. The International Breast Cancer Intervention Study, which has been running for five years, is investigating whether the drug Tamoxifen can be used as a prophylactic by women who have a strong family predisposition towards breast cancer. The participants are women aged from 35 to 70 from the UK, New Zealand, Australia and Europe.

Various studies suggest that the inhibitory effect of Tamoxifen in cancerous cells may be reduced by electromagnetic exposure.

I have just managed a couple of excerpts from that discussion paper. Time does not allow me to go into more detail on those but I think it is time that we stopped sitting back and saying, 'There needs to be a balance of interests,' and trotting out those age-old arguments about the risks of getting this disease being akin to being run over by a bus. That sort of fatalism, which says that if it happens, is all very well until it hits you or somebody in your family.

Again, I urge senators to read the discussion paper and to do more than awareness about breast cancer. My message is that the research must be done and, in the meantime, there should be a much greater awareness of the need to act in a precautionary manner.

I seek leave to incorporate the discussion paper in Hansard.

*Senator Lyn Allison*

## **The Breast Cancer /EMF connection**

### *Melatonin, Tamoxifen, 50-60 Hertz Electromagnetic Fields and Breast Cancer*

**A Discussion Paper Compiled by Don Maisch, EMFacts Information Service, August 1997**

According to recent statistics, breast cancer in Australia effects one in 14 women, kills one in 27 and is increasing at a rate of 3% annually. These figures reflect a growing community concern and as a consequence, in 1995 the Federal Government allocated \$3 million over a 3 year period, solely for breast cancer studies.

It is unfortunate however, that apparently no current Australian breast cancer research is examining the growing evidence that low level exposures to 50-60 hertz electromagnetic fields (EMF) may block melatonin's ability to suppress breast cancer cells and reduce the pineal gland's nocturnal production of melatonin, thereby increasing susceptibility to breast cancer. This evidence consists of both human and laboratory studies, some of which are summarised in this paper. Almost all of these studies have been conducted only within the last few years and are still awaiting the peer review process which can take years to complete. As a result, many of these studies do not yet constitute part of the body of substantiated scientific evidence, often referred to by national and international expert regulatory groups, such as the International Commission on Non-Ionizing Radiation Protection (ICNIRP).

In drafting its own guidelines for both residential and occupational exposure to powerline frequency (50-60 Hz) EMFs, Australian authorities, such as the National Health & Medical Research Council (NH&MRC) and the Australian Radiation Laboratory (ARL) have taken their maximum exposure guidelines from overseas expert groups, mainly the ICNIRP, which are as follows, (for magnetic fields):

For Residential Exposures:

For Occupational Exposures:

\_\_\_\_\_ 1000 milliGauss (mG)

\_\_\_\_\_ 5000 milliGauss

This is the official position taken by Australian regulatory bodies. However it is important to note that these guidelines are only designed to avoid immediate high level hazards and do not consider prolonged low-level exposures at all. This was admitted in 1991 by Dr Keith Lokan, from the ARL in a conference paper published in Radiation Protection in Australia (Vol 9 No.4, 1991), referring to IRPA/INIRC guidelines which were taken over by the ICNIRP in 1993 and reconfirmed at that time.

To quote: " These limits [as above] represent plausible field values, below which immediate adverse health effects are unlikely, and as such serve a useful purpose. They are NOT intended to provide protection against possible cancer induction by continued exposure at the lower field levels implicated in the studies we have been considering at this workshop." (1 - 3 mG)

So not only do the official guidelines fail to consider low level exposures but the scientific research they are based upon (substantiated evidence) was last considered in 1993, when the current ICNIRP guidelines were reconfirmed. This predates the entire body of evidence as examined in this report.

The idea that low level powerline frequency magnetic fields may reduce the pineal gland's production of melatonin and that melatonin's ability to suppress cancer cells is blocked by these fields, is called the "melatonin hypothesis". At the recent international conference, the Second World Congress for Electricity and Magnetism in Biology and Medicine , held in Bologna, Italy in June of 1997, it is mentioned in the program bulletin:

"A number of experimental studies have been conducted to test the [melatonin] hypothesis. Although the literature is still evolving and consensus is being built, it is fair to say, a) there exists credible scientific support for the hypothesis and, importantly, b) this support encompasses in vitro, in vivo, and epidemiological research. The melatonin hypothesis, thus, currently represents one of the more well documented/tested interactions in the field of bioelectromagnetics."

What is the medical fraternity to do when presented with a significant body of reputable scientific evidence that exposure to low level powerline frequency magnetic fields may well be a risk factor in breast cancer? Advice from such government bodies such as the NH&MRC and the ARL can only reflect their official position as mentioned above.

Considering the prevalence of breast cancer in Western society and the extensive body of recent evidence pointing to a connection with EMF exposure, it is the position of this report that with breast cancer patients, avoiding excessive EMF exposure should be part of the treatment, under the Precautionary Principal, which in this case could be defined as:

The precautionary principal should guide decision-makers when confronted by potential threats to human health. The lack of full scientific certainty should not be used as a reason for postponing measures to prevent exposure to these potential threats. If measures generally reducing exposure can be taken at reasonable expense and with reasonable consequences in all other respects, an effort should be made to reduce exposures to a level below that level which evidence indicates may be harmful to health

## 1.0: Melatonin

Both human and animal circadian rhythms are driven by the day/night cycle and are synchronized with natural geomagnetic electromagnetic fields. The major control gland over this natural cycle is the pineal gland which secretes the neurohormone melatonin. During the day, light falling on the eye's retina produces signals which are biochemically amplified to stimulate the pineal gland to reduce its melatonin output. At night the absence of light with sleep stimulates the pineal gland to produce melatonin.

The circadian production of melatonin is thought to control important processes in the eyes, including restoration of rods (for night vision) at the end of the night, and renewal of cones (for colour vision) at the end of the day. One theory on how man made EMF's may affect the pineal gland is that the pineal gland may 'sense' EMF's as light and therefore reduce melatonin production. A possible cause for such an effect is from insoluble granular material contained within the pineal gland.

Research by Dr. Sidney Lang, an expert on piezoelectricity, which is the production of electric fields by pressure on crystalline structures, has shown that the pineal gland has piezoelectrical activity. Dr Lang hypothesizes that this activity is a function of this granular material and if so it may be responding to narrow wave lengths. (1)

Once melatonin is produced, its ability to pass through the cell membrane allows it to pass directly into the blood stream. Once in the blood melatonin has access to every cell in the body where it passes through the cell membrane to the cell nucleus, which has receptors for it. A few cell membranes also have receptors for melatonin, which may control the 24 hour circadian rhythm of the endocrine system.

In the cell nucleus, melatonin plays a role in regulating gene expression. The ability of melatonin to enter all cells is also essential for one of the other important functions of melatonin, which is to act as a scavenger of highly toxic oxygen-based free radicals. The production of these free radicals is a consequence of the utilization of oxygen by all organisms. About 1 - 2% of inspired oxygen ends up as toxic free radicals which can damage macromolecules such as DNA, proteins and lipids. This damage is referred to as oxidative stress.

Because of its ability to eliminate free radicals, melatonin is probably the most efficient natural cell protection and oncostatic agent in our bodies. At night, melatonin production floods our bodies, eliminating the build up of free radicals that are being produced, allowing the DNA synthesis and cell division to occur with a far lower chance of damage and hence producing more healthy cells. Melatonin also dampens the release of estrogen, prolonged exposure to which may increase the risk of breast cancer. ( 2 )

As for the role of melatonin in effective chemotherapy, researchers at the Tumor Radiation Laboratory at the University of Milan in Italy found that elevated blood levels of melatonin significantly enhanced the effectiveness of chemotherapy. The study included 42 cancer patients of both sexes, including 10 breast cancer patients, 13 lung cancer patients, and 11 colon cancer patients. It was found that 75% (12 OF 16) patients whose melatonin levels were enhanced after chemotherapy exhibited objectively measured tumor regression, whereas only 8% (2 of 26 patients) whose melatonin levels did not go up after chemotherapy exhibited tumor regression.

## 2.0: Tamoxifen

Tamoxifen, which is the most widely used therapy for treatment of breast cancer, has proven effective in treating breast cancer in its early stages and is also used by over one million women throughout the world who have had breast cancer, to prevent its recurrence. Although tamoxifen is not as effective as melatonin in inhibiting the growth of MCF-7 breast cancer cells in vitro , the drug has been shown to be about 100 times more effective in inhibiting breast cancer cell growth if the cells have first been pre-treated with a physio-logic concentration of melatonin.

### 3.0: Electromagnetic Fields (EMF)

In 1987 Stephens et al. in the paper, Electric power use and breast cancer; a hypothesis, suggested that electromagnetic fields (EMF's) reduce melatonin production by the pineal gland and that melatonin suppresses the development of breast cancer. ( 3 )

Other researchers have also hypothesized that the possible suppression of melatonin by electromagnetic fields may provide a single mechanism for explaining how number of different types of cancer could be promoted by EMF's, however this suggestion has been hotly debated due to the previous failure to replicate several key studies. Replication is a key step in the scientific method for it takes an unproven hypothesis to a significant conclusion which can be acted upon.

In 1993 Dr David Blask and co-workers first reported that physiological levels of melatonin reduce MCF-7 human breast cancer cell growth in vitro. ( 4 )

Research reported in 1993 by Liburdy, et al. found that melatonin reduces the growth rate of human breast cancer cells (MCF-7) in culture, but that a 12mG 60 Hz magnetic field can block the ability of melatonin to inhibit breast cancer cell growth. ( 5 )

Examined in this report are five in vitro studies, from three major laboratories, using human breast cancer cell cultures, with results showing that low level powerline frequency magnetic fields in the order of 12 milligauss can block melatonin and/or Tamoxifen's ability to suppress breast cancer cells.

It is this body of laboratory evidence and the three human exposure studies also mentioned herein, that have significant implications for the successful treatment of breast cancer and calls for immediate action from researchers and oncologists alike. The failure to do so, under the excuse of "more research needs to be done" is not acting in the best interests of breast cancer patients, to say the least.

In June 1996 at the 18 th. Annual Meeting of the Bioelectro-magnetics Society (BEMS), the following three studies were presented. When these three studies are added to recent research presented at the Second World Congress for Electricity and Magnetism in Biology and Medicine, held in Bologna Italy, in June of 1997, there now exists an important body of scientific research in relation to breast cancer and electromagnetic fields.

#### **3.1: ELF INHIBITION OF MELA-TONIN AND TAMOXIFEN ACTION ON MCF-7 CELL PROLIFER-ATION; FIELD PARAMETERS.**

*(J.D. Harland and R.P. Liburdy. Lawrence Berkeley National Laboratory, University of California, Berkeley, California, USA.)*

This study was designed to define the parameters by which a 12 milli-Gauss (mG) 60 Hz magnetic field can block the inhibitory action of melatonin and Tamoxifen, a widely used drug treatment for breast cancer. They found that a 12 mG field can significantly reduce the growth inhibitory action of melatonin and Tamoxifen on human breast cancer cells (MCF-7) in culture.

"Preliminary experiments suggest that at least three days exposure at 12mG is necessary to block the cytostatic action of Tamoxifen (from 27% growth inhibition,  $p < 0.0001$ ; to 5% growth

inhibition,  $p > 0.5$ ) indicating that prolonged 12mG exposure may be required. This appears to be consistent with a "slow" interaction mechanism. This result also raises the possibility of field effects that may be cell cycle dependent, since measurable effects appear to be delayed or reversible until cell division begins. In addition, all field magnitudes of 12 mG or higher that have been tested thus far (12mG, 20mG, 1Gauss) have been effective at blocking melatonin." ( 6 )

A lower field of 2mG did not have any significant effect, suggesting a threshold might exist between 2 and 12 mG.

### **3.2: INDEPENDENT REPLICATION OF THE 12-MG. MAGNETIC FIELD EFFECT ON MELATONIN AND MCF-7 CELLS IN VITRO.**

*C.F.Blackman, S.G. Benane, D.E. House and J.P. Blanchard. National Health & Environmental Effects Research Laboratory, U.S. Environmental Protection Agency, USA.*

This study was specifically designed to attempt to replicate the previous study, with the cooperation of the originating laboratory. The results independently confirmed the previous study's findings that a) Melatonin can inhibit the growth of human breast cancer cells MCF-7 in culture, and b) A 12 mG 60 Hz magnetic field can completely block melatonin's oncostatic action.

The authors of this study believe these results are particularly significant because these findings represent the first replication of a key magnetic bioeffect, and that these two studies represents a foundation for theorists to generate "testable" hypotheses for biological mechanisms of interaction. (7)

### **3.3: INHIBITION OF MELATONIN'S ACTION OF MCF-7 CELL PROLIFERATION BY MAGNETIC FIELDS ASSOCIATED WITH VIDEO DISPLAY TERMINALS: A PRELIMINARY STUDY.**

*(S.M.J. Afzal and R.P. Liburdy. Lawrence Berkeley National Laboratory, University of California, USA.)*

This study was undertaken to test the hypothesis that ELF and VLF magnetic fields associated with Video Display Terminals (VDT's) influence human breast cancer cell growth in vitro by altering melatonin's natural oncostatic activity. This hypothesis was based on the findings of the two previously mentioned studies.

The conclusions of this study appear to suggest that 12 mG VDT magnetic fields also inhibit the oncostatic action of melatonin in vitro and that the magnetic field component was the operative factor in the 12 mG 60 Hz exposures. Preliminary data from two separate experiments indicated significant growth inhibition (33% and 22%) on day 6 in the 2 mG magnetic field conditions.( 8 )

A fourth study of a 12 mG effect on MCF-7 breast cancer cells was presented at San Antonio Texas in Nov.1996 by Dr Richard Luben, as follows:

### **3.4: REPLICATION OF 12 mG EMF EFFECTS ON MELATONIN RESPONSES OF MCF-7 BREAST CANCER CELLS IN VITRO. R.A.**

*(Luben, S. Saraiya and A. P. Morgan. Division of Biomedical Sciences, University of California, Riverside, California 92521, USA.)*

The objective of this study was to replicate, with the cooperation of the originating laboratories, the studies conducted by Liburdy and Blackman.

They "found that exposure of breast cancer cells to 12 mG 60 Hz EMF induced a reproducible net increase (mean +28%,  $p < 0.001$ ) in the growth rate of MCF-7 cells treated with a physiological dose of melatonin. This constitutes a replication of the observations reported previously by Liburdy and Blackman, in that EMF produced a blocking of the anti-cell-growth effects of melatonin. There are some variations between our findings and theirs: Nevertheless, the net differences between (melatonin+EMF) and (melatonin-EMF) groups is both qualitatively and quantitatively consistent in all the studies. . ." ( 9 )

From the Second World Congress for Electricity and Magnetism in Biology and Medicine , held in Bologna, Italy in June of 1997:

### **3.5: DIFFERENTIAL INHIBITION OF TAMOXIFEN'S ONCOSTATIC FUNCTIONS IN A BREAST CANCER CELL LINE BY A 12 mG MAGNETIC FIELD.**

*(J.D. Harland, M.Y. Lee, G.A. Levine, R.P. Liburdy, Lawrence Berkeley National Laboratory, University of California, USA.)*

"Previously, we have reported that 12 mG (1.2 uT), 60-Hz magnetic fields reduce the inhibition of tamoxifen's cytostatic action in the human mammary tumor cell line MCF-7. tamoxifen is a nonsteroidal antiestrogen, the most frequently prescribed drug for the treatment of human estrogen-receptor (ER) positive breast cancer, and known to bind specifically to the estrogen receptor. However, tamoxifen's action is multifactorial; besides its oncostatic activities in ER+ cells, it also inhibits the growth of some ER-breast cancer cells. The later has been ascribed to tamoxifen's other cellular activities In an effort to determine a possible site of interaction of the 12 mG field with the cell, we are investigating the effect of the 12 mG field on the action of drugs known to differentially mimic one of tamoxifen's cytostatic activities in MCF-7 cells

**RESULTS:** We observe a blocking effect of a 12 mG magnetic field of the pure antiestrogen ICI 162,780 This blocking effect appears to be even greater than that seen for tamoxifen: from 18% inhibition at 2 mG, to 15% enhancement of growth at 12 mG However we also find that the 12 mG field has an even greater inhibition of the calmodulin antagonist W-13, from 16% inhibition at 2 mG to 28% enhancement of growth at 12 mG Future research will be directed at further characterizing the specificity of the 12 mG field interaction "(10)

## **4.0: Related Research**

Also at the Second World Congress for Electricity and Magnetism in Biology and Medicine, held at Bologna Italy in July 1997, R.P. Liburdy from the Lawrence Berkeley National Laboratory, summed up the current state of in vitro research findings:

"Collectively, this body of in vitro research establishes that environmental-level 60-Hz magnetic fields can alter melatonin's antiproliferative activity in human breast cancer cells. The significance of these findings is that a replicated bioeffect involving melatonin has been identified with the potential for elucidation possible biological mechanisms. Moreover, the potential exists for translation to relevant in vivo experiments involving melatonin and environmental-level magnetic fields."

It does not necessarily mean that the above in vitro study conclusions can be directly applied to breast cancer patients. However it is important to note that some recent human exposure studies also indicate a melatonin/EMF effect, and that levels around 12 mG can be routinely encountered in daily life, for example, electric blankets can give emissions in excess of 12 mG, depending upon manufacturer and setting used.

Sleeping with an electric blanket on is a special concern, as it is at night that the pineal gland, located near the centre of the brain, produces melatonin. In the study by Liburdy and Harland, indications were that a prolonged exposure may be required, which is a further possible implication of electric blanket use while sleeping.

In a study by Yaofei Liu and Dr. Indra Chatterjee at the University of Nevada they found that with electric blankets, "The average current density (induced in the body) in the head is higher than the torso because of the smaller cross section of the head." ( 11 )

**4.1:** At the June 1997 Bologna World Congress meeting, mentioned above, a paper presented by the Faculty of Medicine, University of Tokyo, specifically looked at melatonin levels and electric blanket use. This study set out to determine whether the effects of comparably long-term powerline frequency EMF (from electric blanket use) exposure on suppression of the melatonin rhythm in humans could be replicated.

The participants were 9 healthy male volunteers, 23 to 37 years of age. The results of this study found that: "Nocturnal exposures to 50 Hz EMF generated from electric blankets was not related to melatonin production in terms of its mean values (for 8 subjects excluding one whose rhythm could not be calculated) but showed tendencies of suppressing peak value and/or delaying phase of melatonin rhythm in 7 of the 8 subjects.

The present findings may suggest a possibility that exposure to ELF-EMF by electric blankets, if magnitude and duration are sufficient, could lead to changes in melatonin production and its rhythm, at least in highly sensitive individuals.

However, a definitive conclusion could not be obtained from only the present results, since the experiments were performed under unrestricted daily lives. Experiments with major possible modifying factors for melatonin metabolism being controlled are warranted." (12)

It is important to note that the subjects of this study were healthy young male volunteers, with hopefully robust immune systems. What effect would be seen with people who's immune systems are already under stress, such as patients undergoing chemotherapy?

In a soon to be published follow up study by Dr. Henry Lai and Dr. Narendra Singh, who earlier found single and double strand DNA breaks in rats exposed to low level radiofrequency radiation (RFR) after a single two hour exposure, the treatment of either melatonin or a free radical scavenger (PBN) to the exposed rats immediately before and after RFR exposure prevented the DNA damage. (13)

This indicates the importance of melatonin in DNA repair mechanisms, and therefore in cancer suppression, but not that the RFR is effecting is the rats own pineal melatonin production. The current body of evidence examines Extremely Low Frequency (ELF) 50-60 Hz fields and its effects on melatonin. At this point in time evidence for a similar effect on the pineal gland/ melatonin from radiofrequency and microwave radiation has yet to be demonstrated. (14)

In a study by Tan et al in 1993, rats were injected with a chemical carcinogen, Safrole which damages DNA by inducing the production of large numbers of free radicals. Rats injected with Safrole were found to have extensive DNA damage after 24 hours. When melatonin was also injected, the DNA damage was reduced by 99%. (15)

**4.2:** A preliminary study of 60 workers at a Finnish garment factory found "a highly significant effect" of EMF's in reducing nocturnal melatonin levels. Magnetic field measurements were taken for the two types of machines used in the factory and operators were assigned to high or low exposure groups, based on the type of machine they were using, with average exposures either above or below 10 milliGauss. Unexposed non industrial workers were used as controls.

The results of this study found strong effects of both magnetic field exposure and smoking on night time levels of melatonin. No difference was found in melatonin levels on week nights and Sunday nights, indicating "that the possible suppression caused by magnetic field exposure is chronic, with little recovery during the weekend." (16) - consistent with the effect of chronic electric field exposure in the rat experiments of Wilson et al. (1986) ( 17 )

**4.3:** In a study of 192 electric utility workers, Drs. John Reif and James Burch, from the Colorado State University, found that some EMF exposures are associated with lower levels of melatonin. They found a significant association between magnetic field exposures and lower daytime melatonin levels on the second and third of three days of measurement. The lack of an effect on the first day (following a weekend or equivalent) may indicate a cumulative effect of exposure.

Some studies have suggested that EMF effects on melatonin may depend on whether the field is continuous or intermittent. Reif and Burch found that magnetic fields in the home that were "temporally coherent"(less intermittent) had a very significant association with lower melatonin levels at night. They concluded that, "The intensity and temporal characteristics of magnetic fields appear to be involved in melatonin suppression." ( 18 )

**4.4:** Office workers who used computer monitors (VDU's) had a significant reduction in circulating levels of melatonin over a course of the working day, according to a study by researchers Drs. Bengt Arnetz of the Karolinska Institute, and Mats Berg of the Karolinska Hospital in Stockholm Sweden. No such change was found during days at the office with no

VDU use. According to the researchers; "This suggests that there is a direct impact from the electromagnetic environment of the VDU on levels of melatonin."

Levels of a different hormone, adrenocorticotrophic hormone (ACTH), went up during the working day and this showed a strong correlation with worker's subjective assessment of mental strain. Arnetz and Berg note that ACTH is "known as a classic stress hormone that reacts to mental strain." But in contrast, "occupational strain did not correlate with melatonin levels." ( 19 )

This finding supports the Boston University breast cancer study, in which Patrica Coogan and co-workers found a 43% increase in breast cancer among women with a high potential for occupational exposures to magnetic fields, notably those working with main-frame computers. In an interview with Microwave News , Coogan said,"This study lends credence to the idea that EMF's might influence breast cancer." ( 20 )

Not all human exposure studies found a melatonin reduction effect. A study by Dr. Charles Graham et al at the Midwest Research Laboratory in Kansas City, MO. conducted for the Electric Power Research Institute (EPRI), found that a continuous 60 Hz, 200 mG magnetic field applied to people while they slept had no effect on nocturnal melatonin levels.

In a similar study published in 1994, Graham found no overall effect for intermittent EMF exposures, however, data from that study showed that men with preexisting low levels of melatonin had even lower levels when exposed to EMF's, suggesting that a person's prior melatonin level may be an important factor. Later research by Graham failed to replicate this finding however.

Graham cautions against a conclusion that EMF's do not effect melatonin. He points out that all of the volunteers in his studies were "healthy young men", and that the types of EMF's with which people come in contact in an industrialised society are much more varied than those created in the carefully controlled MRI exposure facility. (21)

In relation to this, Dr John Reif of Colorado State University comments, "Most natural observations appear to find melatonin changes, while controlled lab studies tend not to. . . In a general way, I'm concerned that the controlled lab trials may not mimic exposures in the real world."(22)

### 5.0: The International Breast Cancer Intervention Study

This study, which has been running for five years now, is aimed at discovering if the drug Tamox-ifen can help prevent the disease in those who have not yet developed it but are at increased risk.

Women from the UK, Europe, New Zealand and Australia are participating in the study, which is open to women aged between 35 and 70 who have a strong family history of breast cancer.

Those aged 45 to 70 must have had a close family member diagnosed with breast cancer at the age of 50 or under, or in both breasts at any age, or must have two close blood relatives who have had breast cancer at any age. Those aged 35 to 45 must have had a close family member diagnosed with breast cancer before 40 or at least two close blood relatives who have had breast cancer before 50.

Each participant is encouraged to continue with the study for 5 years. During that time they take one tablet, which is either Tamoxifen or a placebo, each day and receive a clinical assessment every six months and a mammogram each year. If Tamoxifen is proved effective it could ultimately be provided to women at increased risk.

Considering the above mentioned studies, especially the study by Liburdy and Harland, ELF Inhibition of Melatonin and Tamoxifen Action On MCF-7 Cell Proliferation; Field Parameters, which found that a 12 mG magnetic field can significantly reduce the growth inhibitory action of melatonin and Tamoxifen, participants EMF exposures should be included in the International Breast Cancer Intervention Study as a possible confounding factor.

If EMF exposures are a possible confounding factor, the statistical model for analysis of the study should take into account this possible factor. If not, the possible EMF factor may put enough statistical noise to the study that the conclusions may well be affected as the effectiveness of Tamoxifen may be reduced in the participants with relevant EMF exposures.

If environmental EMF's, and electric blanket use are a confounding factor, this should be possible to check by questioning the subjects on their habits, maybe even taking home and workplace EMF exposure readings. If some participants are found to be exposed to prolonged EMF exposures in the order of 2 to 12 milliGauss, (there appears to be a dose-response relationship from 2 to 12 milliGauss) it may be advisable to recommend avoiding these exposures. Since the studies examined in this paper found no effect at 2 mG, this may be a safe level to aim to keep prolonged exposures under.

It may also be advisable to do actual measurements of melatonin levels in those subjects identified as being prone to breast cancer. Women with breast cancer have shown a lower nocturnal increase in melatonin levels than control women. (23)

In the September 1996 issue of Epidemiology, Susan Preston-Martin reviews much of the data on topic. She also calls for including melatonin levels in breast cancer risk assessment studies and for obtaining an ELF exposure history.

A possible avenue for research would be to determine if the use of melatonin would have a similar protective effect as Tamoxifen, as breast cancer patients may have a better prognosis if their melatonin levels are high.(24)

Professor Russell Reiter who has been researching the effects of EMF's on melatonin production has done a review paper on this subject. This review paper was prompted by a number of epidemiological studies in which an increased incidence of cancer was reported in individuals living or working in an environment of higher than normal artificial electromagnetic fields. His paper extract concludes with the following observation:

"Reduction of melatonin at night, by any means, increases cell's vulnerability to alteration by carcinogenic agents. Thus, if in fact artificial electromagnetic field exposure increases the incidence of cancer in humans, a plausible mechanism could involve a reduction in melatonin which is a consequence of such exposures."

Dr. Reiter also notes: " Epidemiologists should look for other possible changes, including psychological depression, fatigue, sleep inefficiency, chronic feelings of jet lag, endocrine disturbances and other symptoms; all these may result from a chronically low melatonin rhythm." ( 25 )

As a result of his latest study Dr. Reiter now proposes that melatonin is "more rapidly taken up into tissues during the exposure." He noted that if EMF's result in higher levels of free radicals, then an antioxidant like melatonin "would disappear from the blood more quickly than is normal because it would be required for the scavenging of free radicals." (26)

If Reiter's hypothesis is correct, then prolonged exposures may tax the pineal gland's ability to maintain adequate levels of melatonin to cope with the extra stress created by EMF exposure, and also Tamoxifen's ability to inhibit the growth of breast cancer cells.

## 6.0: World Conference on Breast Cancer on the U.S. National Cancer Institute Linet Study

At The First World Conference On Breast Cancer, held at Queens University, Kingston, Ontario, Canada, from 13 to 17 July 1997, over 600 delegates from around the world met to establish a Global Action Plan to eradicate breast cancer, which currently affects one in eight women in North America. This plan will later be presented to the United Nations, the World Health Organization and other major international organizations.

As noted in the conference bulletin, the conference was "a massive and truly global undertaking, organized by grass-roots women's organizations, survivors, environmental groups, scientists and health-care professionals. For the first time ever, the voices of the women and others most affected by this disease will take centre stage, as experts from around the globe assemble to share knowledge and experience of this complex problem."

Less than two weeks before the conference, the U.S. National Cancer Institute released a study, conducted by Dr. Martha Linet and co-workers, in which it was claimed that there was no evidence that powerline electromagnetic fields increase childhood leukemia risks. This study was published on July 3rd 1997 in the New England Journal of Medicine and has widely been mis-reported in the world's media as the final word in exonerating powerline frequency EMFs from any connection with cancer. This line is also being promoted as proof that future research into EMFs and cancer should cease.

The NCI study was specifically examined at the conference and many concerns were raised on the calls for ending future EMF health effects research, based on the NCI Linet study. The following is a joint press release on the NCI study from the conference:

Dateline: 1st World Conference on Breast Cancer, Kingston, Ontario, Canada , July 15, 1997.

"The recent report in the New England Journal of Medicine by Linet and colleagues has been widely reported as showing no link between exposure to electromagnetic fields (EMF) and one type of leukemia in children.

On the basis of this new study, some scientists and some news media organisations, including the major networks, have repeated the questionable claim that the link between EMF exposure and cancer risk is no longer an issue, and further research is unnecessary.

Such statements, based on a single study, are troubling. More disturbing still, is the fact that the data presented in the Linet study do not support the assertion that no link exists. Even a cursory review of the main data set shows a 53% increase in leukemia incidence at magnetic field exposure levels above 2 mG; a 72% increase (which is statistically significant) above 3 mG; and a more than 600% increase at exposures of between 4 and 5 mG.

Above 5 mG, no link is shown, but there are too few cases in this range to yield any significant result.

Dr. Bary Wilson, who has co-authored a recent book on EMF and breast cancer, and several other speakers at the World Conference on Breast Cancer, including Dr. Kjell Hansson Mild of National Institute of Working Life in Sweden, have stated that a study which is apparently positive and limited only to leukemia should not be used to discount a possible link between EMF and cancer in its entirety.

Any statement claiming the demise of the EMF and cancer issue should be based on an analysis of all the available data and not one study, particularly one in which the reported data are apparently not reflected in the conclusions. In fact, available data on the subject, provided by many scientists over more than a decade, do not support the hypothesis that there is no link between EMF exposure and increased risk for several types of cancer.

Cindy Sage of Sage Associates and Chair of the EMF program at the conference points out that, "even a small increased risk of breast cancer due to EMF exposure has enormous public health implications given the high incidence of this disease in developed countries."

Based on the Linet, et al. study, it is clearly not justified to call for the end of research into the possible link between EMF and cancer. Given the growing body of evidence for a possible link between EMF and breast cancer, in particular, cessation of research funding at this time would be reckless and scientifically indefensible."

Kjell Hansson Mild, Ph.D.

Natl Inst for Working Life, Sweden

Cindy Sage

Sage Associates, USA

Bary W. Wilson, Ph.D.

Pacific Northwest National Laboratory, USA

## 7.0: Conclusion

The evidence as outlined in this report, quite clearly identifies commonly encountered environmental magnetic fields of 12 milligauss, with a possible dose-response relationship down to 2 milligauss, as being a probable cancer promoter.

As to the role of cancer promoters, Dr. Robert O. Becker in his book, *Cross Currents* states: "Cancer promoters, however, have major implications for the incidence of cancer because they increase the number of cases of cancer that become evident. We are constantly exposed to cancer-causing agents in our environment ranging from carcinogenic chemicals to cosmic rays.

As a result, we are always developing small cancers that are recognised by our immune system and destroyed. Any factor that increases the growth rate of these small cancers gives them an advantage over the immune system, as a result more people develop clinical cancers that require treatment." Therefore, it would be fair to say that in the situation of residential and occupational exposures, where cancer patients are routinely being exposed to levels in the order of 12 mG, the necessity of avoiding these exposures is paramount. Since the recent World Conference on Breast Cancer, held in Ontario Canada, there is an increasing overseas awareness that EMFs are a risk factor with breast cancer, but at present there are no figures as to the degree of risk. In relation to breast cancer patients, an important first step is to determine how many are being exposed to EMFs of the order of 2 to 12 mG?

An important initial step would be to conduct detailed surveys of groups of breast cancer patients to build up a profile of any prolonged exposures in relation to the 12 milligauss level. If we take 2 mG as a no-effect level and 12 + mG as a definite level of effect, we could get some idea of the percentage of participants who are most likely at increased risk from this exposure. Ideally such a survey would be conducted independently in several countries, using the same criteria and results then compared.

The outcome of this would be to develop effective advice for patients to avoid exposures, which can come from many sources, such as electric blankets, electrically heated water beds, improperly grounded home wiring, in-floor electrical heating systems, older computer monitors, fluorescent lighting systems, occupational exposures, etc.

Although this paper only deals with powerline EMFs, electromagnetic radiation (EMR) from radiofrequency and microwave emissions are also now being implicated in breast cancer.

Besides some epidemiological studies, such as one showing a significant increase in breast cancer for female radio operators, there is evidence that breast cancer tumors absorb significantly more EMR than other cancers, or healthy tissue. To quote from one study, conducted at Duke University, North Carolina, USA, in 1993.

"In general, at all frequencies tested [50 to 900 MHz], both conductivity and relative permittivity were greater in malignant tissue than in normal tissue of the same type. For tissues of the same type, the differences in electrical properties from normal to malignant were least for kidney (about 6% and 4% average differences over the frequency range in permittivity and conductivity, respectively), and these differences were the greatest for mammary gland (about 233% and 577% average differences in permittivity and conductivity, respectively) (27)

The ability of breast cancer tumors to absorb significantly more EMR than normal tissue should be of concern when compared to an official joint statement, made in the Information sheet, Safety of Mobile Phones and Towers - The Answers (Nov.1995) by the Australian Radiation Laboratory, Spectrum Management Agency, Austel and the Commonwealth Science and Industrial Research Organisation, (under the heading, Is Cancer an issue?)

"There is yet insufficient scientific knowledge of many aspects of health effects of radio waves. One common question is: Do radio waves from mobile phones increase the risks of cancer? The answer is that there is no experimental evidence that radio waves directly cause cancer. Laboratory studies on animals suggest that where cancer exists, radio waves may accelerate its growth."

For this reason, acting under the Precautionary Principle as mentioned previously, one should also consider radiofrequency and microwave exposures as a possible risk factor to be avoided.

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## Breast Cancer Study Downplays Chemical Link

As reported in USA TODAY (30/10/97) by Steve Sternberg, a study from the Harvard Medical School, just published in the *New England Journal of Medicine*, claims that exposure to toxic pesticides and industrial chemicals does not appear to raise a women's risk of breast cancer.

According to the article in US TODAY, "The research casts doubt on the theory that exposure to environmental estrogens - such as those found in the pesticide DDT and in the multipurpose chemicals known as PCBs - has contributed to the rise in the nation's breast cancer rate."

Environmental estrogens can be either natural or man made chemicals that mimic or block the action of the human hormone estrogen. It has been well established from both animal and human studies that estrogen acts as a promoter of breast cancer.

This is true regardless of whether the estrogen is from a woman's ovaries or from a hormone pill. There is also the possibility that environmental estrogens from pesticides and industrial chemicals also have this same promotional effect.

However, as reported in the publication, *Our Stolen Future*, there are dangers from focusing too narrowly on the estrogen factor, warns Linda Birnbaum, head of the U.S. Environmental Protection Agency's Health Effects Research Laboratory.

"Estrogen is just one component in the complicated, integrated endocrine system, and, she says, synthetic chemicals target other parts of the system more commonly than they disrupt processes involving estrogen. The adrenal glands, which produce stress hormones, get hit more than any other organ by man-made compounds, followed by the thyroid gland.

Insults in any part of one system tend to quickly ripple through other systems of the body as well. So while breast cancer could be linked to estrogenic pesticides, it could also be linked to other kinds of hormone disruption. Birnbaum notes, for example, that depressed thyroid levels have been linked to breast cancer just as increased estrogen exposure has."<sup>(1)</sup>

In this study, which is the first of several major studies now under way, David Hunter of the Harvard Medical School and co-workers examined stored blood samples from 32,000 women in Harvard's Nurses Health Study. The researchers focused on 240 of the nurses who had later developed breast cancer and a control group of 240 nurses who did not later develop cancer.

The researchers tested the blood samples for traces of PCBs and DDE, a by-product of DDT metabolism. According to the researchers, women without breast cancer were the ones with higher levels of these chemicals.

"We found no evidence of a positive association between high levels of plasma DDE or PCBs and a risk of breast cancer." Hunter reported in the *NEJM*. "At this point," Hunter added, "the weight of the evidence indicates that it is unlikely that these compounds cause breast cancer."

### Comment.

The concept of the Harvard Medical School study is straight forward; to see if breast cancer patients had higher levels of PCBs and the DDT byproduct DDE. If higher levels were found then we would have convincing evidence of a strong link between breast cancer and pesticide/chemical use.

However just because an obvious link was not found does not mean that there is not a link and that should have been pointed out by the researchers.

The fact is that practically all of us in the industrialised countries have varying levels of chemical pollutants in our bodies but at the same time we all have differing genetic predispositions to developing cancer. It is widely accepted that there is a genetic link with some cases of breast cancer but most importantly, it appears to be an environmental risk factor which 'triggers' it off.

According to testimony from the First World Conference on Breast Cancer, held in Kingston, Ontario, Canada, in July of this year, up to 80 percent of breast cancer cases may be due to environmental pollutants.

Therefore it would be fair to say that one's level of man made chemical compounds and the likelihood of developing breast cancer is very much dependent on genetic factors, or to put it differently, it is dependent upon our individual genetic ability to tolerate these chemicals. As such, in breast cancer patients, their pesticide/chemical levels would not necessarily need to be

elevated in order to be an initiator of breast cancer. If this is the case, then any study which only looks at these chemical levels, would most likely fail to find a connection.

A good analogy would be asbestos. There have been cases of asbestosis being caused by a brief exposure to asbestos, whereas many workers who have had extended exposures have not developed the disease long after the expected latency period. From this we can conclude that there is also another factor to consider than just a level of exposure.

Considering this, for the authors of this study to conclude that "it is unlikely that these compounds cause breast cancer", simply cannot be justified.

It is concerning to note that Gwen Collman the study's administrator at the National Institute of Environmental Health Sciences, states that if the further studies fails to find a link between chemical exposure and breast cancer, "we can say we've answered that question, and do research in other areas."

It is of concern that this preliminary study will probably now be used by the petrochemical industry as evidence that their products are 'safe', in much the same way as the unrelated National Cancer Institute's Linet study (as reported in the last issue of Electromagnetic Forum ) is now being used by the power industry as proof that powerlines electromagnetic fields do not cause cancer.

In the Linet study, the authors concluded that "Children exposed to electromagnetic fields by living near electrical power lines are not more susceptible to developing leukemia." In fact the authors could only come to this conclusion by excluding higher exposures which DID find a significant correlation. They were able to do this by using a cut-off point, below which one would reasonably expect not to find a connection.

The main conclusion I can draw from the Linet study is that it's parameters are conveniently designed to minimise a possible connection between powerline EMFs and childhood leukemia. (2)

With the pesticide/chemical issue, if further down the track we find that the thousands of man made chemicals now in our environment amazingly are not associated with the increase in breast cancer incidence, than what another environmental pollutant may be the culprit for the continuing rapid rate of increase?

The European Parliament may have shed some light that question back in March 1992 in a resolution which stated:

"Thus in the frequency range 100KHz to 300 GHz, 50 years ago it was scarcely possible to measure 10pW/cm<sup>2</sup> on the ground in our countries. Today, depending on the location, values one million to one thousand million times higher are recorded because of the explosion of telecommunications. In the microwave range, the widespread use of the mobile phone, which involves the whole territory of the industrialised countries, will mean increased exposure.

Finally, in the case of low frequencies (powerline frequency), the multiple uses of electricity and the centralisation of its production, together with work on screens (computer monitors), are subjecting an increasingly sizable proportion of the population to high electromagnetic fields."

As mentioned on page 12 of this issue, research indicates that breast cancer tissue may be especially affected from exposure to radiofre-quency and microwave radiation and also that, in a

joint statement from several Australian government departments, it is admitted, "Laboratory studies on animals suggest that where cancer exists, radio waves may accelerate its growth."

Interestingly, it is the industrialised countries that have the greatest increases in breast cancer, with an apparent strong correlation with increasing electromagnetic exposures and breast cancer incidence. The USA. currently has the highest in the world with 1 in 8 women expected to contract this disease during their lifetime.

In conclusion we must consider the likelihood that no one factor will ever be found in isolation to be connected with the increasing incidence of this disease. In today's world we have an increasingly complex environmental mix of both chemical and electromagnetic pollution. It is known that combinations of chemicals can be far more toxic than each one in isolation. Evidence also indicates that the presence of electromagnetic fields can increase the toxicity of chemicals.

It is unfortunate that in a time of cutting back on environmental laws, exempting industries from these laws with increasing talk of risk-benefit considerations and cost effectiveness methods, polluting industries who only consider corporate profits and governments with their main priority on the national economy are all too ready to uncritically accept scientific studies which fail to find adverse effects and yet all too ready to reject those studies that do find a connection.

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## Effects of Electromagnetic Fields on Melatonin and Breast Cancer in the Laboratory

*Bary Wilson, Larry Anderson and Richard Stevens. Pacific Northwest National Laboratory, Richmond Washington, USA.*

(Abstract of paper presented at the First World Conference on Breast Cancer, held at Ontario, Canada, in July 1997.)

The hypothesis that exposure to man-made electromagnetic fields (EMF) and artificial light, or light at night (LAN) may be etiologic factors in breast cancer has been the subject of increasing interest and scientific investigation since it was first proposed in 1987. This hypothesis is based on the demonstrated ability of such exposures to decrease the production of the hormone melatonin, and on the observation that melatonin, in turn, protects against certain types of cancer. A number of epidemiologic and laboratory studies have now provided evidence to support this hypothesis. These studies include both in vitro and in vivo laboratory experiments wherein melatonin has been shown to have oncostatic action against several types of cancers. Particular attention has focused on breast cancer, where the ability of EMF exposure to increase breast cancer incidence in chemically treated animals and block the oncostatic effects of melatonin in human breast cancer cell lines has been demonstrated. This paper describes several

of these studies and discusses what is known about the mechanisms by which the hormone melatonin may influence cancer risk in humans.

Potential implications of the work on effects of EMF and LAN related to breast cancer risk and the possibility that breast cancer risk may be reduced by limiting these exposures, are also discussed.

## Living Downstream - **A walk up the river of breast cancer**

*(From Keynote speaker, Sandra Steingraber, PHD at the First World Conference on Breast Cancer, held in Ontario, Canada, in July 1997.)*

"There was once a village that overlooked a beautiful river. Every so often, a drowning person floated by, and the villagers who lived there did their best to save her. As time went by, the numbers of people caught in the river's swift current began to increase markedly, so the villagers set about developing ever more elaborate technologies to resuscitate them. So preoccupied were these heroic villagers with rescue that they never thought to look upstream to see what was pushing the victims in."

Quote from the book, "Living downstream: An ecologist Looks at Cancer and the Environment" By Sandra Steingraber, Published by Addison, Wesley, Longman Inc. Jan. 1997.

### **PLEASE NOTE:**

There are two distinct areas of the electromagnetic spectrum covered in this publication:

1. The powerline frequency range of 50 or 60 Hertz (cycles per second) which falls in the extremely low frequency (ELF) range of the electromagnetic spectrum, which ranges from 1 to 300 Hz. [Electromagnetic Fields] In this range electric fields are measured in Volts per metre (V/m) and magnetic fields in Amps per metre (A/m). The magnetic portion, referred to as the magnetic flux density is measured in units of either Tesla or Gauss. For fields normally encountered in the environment units are in milli-, micro-, or nanotesla (mT, uT, nT) or in units of Gauss, in milliGauss.(mG)

2. The radio and microwave frequency range (RF/MW). For radio frequency, this is 100 KiloHertz (KHz) to 30 MegaHertz (MHz). The microwave (MW) range spans from 30 MHz to 300 GigaHertz (GHz). [Electromagnetic Radiation] The usual unit of measurement for this range is for the power density level, expressed in units of watts per square metre ( W/m), milliwatts/cm sq. (mW/cm.sq.), or micro Watts/cm sq.(uW/cm/sq. Another unit is the Specific Absorption Rate (SAR) expressed as Watts/kilogram (W/k), which is the rate at which RF/MW radiation is absorbed in body tissues. The rate of absorption varies with frequency and body size but it is possible to determine approximately what intensity of the power density level produces a certain level of heating in the body.