

09FV003 – 09SR026

July 28, 2009

Rapid City Council and Mayor:

The attached information was provided by Mr. George Brown at the July 28, 2009 Public Works Committee meeting in response to applications submitted by Black Hills Power and Light for Fence Height Exception (09FV003) and SDCL 11-6-19 Review to expand a utility substation (09SR026) on property located at the east side of Fifth Street between Cleveland and Oakland Street.

This information is being distributed to the City Council at the request of the Public Works Committee.

Cancerphobia: Electromagnetic Fields and Their Impact in Residential Loan Values

James A. Bryant*
Donald R. Epley**

Abstract. This article examines the issue of cancerphobia or public fear that has been used in recent court cases as the basis for damages to residential and loan value. Special attention is given to methodology used by the appraiser to estimate the damages from electromagnetic fields and the residential property adjacent to the lines. All commonly used research tools suffer from measurement bias from the difficulty of statistical specification. Matched pair analysis will remain as the predominate tool of choice as it accurately reflects the public's opinion of value. The appraiser will need to be more careful to extract an accurate time adjustment to make older comparable sales useable in the current market. All users of comparable sales for property that is stigmatized will need to devote more resources to collection and sharing.

Introduction

A growing issue in recent court decisions is the award of consequential market value damages to residential homeowners for a perceived future health risk from the near proximity of electric power lines. Labeled "cancerphobia" by a recent New York court (*Criscuola v Power Authority of State of New York*, 1993), the public's perception of a health risk from electromagnetic fields (EMFs) has been the basis of a diminution of residential property value and compensable damages. This case reaffirmed the trend in eleven states that proof of public fear is an adequate basis for compensation even though scientific evidence is lacking. Using a similar argument, the California Supreme Court (*Potter v. Firestone Tire and Rubber Co.*, 1993) recently upheld a claim by nearby residents that living next to a toxic waste site was compensable providing they could show that their chances of developing cancer were higher than not developing it.

Cancerphobia has become an issue to any property owner who resides near a power line and the lenders who hold loans on those properties that may suffer a decline in market value. No known data exists to estimate the magnitude of the residential value influenced, but logic must produce a large value as every local community has power transmission lines.

*Dept. of Marketing, Quantitative Analysis and Legal Studies, Mississippi State University, Mississippi State, MS 39762 or jbryant@cobiltan.sstate.edu.

**Dept. of Finance, Insurance, and Real Estate, Washington State University, Pullman, WA 99164 or depley@wsu.edu

An examination of these court decisions is necessary as the legal philosophy used can be the basis for an expansion of this type of claim. Special attention is given to EMFs as power line easements are a frequent and typical appraisal assignment in almost every community. Further, this topic is frequently discussed among residential property owners who can easily recite a number of houses that are located near power lines in their neighborhood or city.

EMFs have already been identified as one type of "stigma" that can influence the value of the property negatively (Chalmers and Roehr, 1993). However, using the expectation of future health problems as the basis of "fear" is new to our literature. A correct definition and measurement of this new concept is critical as it can be a part of the future evidence in any stigmatized property. This is the purpose of this article.

Although the measurement tool for stigmatized income properties has been presented in the recent literature as the discounted loss of adjusted net operating income (Chalmers and Roehr, 1993), little agreement exists on the best estimation technique for residential properties. This article examines the issues that have been covered in a number of current cases to estimate the loss in residential value from fear. This information is critical to residential valuation in future appraisal assignments near a power line and to lenders who have loans on these properties.

Section two examines the fear issues in recent court cases. Section three discusses the appraisal measurement tools commonly used in the literature and the cases. Section four contains an evaluation of these tools. Section five is the conclusion.

X Current Court Cases

Cancerphobia and public fear of a future health hazard have arisen essentially in condemnation cases, typically involving a right-of-way. The Fifth Amendment to the United States Constitution requires that "just compensation" be paid to the owner when property is taken for a public use. The problem is what constitutes just compensation for a future event that is based on the fear that it may occur. Even though the parties will argue over the amount, there is no serious controversy whether the landowner will have to be compensated for the value of the easement. The controversy arises when fear of the easement causes the value of the remaining property located outside the easement to decline in value.

Fear Issue

Public fear has been used as a basis for damages in power line and gas or oil pipeline easement condemnation proceedings.¹ The issue of fear has also been litigated in reference to explosives when the United States Government condemned an additional safety zone around wharves used to load and unload explosives.² An interesting case involving fear occurred in Santa Fe, New Mexico when land was condemned for a highway to transport nuclear waste from Los Alamos to the Waste Isolation Pilot Project site near Carlsbad, New Mexico.³ In this case the court held:

Whether the transportation of hazardous nuclear materials is or is not safe is irrelevant; the issue is whether public perception of those dangers has a depressing effect on the value of the property not taken.⁴

In one case the controversy was over ghosts and whether the buyer had a right to cancel a contract for the purchase of a house that had a reputation for being haunted.⁵ It is important that the action was for the equitable remedy of rescission rather than an action at law for fraud because of the difference in the way equity treats representations.⁶ Furthermore, the reputation for ghosts was created by the seller's publicity in the national and local media.⁷ The court reasoned that because of the prior representations the house was haunted as a matter of law, therefore, the seller was not allowed to deny the existence of ghosts.⁸ The case was ultimately settled for \$25,000.⁹

In *Potter v Firestone Tire and Rubber Company*,¹⁰ the California Supreme Court ruled the plaintiffs in a toxic tort case may recover for fear of developing cancer. The plaintiffs resided next to a landfill where the defendant allegedly had dumped toxic waste. The significance of the Potter case is that fear was compensated with no relationship to land value.

EMF Controversy

EMFs are concerned with both electric fields and magnetic fields.¹¹ Electric fields are measured in volts per meter, and magnetic fields are measured in milligauss. While these fields are a form of radiation, they are nonionizing radiation. In contrast, X-rays and nuclear radiation are forms of ionizing radiation. The distinction between ionizing and nonionizing radiation is that ionizing radiation can dislodge electrons in an atom thereby rendering it a charged particle. Nonionizing radiation does not discharge electrons in atoms, and until recently, was not considered to be harmful.

One of the reasons the courts have difficulty dealing with this issue is that the scientific research is not conclusive. Many conflicting studies have been performed.¹² However, it has been established that low frequency magnetic fields can produce changes in biological systems.¹³ The public controversy surrounding power lines began in this country following the publication of an epidemiological study by Wertheimer and Leeper (1979) linking childhood cancer to the proximity of electric power lines to residences.¹⁴ While the Wertheimer and Leeper study has been criticized and was not conclusive, it did raise public concern.¹⁵ Additional studies, while not proving that EMFs cause cancer, certainly give enough credibility to a possible risk that a reasonable person could be concerned.¹⁶

Three Rules

There are three basic rules that are applied by the courts with respect to severance damages in power line condemnation cases.¹⁷ The first rule does not allow compensation for fear. The second rule allows compensation if the fear is reasonable.

The third either assumes the fear is reasonable or that reasonableness is irrelevant. The only relevant issue is the final impact on market value. The first rule which is sometimes referred to as the majority rule is the least followed of the three.¹⁸ The second or intermediate rule has a fairly wide following and has some appeal until it is examined carefully.¹⁹ The third or erroneously named minority rule seems to be the most followed of the three rules.²⁰

- * A recent survey mailed to real estate appraisers indicates that the proximity of high voltage power lines to residential property has a negative impact on the value of the property.²¹ This is in contrast to earlier research that did not indicate that the proximity of power lines had such a negative impact on residential property values.²² The Delancy and Timmons (1992) survey indicated an average decline of about 10% in the value of property located near high voltage power lines compared to property not so located.²³ It would be logical to expect that some of this decline is related to increased public awareness of the potential adverse health consequences from exposure to electromagnetic fields.²⁴

Case Law

One of the leading cases recognizing fear of electric power lines to be considered in assessing damages in an eminent domain case is *Hicks v. United States*.²⁵ One aspect that is interesting when considering *Hicks* is that it was decided in 1959, before the controversy about the harmful affects of electromagnetic fields became a public issue. *Hicks* dealt with incidental or severance damages to agricultural land suitable for residential development. The power line easement cut the farm in half with the towers and power lines visible from every point on the property. When considering the value of the property, the landowner was entitled to the highest and best use of the property, which in this case was development as a residential subdivision. The measure of damages to the remaining property was the difference in value of the land before and after the right of way was condemned. The court in *Hicks* seemed to accept that the fear of power lines was reasonable when it held:

The apprehension of injuries to person or property by the presence of power lines on the property is founded on practical experience and may be taken into consideration in so far as the lines and towers affect the market value of the land.²⁶

The court went on reciting, with approval, the Tennessee law on the subject, which provides:

It is a question for the jury whether a reasonable apprehension of danger from inherent defects and unavoidable accidents may exist, and, if so, such an apprehension so far as it depreciates the present market value of the land not taken is an element of incidental damages.²⁷

Another case decided before the current controversy about EMFs is *United States Ex Rel. T.V.A. v. Easement and Right of Way*.²⁸ The court accepted fear of injury from

power lines as partly responsible for incidental or severance damages. The land in question was neither exclusively suitable for farm or residential use. Since *Hicks*, TVA had conducted studies about the impact of power lines on property values and about the safety of power lines. These studies indicated that power lines did not adversely affect property values, that objectively power lines were safe, and the fear was unfounded.²⁹ The easement in question was 200 feet wide and extended diagonally across the land isolating a small diagonal tract. Ultimately the court approved incidental damages of 50% of the value per acre to the triangular tract and of a strip of land 100 feet wide on either side of the easement.³⁰ In so doing, the court relied on *Hicks* that fear of power lines was reasonable.³¹

In *Florida Power & Light Co. v. Jennings*,³² the Supreme Court of Florida rejected the intermediate rule and adopted the rule that public fear is a factor and may be considered whether or not it is objectively reasonable so long as such fear affects the value of the property.³³ At issue was severance damages or the diminution of the value of the remaining property after an easement for a 500,000 volt (500 kV) transmission line was condemned. The 500 kV lines would be supported by 115–125 foot high towers with 99 foot crossarms. Expert testimony of both an electrical engineer and an epidemiologist was introduced at the trial to establish a reasonable basis for the fear on the part of the buying public. Fear was one of the factors the appraiser took into consideration when testifying about severance damages to the remaining land.

The court in *Jennings* then examined the intermediate rule and how the scientific testimony introduced to show the reasonableness of the fear was more prejudicial than useful in establishing the amount of severance damages.³⁴ The scientific evidence was not introduced to show the adverse health effects but rather to form a basis for additional compensation for loss in property values resulting from public fear of electromagnetic fields. The testimony, rather than being relevant to show diminution in value of real property, was deemed so inflammatory and prejudicial as to require a new trial without such testimony.³⁵ The court noted the scientific testimony rather than aiding in a determination of the relevant issue of property damage confused the issue and the focus of the trial.³⁶ The court explained under the rule it was adopting “the reasonableness of the fear is either assumed or is considered irrelevant.”³⁷ The court concluded “any factor, including public fear, which impacts on the market value of land taken for a public purpose may be considered to explain the basis for an expert’s valuation opinion.”³⁸ Ideally the expert should use the value of comparable property with and without the power lines in arriving at the loss in value to the remaining land after the power line is in place.

Severance damages resulting from the condemnation of a 200 foot wide power line easement were an important issue in *San Diego Gas & Electric Co. v. Daley*.³⁹ The landowner wanted to introduce both expert testimony of the harmful biological effects of electromagnetic radiation and the effect public fear of overhead transmission lines had on property values. The line in question was a 500,000 volt transmission line. Some of the factors having an impact on the environment include noise, unsightliness and EMFs. Testimony indicated that the studies involving the harmful biological effects of EMFs were inconclusive and there was a controversy within the scientific

community. The landowner's appraiser testified that the greatest impact on the value of the remaining property was the visual impact and the irritation noise generated by the power line. Electromagnetic radiation was only one of several factors negatively affecting property value of the remaining property. Remote or mere fears are not compensable, however, any loss of market value resulting from the power line easement is compensable. The testimony with regard to a conflict about the health hazard and its affect on market value was properly admitted. It was also proper to exclude evidence about biological effects of electromagnetic radiation since the issue was not whether the power lines were a health hazard but rather whether fear affected the market value of the property

One of the most instrumental cases in the development of the law in dealing with fear of power lines is *Willsey v Kansas City Power & Light Company*.⁴⁰ The court recognized that remote, speculative and conjectural damages cannot be awarded, but concludes loss of market value that is proven with a reasonable degree of certainty should be compensable.⁴¹ The court in *Willsey* preferred the rule where market loss is compensated regardless of its cause thereby eliminating the need to deal with the reasonableness of the fear. However, since the facts were strong enough to allow recovery under the intermediate rule, allowing reasonable fears to be compensated, the court only had to adopt the intermediate rule.⁴² The court expressly rejected the rule that fear was unreasonable as a matter of law and held that the reasonableness of the fear was a question of fact.⁴³ Expert testimony at the trial went into detail on the subject of public fear of power lines. The expert who testified about the value of the land testified there is a latent fear of high voltage power lines on the part of the buying public.⁴⁴ It is based in part on what the public sees in newspapers, on television and what they hear on the radio. He also used the power company's own warnings to the public about the dangers of power lines to explain why the public is afraid of power lines.

The sequel to *Willsey* is *Ryan v. Kansas Power & Light Company*.⁴⁵ The Supreme Court of Kansas finishes what the court in *Willsey* wanted to do and adopts the rule that loss of value to land, because of public fear of power lines, is compensable regardless of the reasonableness of the fear. The issue in question is severance damages resulting when the power company condemned an easement for a 115,000 volt transmission line supported by "H" frame towers. The court in *Ryan* quoted with approval from *Willsey* the following:

In any condemnation case the objective is to compensate the landowner for damages actually suffered. Remote, speculative and conjectural damages are not to be considered; the owner cannot recover today for an injury to his child which he fears will happen tomorrow. *Logic and fairness, however, dictate that any loss of market value proven with a reasonable degree of probability should be compensable regardless of its source...*⁴⁶

The court in *Ryan* went on to clearly state its ruling with respect to its treatment of fear when it affects the value of property:

In a condemnation action to acquire an easement for installation of a high voltage electrical line we find evidence of fear in the marketplace is admissible with respect to the value of property taken without proof of the reasonableness of the fear. . . . fear of a high voltage line is reasonable.⁴⁷

After accepting that the fear of power lines was reasonable, the court in *Ryan* dealt with proof that fear existed in the marketplace.⁴⁸ Expert testimony would be required to establish the value of land because nonexpert witnesses were not qualified to testify as to the value of land.⁴⁹ The reason for allowing the expert witness to testify about fear is so the expert could explain the factors that were used in producing the estimate as to the value of the property. Even though the nonexpert was not allowed to testify about the value of the property, a qualified nonexpert testified to corroborate and provide a foundation for the expert testimony. The landowner and other nonexpert witnesses, if they are qualified, might give testimony about fear in the marketplace but were not allowed to testify about personal fears. Even experts are not allowed to testify about personal fears and are restricted to testimony about fear in the marketplace. Another source of evidence to show public awareness was information in the public press. Newspaper and magazine articles might be introduced to show public awareness or knowledge. These articles could not be used to show the truth of what the article purports to show but only for the purpose of showing public awareness.

The court in *Criscuola v. Power Authority of the State of New York*⁵⁰ held that landowners in a condemnation proceeding were entitled to recover for public fear without having to show the reasonableness of the fear. In its holding the court in *Criscuola* relied on and quoted from both *Willsey* and *Ryan*.⁵¹ Of concern in *Criscuola* was public fear of health risk from exposure to electromagnetic radiation and what is known as cancerphobia or the public's fear that everything causes cancer.⁵² Since the issue is market value, it does not matter if the danger is scientifically verifiable. The court explained the matter:

Should be left to the contest between the parties' market value experts, not magnified and escalated by a whole new battery of electromagnetic power engineers, scientists or medical experts.⁵³

The court further explained the proof requirements:

Some credible, tangible evidence that a fear is prevalent must be presented to prove the adverse market value impact. Claimants should have to connect the market value diminution of the property to the particular fear in much the same manner that any other adverse market effects are shown, c.g., by proffering evidence that the market value of property across which power lines have been built has been negatively affected in relation to comparable properties across which no power lines have been built...Thus, while a personal or quirky fear or perception is not proof enough, the public's or

the market's relatively more prevalent perception should suffice, scientific certitude or reasonableness notwithstanding.⁵⁴

Criscuola represents the culmination of an evolution of cases and the courts finding a way to deal with the issue of fear and property values. *Criscuola* also seems to represent the trend in the way power line condemnation cases are being decided with respect to severance or incidental damages.

Related Issues

Read

Other issues also exist that may create a greater problem for electric utility companies than added cost in procuring power line easements. If a causal relationship between exposure to electromagnetic fields and cancer or other serious health problem is established, the potential for personal injury tort liability is beyond comprehension.

While it was reversed on appeal, a jury awarded \$25 million in punitive damages against the Houston Power & Light Co. for abuse of discretion in taking an easement and erecting power lines near two schools.⁵⁵ The easement over the school ground was 100 feet wide and was for a 345,000 volt transmission line. After winning the reversal of the punitive damage award, the utility relocated the power lines which it should have done originally.⁵⁶

Traditional personal injury litigation must still get past the problem of proving causation. While the scientific evidence may be strong enough to create a reasonable basis for fear on the part of landowners, at present it is still difficult to prove that an individual plaintiff's cancer was caused by a particular power line. The causation problem has not prevented attempts at personal injury litigation.⁵⁷ One recent case went to trial and ended in a jury verdict for the defendant.⁵⁸ More such cases are being tried leaving the future uncertain. In addition to personal injury liability, there is also a potential for workers' compensation if it can be shown that on the job exposure to electromagnetic radiation causes cancer or other health problems. Whether or not power line litigation will be the next asbestos remains to be seen. The potential, however, certainly exists and electromagnetic field litigation could even exceed asbestos because power lines and other sources of electromagnetic radiation are all around us.⁵⁹

Summary of Measurement Tools

Recently, four states reaffirmed that reasonableness is not a factor in determining whether fear causes value to decline. Florida (*Florida Power and Light Co. v. Jennings*, 1987), California (*San Diego Gas and Elect. v. Daley*, 1988), Kansas (*Ryan v. Kansas Power and Light*, 1991) and New York (*Criscuola v. Power Authority*, 1993) insisted that the claimants present credible, tangible evidence to prove the adverse impact on value. None of these cases describe explicitly the measurement tools that were used to assess damages

Research Literature

The research literature classifies the tools used to estimate the impact of power lines on residential values into four groups: contingent valuation methodology and several types of statistical models including regression, matched pairs and the expert witness's opinion.

CVM. The first involves a contingent valuation methodology (CVM) that consists of a careful interview of the participants. Building on previous work by Patchin (1988), Chalmers and Roehr (1993) outline the framework in which valuation must take place for property that carries a stigma from contamination. CVM is a formalized technique of direct interviews of informed buyers, brokers, sellers and lenders to obtain opinions on the appropriate discount to be used in the valuation. One example explains the use of visual materials that show the difference between property before and after the contamination. The respondents indicated that an average discount of \$40,000, or approximately 10%, was appropriate. In the absence of reliable market sales, CVM is a straightforward technique of extracting a consensus of opinion on the amount of just compensation.

A mail survey can be used to extract market reactions, rather than the CVM approach which is a direct interview. Hoyt, Schwer and Thompson (1992) mailed a questionnaire to representative households to extract their concerns, or lack of concerns, when making a home purchase decision near a proposed nuclear waste repository and the transportation of these wastes on nearby roads. Their conclusion did not produce an estimate of loss in value, but did show awareness and knowledge of the location of hazardous waste facility reduces homeowner's concerns.

Delancy and Timmons (1992) conclude in their survey of the literature on the impact of high voltage power lines on residential value that little or no evidence exists that significant declines in value occur regardless of the methodology employed. They surveyed members of the Appraisal Institute to solicit opinions on the average property decrease in residential property value from an adjacent location to power lines. Appraisers who answered gave such reasons for a negative decline as unattractiveness, health problems, sound and interference with radio and TV reception. The measurement tools used in priority were matched pairs, public data including MLS, discussions with the public and appraiser opinion. The mean decline in value for all factors was 10.0%.

Only one reference could be located in the court cases that actually described the contents of a public survey (*City of Santa Fe v. Komis*, 1992). An expert witness conducted a survey of public perception of value and concluded the values had declined from 11%–30%

Regression Analysis

Both studies by Colwell (Colwell and Foley, 1979; and Colwell, 1990) are unique because they are among the few that have found a negative impact on residential

value. The first uses a regression equation that includes distance to the transportation line as an objective index of the extent of damage, and the second employs a hedonic price equation that holds the lot area constant. Both papers conclude that proximity to an electric transmission line is associated with a diminished selling price. This reduced value declines in magnitude with an increase in distance and visual impairment such as the growth of trees

Regression analysis has been used to estimate the decline in value from other types of contamination such as sanitary landfills (Ziess and Atwater, 1989) and nuclear waste disposal (Hageman, 1982). The dependent variable typically is the sales price, and the independent variables are the elements of comparison in the local market.

Matched Pairs

Matched pair analysis will be found as a tool in every condemnation appraiser's toolkit as it conveniently fits the eminent domain "before and after" rule. Value must be estimated prior and after the taking. The typical methodology is to locate similar sales prior and similar sales after and contrast the difference in price that would be attributable to the damage. The appraiser's problem is to show that any loss in value is from only the stigma (*US Ex. Rel. T.V.A. v. Easement and Right of Way*, 1968; and *Claiborne Electric Coop v. McKenzie*, 1978).

Expert Witness Opinion

Two expert witnesses on each side presented their professional opinions on the magnitude of buyer resistance (*Willsey v. Kansas City Power*, 1981). One witness based his opinions on personal dealings with landowners and his own personal feelings that buyers do not like (1) unsightliness of the lines and (2) latent fear. Part of the fear originated with the power company's advertisements that contained admonishments like "don't fly a kite near the lines," "don't get a ladder caught in the lines" and "don't get model planes caught in the lines." A real estate appraiser based his opinion on a perceived negative impact using three criteria of unsightly visual influence, excessive audible vibration and decreased marketing time of property located nearby.

Evaluation of Appraisal Methodology

Each of the four appraisal methods described in the previous section are evaluated next relative to the effectiveness of each in estimating just compensation.

Matched Pairs

The only reflection of the public's view of diminished value is measured through verified and reliable sales of comparable property that occurred before and after the contamination. This appraisal procedure will remain since it is part of the traditional

appraisal methodology that underlies the sales comparison approach that is universally applied by the courts.

The appraisers and the courts will need to be more diligent in locating and accepting sales from the market. For example, an older transaction could be acceptable providing the appraiser worked diligently to justify and use an appropriate time adjustment. Furthermore, sales from other similar situations in other regions could be acceptable providing the appraiser could prove that the market conditions and elements of comparison were similar in the comparable markets. Third, the appraisal trade organizations need to concentrate on the creation and maintenance of data files on sales of property that could be stigmatized.

CVM and Mail Surveys

A direct interview (CVM) or answers to a mail questionnaire will never simulate the actual transaction as money is not involved. An individual cannot accurately estimate his/her reaction without the pressure of the transaction, negotiation and financial commitment.

Also, a direct interview or mail survey can be meaningless unless the survey instrument is very carefully crafted. Otherwise, the results can be self-fulfilling. Any one respondent will answer that a negative impact will occur from any perceived nearby pollution of the environment, such as transmission lines. Also, questions that ask the amount of potential decline in property values are similar to a doctor of medicine asking a patient to diagnose the illness and determine the degree of medicine.

More time and analysis needs to be devoted to the location of valid comparable sales rather than the construction of a survey instrument. Older sales or sales from other markets can provide estimates of value that are more meaningful than the opinions of local potential buyers, sellers and lenders who must simulate their behavior in a hypothetical situation.

Expert Witness Testimony

An estimate of value given in court by an expert witness should not be allowed or used unless the expert will certify that the Uniform Standards of Professional Appraisal Practice have been followed. Only licensed appraisers can qualify as experts, and their testimony must follow standard appraisal procedure. Thus, any estimate of value and reduction of value must be supported by market and statistical analysis.

The use of expert witnesses will continue as the court system relies on their testimony for valuation estimates. The level of accuracy in their valuation estimates should increase significantly with the advent of the Uniform Standards in 1987. The courts will no longer be concerned that the expert's opinion is not supported with market

analysis. Under these standards, oral court testimony must rely on a workfile that contains all data used and analysis

Regression Analysis and Other Statistical Tools

Regression analysis is the typical research tool of choice of the real estate analyst. It will continue to be used as long as a substantial quantity of comparable sales exists.

All statistical tools have difficulty with the specification and accuracy of intangible variables such as fear. Power line EMFs are one type of pollution that contributes to electromagnetic radiation in the environment. Other sources potentially include TV, radio, cellular phones, microwave ovens and natural occurring magnetic fields. Separation of the effect of the powerline EMFs from the others and the exact statistical measurement of its influence alone with no interaction is a very difficult task.

Further, the error terms from the regression most likely contain valuable information that is not easily extracted without the application of sophisticated econometric techniques. The results give information that is used to interpret the accuracy of the estimating equation, but do not produce direct information on the source of the negative influence

A fruitful approach for future research is to quantify and estimate the impact of the variables that we know are measurable, such as square footage, location, bedrooms, baths, etc., and lump all negative influences from all sources into one variable. The magnitude of the coefficient of this variable and its significance is derived from a negative influence that is the "most obvious" or the "most proximate."

Several recent court cases have stated that the claimants do not have to prove the reasonableness of the expectation of public fear. They must present credible evidence that public fear causes buyer resistance. The three methods of estimation that have been used are: (1) interviews with the public either directly, called contingent valuation methodology, or by mail survey; (2) regression analysis with comparable sales; and (3) an opinion from an expert witness.

This article argues that the estimation of value and damages in stigmatized properties should not stray too far from the use of comparable sales. The analyst should be more diligent in the market analysis to extract a useable time adjustment to make an older sale current and reliable, and to find properties in similar markets in other regions that are comparable to the subject property.

All measurement techniques suffer from specification and reliability in that adequate data does not exist to separate the impact of the EMFs from other negative influences on property value.

Conclusion

This article has examined fear or cancerphobia and its impact on residential and loan values. Historically, the issue of fear has been used in the assessment of severance

Notes

¹Vitauts MGulbis, Annotation, Fear of Powerline, Gas or oil Pipeline, or Related Structure as Element of Damages in Easement Condemnation Proceedings, 23 A.L.R. 4th 631 (1983)

²*United States v 760 807 Acres of Land*, 731 F.2d 1443 (1984)

³*City of Santa Fe v Komis*, 845 P.2d 753 (N.M. 1992).

⁴*Id.* 760.

⁵*Stambousy v. Ackley*, 169 A.D.2d 254, 572 N.Y. S.2d 672 (1991).

⁶*Id.* 675

⁷*Id.* 674.

⁸*Id.*

⁹See Goldberg (1994).

¹⁰836 P.2d 795 (Cal. 1993).

¹¹See Krieger (1994).

¹²See Weiss (1990).

¹³*Id.*

¹⁴See McCune (1991)

¹⁵*Consumer Reports* (1994).

¹⁶*Id.* 355.

¹⁷*Willsey v Kansas City Power*, 631 P.2d 268 (Kan. App., 1981).

¹⁸*Id.* 274.

¹⁹*Id.* 275.

²⁰*Id.* 274.

²¹See Delaney and Timmons (1992).

²²*Id.* 316.

²³*Id.*

²⁴*Id.* 324.

²⁵266 F.2d. 515 (6th Cir., 1959).

²⁶*Id.* 521.

²⁷*Id.*

²⁸405 F.2d 305 (6th Cir., 1968)

²⁹*Id.* 308.

³⁰*Id.* 309.

³¹*Id.*

³²518 So.2d 895 (Fla., 1987).

³³*Id.* 899.

³⁴*Id.* 895

³⁵*Id.* 899.

³⁶*Id.*

³⁷*Id.*

³⁸*Id.*

³⁹253 Cal. Rptr 144 (Cal.App., 1988)

⁴⁰631 P.2d 268 (Kan. App., 1981)

⁴¹*Id.* 277.

⁴²*Id.* 279.

⁴³*Id.*

⁴⁴*Id.* 271.

⁴⁵814 P.2d 528 (Kan., 1991)

⁴⁶*Id.* 533.

⁴⁷*Id.*

⁴⁸*Id.* 535.

⁴⁹Id.

⁵⁰621 N.E.2d 1195 (N.Y., 1993)

⁵¹Id.

⁵²Id.

⁵³Id. 1196

⁵⁴Id. 1197

⁵⁵*Houston Power and Lighting Co. v. Klein Independent School Dist.*, 739 S.W.2d 508 (Tex. App., 1987).

⁵⁶See Weiss (1990, note 12)

⁵⁷See Krieger (1994, note 11)

⁵⁸Id.

⁵⁹Id.

⁶⁰U.S. Const. Amend. V.

References

- Chalmers, J. and S., Issues in the Valuation of Contaminated Property, *The Appraisal Journal*, 1993, 61, 28–41.
- Colwell, P., Power Lines and Land Value, *Journal of Real Estate Research*, 1990, 5, 117–27.
- Colwell, P. and K. Foley, Electric Transmission Lines and the Selling Price of Residential Property, *The Appraisal Journal*, 1979, 490–99.
- Consumer Reports*, Electromagnetic Fields, 1994, 59, 354.
- Delaney, C. and D. Timmons, High Voltage Power Lines: Do They Affect Residential Property Values? *Journal of Real Estate Research*, 1992, 7, 315–30.
- Goldberg, D., Realty and Market Value, *The Appraisal Journal*, 1994, 62, 473–74.
- Hagman, R., Nuclear Waste Disposal. Potential Property Impacts, *Natural Resources Journal*, 1982, October, 789–10.
- Hoyt, R., R. Schwer and W. Thompson, A Note on Homebuyer Attitudes Toward a Nuclear Repository, *Journal of Real Estate Research*, 1992, 7, 227–33.
- Krieger, R. W., On the Line, *ABA Journal*, 1994, 40–45.
- McCune, P. S., The Power Line Health Controversy: Legal Problems and Proposals for Reform, *University of Michigan Journal of Law Reform*, 1991, 24, 429–68.
- Patchin, P., Valuation of Contaminated Property, *The Appraisal Journal*, 1988, 56, 7–16.
- Weiss, J., The Power Line Controversy. Legal Responses to Potential Electromagnetic Field Health Hazards, *Columbia Journal of Environmental Law*, 1990, 15, 359–88.
- Wertheimer and Leeper, Electrical Wiring Configurations and Childhood Cancer, *American Journal of Epidemiology*, 1979, 109, 273–84.
- Ziess, C. and J. Atwater, Waste Facility Impacts on Residential Property Values, *Journal of Urban Planning and Development*, 1989, 115, 123–34.



The resonance effect between EMF and the surfaces of cells may help explain the strange window effect. To understand why, an analogy may be made with the noisy shaking of water pipes sometimes observed when running water from a faucet. As the faucet is opened, a small flow presents no problem. Then, as the initial low flow is increased, a loud noise may occur due to pipe resonance. When the flow is increased even further, the effect doesn't get worse, and usually it stops.

The shape of the magnetic pulse also seems to play a role, too, as different pulse shapes cause different effects. The strength of a 60 Hz EMF field from power lines and household wiring increases and decreases smoothly, while the VLF field from a VDT has a saw-tooth pattern. All this complicated evidence makes it difficult to reach any conclusions on what level of EMF exposure is safe and what isn't. The consensus is that more research is needed.

ELF AND VLF RADIATION

There are two frequency ranges for magnetic fields which are commonly found around our homes and businesses ELF (extremely low frequency) which radiates from a 60 Hz current, such as power lines, and VLF (very low frequency) which comes from the 15 kHz to 85 kHz scanning frequencies of TVs and cathode ray tube video displays. The full ELF frequency range is between 0 Hz and 1,000 Hz, and the VLF range extends from 1,000 Hz (1 kHz) to 500,000 Hz (500 kHz).

THE GAUSS METER

A Gauss is a common unit of measurement of AC magnetic field strength. A Gauss meter is an instrument which measures the strength of AC magnetic fields. Inside a Gauss meter there is a coil of thin wire, typically with hundreds of turns. As a magnetic field radiates through the coil, it induces a current, which is amplified by the circuitry inside the Gauss meter. If a Gauss meter were to have an induction coil with approximately 40,000 turns, a relatively low magnetic field strength of 1 milliGauss (1,000 milliGauss = 1 Gauss) would induce enough current to be read directly with a voltmeter. It is more practical, however, to build a Gauss meter with fewer turns and, through operational amplification circuitry, to increase the voltage or current and then calibrate the meter to read in Gauss or milliGauss (mG).

On occasion, you may encounter different units of measurement for magnetic fields, such as a Tesla, a micro-Tesla (uT), a nano-Tesla (nT), and milliamps per meter. These units are related as follows:

1 Tesla = 10,000 Gauss (A Tesla is 10,000 times larger than a Gauss)

1 Gauss = 1,000 milliGauss (mG) (A Gauss is 1,000 times larger than a milliGauss)

1 milliGauss (mG) = .0000001 Tesla = .0001 milliTesla (mT) = .1 microTesla (uT) = 100 nanoTesla (nT)

1 milliGauss (mG) = 80 milliamps/meter

start here

*POWER LINES

An enormous amount of electricity is created at power generating stations and sent across the country through wires that carry high voltages. These voltages can be 69,000, 100,000, 161,000, 230,000, 500,000, or even 765,000 volts. All power lines emit magnetic and electric fields. The electric field is proportional to the line voltage, while the magnetic field depends on the load current.

Typically high voltage transmission lines carry high current and therefore give off both high electric and high magnetic fields. The ELF magnetic field emitted by a 500,000 volt transmission line can be as high as several hundred mG directly underneath the power line, and the field can still be measured (at reduced levels) more than a thousand feet away. Unfortunately, the problem of EMF does not end with high power transmission lines. Networks of secondary distribution lines criss cross most cities and towns, and these distribution lines have strong magnetic fields, even if one is 10-50 feet away.

The amount of EMF coming from a high power transmission line depends upon its particular configuration. Power

companies know which power line configurations are best for reducing EMF, but most utilities feel that the evidence so far does not support costly changes in the way electricity is delivered. ②

One of the more common transmission line configurations is called a "vertical double-circuit," where a set of three cables is attached, one on top of each other, to each side of the transmission tower. The three cables in each set comprise the "three phases" of the power network, with each cable carrying current. The current peaks in each cable are intentionally out of phase with each other (i.e., they don't peak at the same time) by 1/3 of a cycle. Electric utilities use the letters A-B-C to denote a three phase circuit, with each letter representing one cable and its phase. EMF can be reduced by 50 percent or more with very little expense by reversing the phase order in one circuit with respect to the other (i.e., C-B-A). This configuration causes both the electric and magnetic fields to partially cancel each other. In early 1989, the Bonneville Power Administration adopted this scheme for implementation on both old and new transmission lines. This configuration is not used by most utilities, however, because it creates interference with nearby TVs and radios, and it causes snapping and buzzing noises.

A single-circuit transmission line still has three cables, one for each phase. Typically the three cables are strung in a flat configuration, with all three cables in the same plane. Significant cancelling can be achieved by merely changing from a flat configuration to a "delta" configuration, with the three cables forming a triangle. Moving the cables closer together also helps to cancel the fields, but it reduces safety for the maintenance workers and degrades the line's performance during lightning.

Sometimes burying electric power lines can reduce EMF, but this is not necessarily the case, as magnetic fields travel through dirt, rocks and cement. Unless the underground lines are configured to reduce EMF, simply hiding the lines out of sight may create a false sense of security. If the underground service is just a single phase wire, radiation levels on the ground directly over the wire will be higher than from overhead lines because you will be closer to the source. On the other hand, some underground lines have several circuits which can be balanced to cancel the magnetic field.

In a 1991 study conducted by the Electrical Systems Division of the Electric Power Research Institute, researchers found that magnetic fields produced by underground cables vary by as much as 10 to 1, depending on the method of installation and cable construction. According to the study, a person standing directly over an underground cable with the worst configuration (from an EMF perspective) will be exposed to the same level of EMF as a person standing at the edge of the right-of-way for an overhead transmission line. Unfortunately, the study also found that the best configurations for the lowest EMF are less efficient for electric power transmission.

With concern about EMF in mind, new and different underground cable systems are being developed. The lowest field underground design has three insulated cables lying adjacent to each other in an oil-filled pipe that cools the cables. This configuration can result in magnetic fields 1/10 to 1/20 of the equivalent overhead line. The EMF can be reduced even further, sometimes to near ambient background levels, if the pipe is grounded in a special way.

SUBSTATIONS

Read

A substation is an assemblage of circuit breakers, disconnecting switches, and transformers designed to change and regulate the voltage of electricity. Primary distribution lines, carrying high voltages typically of 115,000 volts to 230,000 volts, bring the current from the power plant to the substation, where the transformers reduce it to lower voltages, typically 4,000 to 13,800 volts. The transformers give off magnetic fields because they depend upon magnetic fields to operate. (See discussion of transformers under "The Nature of Electromagnetic Radiation.") Further compounding the problem, the incoming and outgoing currents at a substation are generally unbalanced. High magnetic fields from substations have been blamed for causing cancer clusters among nearby residents.

Paul Brodeur wrote about several such cancer clusters in the July 9, 1990, issue of the New Yorker. Citing evidence that a cancer cluster had occurred among the residents of Meadow Street in Guilford, Connecticut, Brodeur pointed out that during a twenty year period, seven tumors - four brain tumors, an eye tumor, an ovarian tumor, and a bone tumor - were recorded among the residents. This was particularly extraordinary since the street has only nine houses. The cancer victims lived in five of six adjacent houses located near an electric-power substation and next to a pair of 115,000 volt high-current distribution lines, called feeders, which carry current to the substation. Measurements of magnetic fields taken at that time near the peripheral fence around the Meadow Street substation showed magnetic fields ranging from

20 mG to several hundred mG.

NEIGHBORHOOD TRANSFORMERS

A key component of a utility's electrical distribution network depends upon numerous, small transformers mounted on power poles. A transformer looks like a small metal trash can, usually cylindrical. Even when the electrical service is underground, you will often see a metal box (usually square) located on the ground near the street. Many people don't realize that when they see a transformer, the power line feeding the transformer is 4,000 to 13,800 volts. The transformer then reduces the voltage to the 120/240 volts needed by nearby homes. Since these transformers can be seen in almost every neighborhood, they are a source of popular concern.

The ELF magnetic field near a transformer can be high, but due to its small structure, the field strength diminishes rapidly with distance, as it does from a point source. In fact, measurements at street level directly underneath a power pole transformer are no greater than underneath the power lines themselves. Ground level transformers may have readings as high as 200 mG right next to the box, and 50 mG at 4 inches away. Fortunately the fields drop off quite rapidly, with a 3 mG reading at 2 feet, and near ambient levels 10 feet away. For this reason, having a transformer located near your home is not usually a major source of concern, although just to make sure, you should measure the field strength around it.

WIRING INSIDE THE HOME

WARNING: DO NOT TOUCH ELECTRIC WIRES, EVEN IF YOU THINK THE CURRENT IS TURNED OFF. IF YOU NEED TO DISCONNECT ELECTRICAL CIRCUITS TO DETERMINE THE SOURCE OF MAGNETIC FIELDS, YOU SHOULD CALL A LICENSED ELECTRICIAN.

AC magnetic fields can be found inside everyone's home. These fields can come from power lines outside the home, wiring inside the home, and appliances. Some experts feel a background level of less than 1 mG is desirable, but many homes have readings much higher than this level. If your home has high EMF readings, it is important to determine the sources of the magnetic field so that remedial action can be taken, if possible. Often the source of a high AC magnetic field is incorrect wiring, so it is important to understand how you can correct this problem.

Household electric current comes through two hot wires and one neutral. For appliances that require 240 volts, the "hots" are put together; for appliances and outlets that need only 120 volts, just one hot wire is used. Modern homes have electrical outlets with three holes - two rectangles and a smaller half-round hole at the bottom. The rectangle on the right is smaller, and this is for the hot wire. The rectangle on the left is larger, and this is for the neutral wire. The ground is wired to the bottom, half-round hole in each outlet. The most important consideration in wiring a house is that the ground and neutral wires be kept separate and run directly back to the panel box (either a fuse box or a circuit breaker box), where they are grounded. This is a requirement of the National Electrical Code (NEC). Under no circumstances should the neutral or ground wires be grounded to the plumbing or any other ground except at the panel box.

Electric current needs to flow through a closed loop in order to work. This closed loop is referred to as a circuit. To understand how the current is supposed to flow in a correctly wired circuit, let's examine a circuit used to power a refrigerator. From the panel box electricity flows through the hot wire to the refrigerator, where it turns the motor. The electricity then flows back through the neutral wire to the panel box. With the loop closed in this way, the field is canceled out because the hot and neutral wires are close together. A ground wire runs from the panel box to the refrigerator, but if everything is wired correctly then the ground carries no current. The ground is for safety reasons, so that you will not get electrocuted in case the insulation on the hot wire becomes worn and the hot wire comes into contact with the frame of the refrigerator. The frame of the refrigerator is connected to the ground, so that any stray current from a worn or loose wire will flow back through the ground instead of through your body.

If the neutral has been grounded to your plumbing instead of running back to the panel box, your house is wired incorrectly, and this may result in a significant magnetic field. Suppose this is the case. Tracing the flow of the electric current from the panel box to the refrigerator, after the electric current powers the refrigerator it will run to the neutral and, if wired incorrectly, through the plumbing where it is grounded. Since it is no longer paired with the hot wire, the magnetic field will not cancel out. Instead, there will be a magnetic field around the hot wire that is connected to the

refrigerator, and another field may surround all your plumbing. Just one incorrectly grounded appliance can send electricity through all your water pipes, and create a magnetic field throughout your entire house! Changing the plumbing from metal to plastic is not a proper solution, because electric current is not supposed to flow through the plumbing. The only solution is to rewire correctly, with all hot and neutral wires paired closely together, and without any current flowing through the ground wire or through your plumbing. (4)

Ground currents from underground non-electric utility lines have also been implicated in as a major source of EMF in the home. Present regulations in the United States require that utility lines such as gas, cable TV, telephone, and water be connected at each residence to the same ground as used for electric current. This practice "provides an alternate path for the [neutral return] current to flow from your house back to the distribution system," says Gary Johnson, an executive at a General Electric facility doing EMF research for the Electric Power Research Institute. As a result, an imbalance is created which reduces the cancelling effect of the neutral's field on the hot conductor. This little-known fact can be an eye opener for explaining mysterious EMF in some homes. According to Johnson, you could create fields in your neighbor's house when you switch your appliances on and off, and your neighbor could create them in your house, too. This phenomenon can also account for fields outside of the home and in overhead distribution lines.

Still another source of EMF comes from the power line where it enters your home. The area of your home near this feeder line will have a reading even if the rest of the house is properly wired. If your supply line enters your home with an overhead wire, as opposed to underground, you may want to avoid using a corner of your home, or part of a room, for any prolonged period of time.

To test your home for magnetic fields, simply walk through your home with an ELF Gauss meter. If the reading is generally below 1.0 mG except near appliances, your home is wired correctly. If you find extensive zones of higher readings, you need to first determine if the EMF is coming from your own wiring or from a source outside your home. To start, walk outside and see what the readings are around your home. Then turn off your electricity at your panel box and check inside your home. The results will tell you if you need to go further and check your wiring.

If you suspect that your home is wired improperly, obtain the services of a licensed electrician. Ask the electrician to disconnect all circuits at the panel box and test one circuit at a time. If your home has circuit breakers, you can just turn off all the circuit breakers and turn on one at a time. Then take a reading throughout the house with the Gauss meter. As an alternative, your electrician can test for the presence of unwanted ground currents with a clamp-on ammeter attached to your plumbing (it should read zero), but a Gauss meter is still recommended as it is generally more sensitive and doesn't require open access to the plumbing. This way, you'll be able to determine which circuits or appliances are causing the problem. Hopefully only a single circuit will be responsible for most of the trouble, but sometimes the house is in need of complete rewiring.

Automatic ice makers in refrigerators and in-sink disposal units are often the source of unwanted EMF since these devices are usually connected through copper piping to your plumbing. It is important that these devices be wired so that no current flows through the ground.

COMPUTER DISPLAYS

A video display terminal (VDT) is used to display information from a computer, either in the form of text or graphics. A VDT can be one of several different types: cathode ray tube (CRT), liquid crystal display (LCD), gas plasma display, and electroluminescent display. By far the greatest percentage of video displays are of the CRT type, and for this reason the term "VDT" is generally used to mean the CRT-style VDT.

CRT-STYLE VDTs

A CRT-style VDT uses the same type of picture tube as a television set. The cathode ray tube is a large vacuum tube made of glass, and coated with phosphor on the inside. An electron gun shoots a beam of electrons from the back of the tube toward the front of the screen (i.e., toward the computer operator) until it hits the phosphor. The phosphor gives off visible light when it is excited by the electrons. A full screen image is comprised of thousands of dots, each one of which is refreshed (re-excited by a burst of electrons) between 50 and 80 times per second.

A CRT's resolution is expressed as two numbers, such as 640 X 480, 800 X 600, 1024 X 768, 1280 X 1024, 1600 X 1200, or more. The first number is the number of horizontal dots, or pixels, between the left and right sides of the screen, and the second number is the number of vertical dots between the top and bottom of the screen. The electron beam starts in the upper left corner of the screen, and then scans each horizontal line from left to right, one at a time, lighting up whatever pixels are required to comprise the picture. At the end of each line, the electron beam is pushed back to the beginning of the next line, where it begins another horizontal scan. The deflection coils, which are wound around the yoke (the rear, narrow part of the tube) of the CRT, control the movement of the electron beam as it sweeps across the screen. The horizontal deflection coils push the electron beam from side to side between 15,000 and 85,000 times a second or more (corresponding with a scan rate of 15 to 85 kHz), and the vertical deflection coils push the electron beam from the bottom line back to the top line 50 to 80 times a second or more (corresponding with a refresh rate of 50 to 80 Hz).

CRT-style VDTs give off all sorts of electromagnetic radiation: radio waves, infrared radiation (heat), visible light, ultraviolet light, microwaves, X-rays, ELF and VLF radiation. The radio waves are typically shielded with a layer of conductive material in order to meet the limits set by the Federal Communications Commission. The infrared radiation in the form of heat is not a health hazard, and of course the visible light is necessary in order to see the screen. The levels of ultraviolet light are substantially less than indoor fluorescent lights or outdoor sunlight, and the amount of microwaves is so small that it is almost undetectable. X-rays were once a problem, but strict guidelines in effect since 1970 have reduced the level of X-rays to less than what is naturally present in the environment. Most experts now agree that X-rays from CRT-style VDTs pose no problem unless the display is defective.

It is the ELF and VLF electromagnetic radiation from CRT-style VDTs which is presently raising concern. The ELF radiation (50 Hz to 80 Hz) comes from the vertical deflection coils, and the VLF radiation (15 kHz to 85 kHz) results from the horizontal deflection coils. CRT-style VDTs also have a power transformer which creates a 60 Hz field, and a flyback transformer which steps up the CRT's voltage to tens of thousands of volts and emits VLF electromagnetic radiation.

The levels of EMF emitted by a VDT can be quite high, but the measurements drop off rapidly with distance. That's why it is important to sit back at least an arm's length from the front of the screen. Measurements taken from a typical color VDT (a popular 13 inch color display was used for this test) show 37 mG of ELF at 6 inches, 12.6 mG at 12 inches and 4.5 mG at 20 inches. The VLF field (which contains several hundred times more energy than an ELF field at the same mG reading) is 6.3 mG at 6 inches, 2.0 mG at 12 inches, and .66 mG at 20 inches. At 6 to 7 feet the ELF level drops to background, but the VLF level is still measurable 10 feet away.

Because the EMF comes from the internal components, the EMF levels on the back and sides of a VDT are higher than in front, often by a factor of 2. This means you must distance yourself further away from the back and sides of a VDT (at least 3 to 4 feet, respectively) in order to achieve the same level of exposure. Smaller VDTs are not necessarily better, either. A 15 inch VDT might well generate a stronger magnetic field than a 21 inch one, because the field's strength depends more on the internal design of the deflection coils and electronic components than on the screen size.

The electric components of a VDT consist of an electrostatic potential and alternating electric fields at ELF, VLF and radio frequencies. The electrostatic potential results from a build-up of an electric charge on the surface of the screen. Its effect is similar to what most of us have experienced when we get a static shock by walking across a carpet and touching a metal object in a dry environment. This static may attract dust on your screen and cause eye irritation. On some occasions, skin irritations have been reported, although this is infrequent and the cause has not been proven. Fortunately, no long-term or serious health effects have been attributed to the electrostatic or alternating electric fields. Moreover, the electric fields can easily be blocked by incorporating a grounded conductive layer into an anti-glare shield.

On the other hand, ELF and VLF magnetic radiation is not easy to block. Low frequency magnetic fields can easily travel through layers of solid aluminum, copper or steel with little reduction in strength. Further, unlike an electric field which travels in a straight line, a magnetic field loops outward in curves, forming an irregular, rounded envelope of energy. Adding to the problem is the source of the EMF, which is not the front of the screen but the deflection coils, flyback transformer, and power supply inside the VDT. The EMF travels up and over the top of the screen, around the sides, and underneath in all directions.

However, pregnant women and their unborn fetuses are not the only ones at risk. CRT-style VDTs can emit levels of ELF magnetic radiation which is far higher than 2 to 3 mG (the level associated with higher risks of brain tumors, leukemia and other cancers). A link between VDT use and cancer has not been established, but this does not mean there is no danger. Consider the fact that the vast majority of VDT operators in the U.S. are women and that the incidence of female breast cancer has been rising steadily along with VDT use. Breast cancer now accounts for 29% of all cancers among women, and an astounding 1 out of 9 women will contract the disease. ①

Because of the relatively short period of time computers have been used, more studies are needed before there is conclusive evidence regarding adverse long-term effects. However, with the extremely strong evidence that ELF magnetic radiation increases the incidence of leukemia and brain cancer, some experts fear that long-term VDT use will also be shown to increase the likelihood of contracting cancer, and/or inhibit the ability of the computer operator to fight off cancer that might otherwise be held in check or destroyed by the body's immune system. Remember that power lines have been around for one hundred years and the cancer link is just now being established. It took over 40 years of research to conclusively establish the dangers of smoking. VDTs have only been widely used for the past twenty years. X

Other less severe problems sometimes associated with VDTs are headaches, fatigue, nausea, dizziness, irritability, skin redness or rashes, and eye strain. X

THE SWEDISH STANDARD

Sweden has been a leader in developing recommended visual ergonomic and electromagnetic emission standards for computer displays. In 1987 the Swedish National Board for Measurement and Testing (MPR) introduced the first, non-mandatory testing procedures for VDTs. The test methods, called MPR 1, specified a maximum of 50 nT (.5 mG) of peak VLF magnetic field strength in the 1 kHz to 400 kHz range at 50 cm (19.7 inches) from the front of the screen. The full test procedure called for 16 measurements taken on 5 horizontal planes at 22.5 degree intervals all around the display F for a total of 80 measurements in all. No ELF requirements were included in the MPR 1 standard, because widespread concern over ELF radiation was just developing.

On July 1, 1991, new guidelines became effective. The new test methods, called MPR 2, specify less than 2.5 mG rms (root mean square) of ELF magnetic emissions in the 5 Hz to 2 kHz range (Band 1) and less than .25 mG rms of VLF magnetic emissions in the 2 kHz to 400 kHz range (Band 2). The number of measurements was reduced to 48 for each band F taken at 50 cm (19.7 inches) starting from the front of the screen and every 22.5 degrees all around the display (16 points) on each of three horizontal planes 25 cm apart.

The change in the VLF standard from the previous .5 mG peak to .25 mG rms, as explained by Lars-Erik Paulsson of Sweden's National Institute of Radiation Protection, is not a tightening of the standard, but rather a change in the method of measurement. "The two limits are essentially the same," Paulsson stated, because "the peak value is the maximum reading during each cycle, while the rms value is a time-weighted average." Commenting on this, electrical engineer Mark Kettering says that "using an oscilloscope to study the wave forms from VDTs shows that the two limits are not 'essentially the same.' The shape of the wave form (mG vs time) varies, depending upon the manufacturer. Some VDTs have sharp spikes in their wave form, but the rms value essentially ignores these spikes." Based on current knowledge, it is not known which method of measurement is most appropriate.

MPR 2 also includes guidelines for visual ergonomics (such as focus, jitter and character distortion), X-ray radiation (which is not a problem), electrostatic potential, electrostatic discharge, and AC electric fields. The source of the electric fields are the power supply and deflection coils. These components can also create a surface potential of several kilovolts, depending upon humidity, temperature, air velocity and ion concentration in the air. Reduction of the electrostatic potential and the electric fields is normally achieved by a conductive surface coating on the screen, which is connected to the power ground, together with metallic shielding of the power supply. Sometimes a CRT-style VDT will include a metal cage around all the components, or metal foil on the inside of the cabinet, to help shield the electric field.

The Swedish guidelines have received a formal embrace from many major manufacturers of computer displays. Yet even in Sweden there is not a complete consensus on the limits. A major Swedish union (the Swedish Confederation of Professional Employees, or TCO) is seeking more stringent limits and test protocols F as low as 2 mG for ELF magnetic fields at 30 cm (12 inches) from the front of the screen. Their reasoning is that levels above 2 mG have been linked to

increased risks of cancer, and that many VDT users' heads, hands and/or breasts are often closer than 50 cm from the screen. Some experts have also questioned the validity of .25 mG for VLF, pointing out that the higher frequency VLF field contains more energy than ELF. These experts say that if induction levels are used to measure the amount of energy in the radiation, then 2.5 mG of ELF is equal to .01 mG of VLF. MPR's response is that "there are no proven biological reasons" for limiting VDT EMFs, and that the guidelines are not based on health risks. Rather, the recommended limits are based on what is technically feasible to measure and on what is achievable "today or within the near future."

This presents a dilemma for VDT users: If a computer display meets the Swedish guidelines, is it safe? No one can say for sure, since there are no conclusive studies which quantify the danger. On the other hand, there is no harm in being cautious. This means when buying a VDT you should know whether it meets just MPR 1 (in which case the ELF fields could still be quite high), or whether it complies with MPR 2, which includes ELF measurements. Purchase your low radiation VDT from a reputable company, or bring along a Gauss meter and buy the display with the lowest emission levels, not just the one which claims it meets the Swedish standard.

The United States does not have any regulations governing ELF and VLF emissions from VDTs. FCC requirements deal only with radio frequency emissions.

For health enthusiasts, Technology Alternatives Corporation offers CRTs certified at 0.1 milligauss. All experts agree that fields under 0.5 milligauss are safe. (See www.safelevel.com)

NON-CRT DISPLAYS

LCDs (liquid crystal displays) are commonly used in portable laptop and notebook computers. Many experts consider LCDs safe, believing that they have lower EMF levels. Since LCDs are backlit or sidelit with fluorescent lights, they emit magnetic fields in the ELF and VLF range. The strength of the ELF and VLF magnetic fields coming from an LCD vary greatly, depending upon the manufacturer. Although LCD magnetic fields are less than those produced by CRT-style VDTs at comparable distances, at 6 inches some laptops emit up to 22 mG of ELF magnetic fields, and 2 mG of VLF fields and that far exceeds the levels set under the Swedish MPR 2 guidelines at 20 inches. This is significant because a laptop may actually be placed on a person's lap.

Technology Alternatives offers LCDs that have been certified at 0.0 milligauss. (See www.safelevel.com)

TELEVISIONS

TVs emit the same assortment of radiation as computer displays, since both devices incorporate a cathode ray tube (CRT). Fortunately, a viewer doesn't have to sit right next to a television set to still see the image. Sitting ten feet away from a 19 inch TV distances the viewer from any measurable ELF or VLF fields. Some televisions, though, are particularly strong, so it makes sense to test your TV with a Gauss meter. A Gauss meter is also useful when buying a TV, since sets can vary quite a bit from one another.

Many appliances generate AC electric and AC magnetic fields, even when they are turned off. For example, televisions with remote controls still have current flowing when not in use. This current generates EMF, although it is less than when the TV is in use. Radios, too, may produce EMF even when turned off.

If you need to watch TV in a confined space, you should consider purchasing a small LCD TV. They have quite a strong electric field at 1 inch, but at the distance of 1 foot, the magnetic fields are negligible.

ELECTRIC BLANKETS

Electric blankets create an AC magnetic field that penetrates about 6 or 7 inches into the body. Thus it is not surprising that an epidemiological study has linked electric blankets with miscarriages and childhood leukemia. This pioneering

work was performed by Dr. Nancy Wertheimer and Ed Leeper, who originally discovered that magnetic fields were linked to childhood leukemia. (9)

In response to EMF concerns, the major U.S. electric blanket manufacturers: Fieldcrest, Casco-Belton and Northern Electric (Sunbeam) have come out with "zero magnetic field" blankets. In one design the wires are laid out in pairs so that the magnetic fields are balanced. Another design uses DC electricity, which doesn't emit pulsed EMF. Although these models reduce or eliminate magnetic fields, the blanket may still produce electric fields, even when turned off. This is because current does not have to be flowing for an electric field to exist. If the on/off switch cuts the neutral wire instead of the hot wire, the user would then be subjected to the electric field coming from the hot wire in the blanket. That's why it is best to use an electric blanket only to warm your bed before you get in it. Once you're in bed, the blanket should be unplugged to be absolutely safe. This advice is especially valid for children and pregnant women.

Waterbeds should be warmed during the day, but unplugged before going to bed. However, an unheated water bed can get quite chilly, so you may need a thick mattress pad or quilt to stay warm. Use of heating pads for chronic problems should be discontinued and replaced with hot water bottles.

ELECTRIC CLOCKS

A dial-face (analog) electric clock has a very high AC magnetic field, as much as 5 to 10 mG up to two feet away. If you are using a bedside plug-in dial-face alarm clock, it should not be placed near your head. Studies have linked high rates of brain tumors with chronic exposure to magnetic fields, so it is wise to place all plug-in clocks and other electric appliances at least 5 feet from your bed. Better yet, you may want to use a battery-powered alarm clock. Some travel clocks feature snooze, a digital display and even a radio alarm, yet they work on batteries so they have a negligible magnetic field.

FLUORESCENT LIGHTS

Fluorescent lights have replaced incandescent lights in most offices and schools. Fluorescent lights are cooler, last longer and consume less electricity, so they are more economical to use. A fluorescent bulb has no filament. Instead, the bulb is coated on the inside with a fluorescent material called a phosphor. The bulb is also filled with argon gas and mercury vapor, and a transformer (called a ballast) is used to increase the voltage to the electrodes on each end of the bulb. The high voltage excites electrons in the gas, which give off ultraviolet light. When the ultraviolet light strikes the phosphor coating on the bulb, the phosphor emits visible light which passes through the glass.

Fluorescent lights produce much more EMF than incandescent bulbs. At a distance of two inches from an incandescent bulb, the ELF field is .3 mG, and at six inches it is barely measurable. On the other hand, a typical fluorescent lamp of the type commonly found in office ceilings can have a reading of 160 to 200 mG 1 inch away. At 6 inches the reading drops to 45 mG, at 12 inches the reading is 14 mG, at 24 inches the level is 1.7 mG, and at 30 inches the level is close to background. Thus rooms with low ceilings and fluorescent lights may have readings above 2 mG at head level. In multi-story schools with fluorescent lights, although young children may be far enough away from the ceiling fixtures, they may still be exposed to EMF from the lights on the floor below.

MICROWAVE OVENS

Microwave ovens are interesting because they emit two types of radiation: microwave and ELF. The microwave radiation, which is very high in frequency (in the billion Hertz range), is produced by an element called a magnetron. Microwaves make water molecules vibrate. It is this vibration that creates the heating process, and stray microwaves can cause serious health problems by heating body tissue. Current regulations require that a microwave oven leak no more than 1 milliwatt per square centimeter when it leaves the factory. We have no idea if this level is safe, and one study has indicated that the level should be less than .5 milliwatt per square centimeter. Since microwave emissions can change with normal use, it is best to have a qualified repairman check your oven each year.

Microwave ovens also create a 60 Hz EMF field because they have a strong power transformer. The 60 Hz component of a microwave oven usually travels five feet, so it is recommended that you stay at least five feet away from a microwave oven while it is in operation.

TELEPHONES

10

Telephones can emit surprisingly strong EMF, especially from the handset. This is a problem because we hold the phone so close to our heads. Measuring different telephones before you buy is important because the field strength can vary a great deal in just a matter of inches. Place a Gauss meter right against the ear piece and the mouth piece. There are several telephone handsets in the market with no measurable fields, while others emit a relatively strong field that travels several inches. That's the same distance from your ear to your brain!

As with most small appliances, the body of the telephone has a magnetic field that extends one or two feet. Because of this it is a good practice to position the phone as far as possible from the user.

ELECTRIC RAZORS AND HAIR DRYERS

An electric razor which plugs into the wall produces an extremely high-strength AC magnetic field, as high as 200 to 400 mG one-half inch away from the cutting edge. This seems alarming, but we don't know if this is worse (or better) than exposure to a 2 to 3 mG field (the level linked to increased risk of cancer). If exposure to such high fields is a problem, the duration of the exposure (the dose-rate concept) might mitigate the effects. To understand the dose-rate concept, consider that we can zip a finger through the flame of a match without burning ourselves. This is evidence that short-term exposure to certain harmful influences can produce dramatically different results than longer exposure. If the dose-rate concept applies to EMF (and we don't know if it does), since an electric razor is used only a few minutes each day, it is probably safe. Keep in mind, however, that the data on short-term exposure to high-strength fields is incomplete, and that the use of non-electric razor blades will eliminate all EMF risks. There are now wind up mechanical razors available, which use a non electrical flywheel for power. A small epidemiological study found a link between electric razor use and higher skin cancer in men. Presumably the fields, being close to the brain, could influence production of melatonin, a cancer fighting hormone. Also, recent reports are pointing to the fact that cells go through the most disturbance at the beginning of field exposure, and later try to compensate. As such, non electrical razors are recommended.

Electric hair dryers are another source of extremely high AC magnetic fields because they require high currents to produce heat. A 1600-watt model will produce 100 to 200 mG near the handle and 10 to 50 mG at normal drying distances (6 to 18 inches). When it is operated on its "high heat" setting, it will draw more current and generate a higher magnetic field than when it is operated on its "low heat" setting. Again, in evaluating the health risks, the dose-rate concept may provide comfort, since a hair dryer is used only a few minutes each day. On the other hand, hairdressers who use a hand-held hair dryer repeatedly each workday may have something to worry about.

PRUDENT AVOIDANCE

Electricity is an inseparable part of our modern day society. This means that electromagnetic radiation will continue to be all around us for the foreseeable future. But, as Discover Magazine postulated, aside from making our lives easier, is electricity also making our lives shorter? Perhaps a more important question is "Until more is known, what can we do to minimize the potential risks?"

Prof. M. Granger Morgan, a well-known expert at Carnegie Mellon University, says it certainly can't hurt to take simple steps. EMF "may pose no risk," he says, "but most experts I have talked with give me odds somewhere between 10 percent and 60 percent that within the next decade it will become clear that they do." Prof. Morgan advocates "prudent avoidance." "Prudence" means to be sensible and to exercise sound judgment in practical matters. Hence, prudent avoidance means that we should avoid exposure to EMF when it is consistent with sound judgment. In other words, learn where EMF comes from and then distance oneself from it whenever such avoidance won't cause too much personal or economic disruption.

Most experts agree that limited, non-chronic exposure to EMF is not a threat. For example, it is probably acceptable to be near a toaster in the morning, but it is not advisable to sleep under an electric blanket operating all night. Certainly the person who works on a computer all day, watches TV close up at night, lives near a power line, and sleeps under an electric blanket, is under an extreme case of chronic exposure. This condition applies to millions of Americans and people throughout the world.

If you wish to practice prudent avoidance, the following advice is offered:

(11)

Measure your environment with a Gauss meter, and avoid areas where the field is above 1 mG. Measure the fields both inside and outside your home, and don't let your children play near power lines, transformers and microwave towers.

Measure the magnetic fields from appliances, both when they are operating and when they are turned off. Magnetic fields are created only when current is flowing, but some appliances (such as TVs) are still drawing current even when they are switched off.

Don't sleep under an electric blanket or on a water bed. If you want to warm your bed before go to sleep, when you're ready to get under the cover, unplug the electric blanket (don't just turn it off). Even though there is no magnetic field when the blanket is turned off, there may still be a high electric field.

Don't sit too close to your TV set. Distance yourself at least 6 feet, but keep in mind that EMF from some TV sets can be measured as far away as 10 feet or more. An ELF and VLF Gauss meter can help you decide where to sit.

Don't sit too close to your computer display. Keep at least an arm's length away from the screen, but remember that at this distance you will still be within the magnetic field. Computer monitors vary greatly in the strength of the magnetic fields which they emit.

Rearrange your office work area so that you and your co-workers are not exposed to EMF from the sides and backs of each other's VDTs.

Turn off your VDT when you are not using it.

Consider purchasing a low radiation VDT which contains an active compensating coil, or a zero radiation display based on shielded LCD technology.

Don't stand close to your microwave oven when in use. Even if your microwave oven is not leaking microwaves, it will still give off strong ELF magnetic fields.

Move your electric clock away from your pillow. Several feet away should be sufficient. Better yet, buy a battery-powered digital clock.

Keep other electric appliances away from your pillow, too. Telephones and answering machines generate EMF.

Eliminate dimmers and three-way switches; they create high fields.

Eliminate wires running under your bed.

Be wary of cordless appliances such as electric toothbrushes, which use magnetic induction to charge the battery. Such devices deliberately create a large magnetic field.

Remember that EMF passes right through walls, so check out what's on the other side. It could be a cordless electric toothbrush, or a television set, or a clock-thermostat radiating EMF into your bedroom.

A final note on AC fields: just like medicines have good and bad effects, not all AC electric and magnetic fields are negative influences. Under controlled circumstances, AC fields can be used to help our health. Some AC magnetic fields, for example, are used at hospitals to promote bone growth in the case of fractures. Similarly, Magnetic Resonance Imaging (MRI) machines are very useful in detecting tumors, aneurysms, etc., and are an excellent alternative to X Rays or CAT Scans. Other devices that use AC magnetic fields are also in use, such as AC Tens units to treat pain, as well as other magnetic devices that treat other symptoms and complaints. Static magnets have now been reported in the medical literature as being beneficial for diabetic neuropathy, (tingling and chronic pain in the feet), a condition affecting half of all diabetics, or almost 10 million people. Static magnets have also been shown to be effective in many pain complaints.

Technology Alternatives Corporation, located in Miami, FL, has been a pioneer in the area of prudent avoidance of EMF. Technology Alternatives manufactures a zero radiation LCD computer display and several models of hand-held, inexpensive Gauss meters for measuring magnetic radiation from power lines, home wiring, appliances, televisions, and computer displays. Technology Alternatives also markets ultra-low radiation CRT-style video displays, and offers a radiation reduction service for retrofitting selected models of existing CRT-style VDTs.

Technology Alternatives Corporation has received worldwide acclaim for its innovative products. The company has been featured or mentioned by the following news sources: The Boston Globe, the Chicago Sun Times, The Washington Post, Business Week, MIS Week, The Boston Business Journal, UPI, NBC radio, WXEX in Richmond, Virginia, Channel 6 in Providence, RI, Good Morning America, USA Tonight, Channel 7, an ABC affiliate in New York, Glamour Magazine, PC Week Magazine, Lotus Magazine, Compuserve Magazine ("Averting Desktop Chernobyl"), Adweek's Computer Magazine (Cover story: "Are VDT's Safe?"), Marketing Computers Magazine (Cover story: "Caught in the Crossfire"), PBS TV, WAGA Atlanta TV (a CBS affiliate), Channel 4 WNBC NY TV, and CNN Business News.

For free information, contact:

Technology Alternatives Corporation
1950 NE 208 Terrace
Miami, FL 33179

www.safelevel.com mgauss@netrox.net

Phone 1-800-222-3003
1-305-933-2026

Copyright 1991, 2003 Technology Alternatives Corporation.
All Rights Reserved.

Appendix 1. The Latest News:

The Latest News:

Excerpts from: MICROWAVE NEWS -- A Report on Non-Ionizing Radiation

August 2002

California EMF Program to issue Strongest Health Warning Yet

After spending more than \$7 million over the last eight years, the California Department of Health Services (DHS) will soon issue the strongest warning to date on the potential health risks from exposure to power-frequency electromagnetic fields (EMFs).

Drs. Raymond Neutra, Vincent DelPizzo and Geraldine Lee, who wrote the report, conclude that they "are inclined to believe" that EMFs are a cause of childhood leukemia, adult brain cancer, amyotrophic lateral sclerosis (ALS) and miscarriages.

The final report of the EMF Program, which runs more than 500 pages including appendices, has not yet been released, but *Microwave News* has obtained a copy. It "is slowly working its way through the bureaucracy," said Neutra of the DHS, who led the program. He expects to submit it to the California Public Utilities Commission (PUC) "at the end of the summer."

"We lowered a few of the risk estimates, but overall the conclusions in the final report are very similar to those in the draft," said DelPizzo, who served as research director of the EMF program before retiring recently to Reno, NV.

July/August 2001

ELF EMFs (electromagnetic fields) are now classified in the same category as DDT, lead, Carbon Tetrachloride and Chloroform, Category 2B possible carcinogens.

IARC Finds ELF EMFs Are Possible Human Carcinogens

A working group assembled by the International Agency for Research on Cancer (IARC) has unanimously concluded that power-frequency magnetic fields are possible human carcinogens. This finding, announced on June 27 in Lyon, France, is based on the consistent association between childhood leukemia and residential exposure to extremely-low-frequency electromagnetic fields (ELF EMFs).

The makeup of the IARC panel spanned all sides of the EMF controversy, from those who openly believe that EMFs promote cancer to industry consultants who are skeptical of any such connection. "We all agreed," said Dr. Larry Anderson. EMFs have now been formally designated "2B Possible Carcinogens." (For a list of the members of the working group and their affiliations, and examples of each type of IARC carcinogens, see below.)

"There was a unanimous feeling about it," said Dr. Jan Stolwijk. Dr. Maria

Stuchly, who remains unconvinced that magnetic fields are responsible for promoting leukemia in children, nevertheless joined the others in voting for the 2B designation. "The epidemiological data are there and it is hard to dismiss them," she said. Dr. Vincent DelPizzo believes that the cancer evidence is stronger than do any of the other panelists. He cast the only vote that there is "sufficient" human evidence for childhood leukemia, which implies that EMFs are known human carcinogens. "I am sure that the childhood leukemia finding cannot be attributed to chance, bias or confounding," he said. (See table below for definitions of "sufficient," "limited" and "inadequate")

The IARC decision follows similar reviews by panels in the U.S. and the U.K. In 1998, a working group of the National Institute of Environmental Health Sciences (NIEHS), using the same IARC criteria, also classified EMFs as 2B possible human carcinogens, a view that NIEHS Director Kenneth Olden later endorsed in his report to Congress. Earlier this year, an advisory committee to the UK National Radiological Protection Board chaired by Sir Richard Doll, also acknowledged the possible link between EMFs and cancer.

The childhood leukemia studies have had a major impact on all of these prior assessments. The Doll report was heavily influenced by the two recent pooled analyses: one led by Dr. Anders Ahlbom and the other by Dr. Sander Greenland. The IARC panel was similarly swayed, according to both Stolwijk and Dr. Elizabeth Hatch. "The Ahlbom analysis was found to be most impressive," noted Stolwijk. Much more surprising was the IARC panel members' view of the animal data. They came close to finding "limited" support for a cancer association based on the animal exposure experiments.

IARC Carcinogens: Definitions and Examples:

Category 1: Carcinogen

Evidence: Sufficient in humans

Chemical and physical agents:

Asbestos, benzene, dioxin, hepatitis C virus, radon, vinyl chloride. Total number of agents: 87.

Category 2A: Probable Carcinogen

Evidence: limited in humans and sufficient in animals

Chemical and physical agents:

Benzo[a]pyrene, formaldehyde, PCBs, ultraviolet (A,B&C) radiation. Total number of agents: 63.

Category 2B: Possible Carcinogen

Evidence: limited in humans and less than sufficient in animals

Chemical and physical agents:

Carbon tetrachloride, chloroform., coffee, DDT, ELF EMFs, lead, PBBs. Total number of agents: 236

June, 2001

Maximum EMF Exposure Emerges

As Strong Miscarriage Risk

A new and innovative epidemiological study has found an up to six fold increased risk of spontaneous abortions among women exposed to magnetic fields of 16 mG or greater. The results “should have wide implications,” concludes Dr. DeKun Li, who led the study team at Kaiser Permanente’s research division in Oakland, CA.

Unlike past efforts, which have essentially all used average fields, Li focused on *maximum* magnetic field (MMF) as the key index of exposure. While Li found miscarriage risks that are significantly higher for women who had an MMF of at least 16 mG, he saw no excess for women with time weighted averages (TWA) of 3mG or more. Nor did he observe any increased risk for elevated spot electromagnetic field (EMF) measurements or with wire codes.

“With TWAs you are diluting any possible effect because you are combining relevant and irrelevant exposures,” Li told *Microwave News*. In a paper summarizing his results, Li argued that, “It seemed more plausible to us that EMF exposure has a threshold below which any exposure is biologically irrelevant.”

Li’s paper is an appendix to the as yet unreleased final report of the California EMF Project (see p.2). An advance copy of Li’s paper was obtained by *Microwave News*.

“My study convinced me that EMFs probably have a biological effect,” Li said. “We are entering a new chapter in the field of EMF epidemiology. There is more evidence that there is an association—the better conducted studies consistently show an association.”

A “Robust” Association

“This population based cohort study with prospectively measured EMF exposure level revealed for the first time (based on our search of Medline) an increased SAB risk associated with a MMF exposure level of 16mG. The adverse MMF effect appeared to have a threshold around 16 mG and persisted regardless of the sources/locations of MMF exposure. Prenatal MMF exposure had a greater effect on early spontaneous abortion (< 10 weeks of gestation) when embryos or fetuses are much more sensitive to environmental insults, and among women who may be more susceptible to environmental exposures.

The association was much stronger when women whose 24 hour MF measurements may not reflect their true prenatal MF exposure were excluded. These biologically coherent observations, all based on a priori hypotheses, provide strong evidence that prenatal MF exposure above a certain level (possibly around 16 mG) may increase SAB risk. It is also unlikely that the observed association was due to biases or unmeasured confounders, because any such biases or confounders would have to explain the above observations simultaneously. The robustness of the association against potential confounders was further supported by the evidence that, despite adjusting for more than 30 variables of known or suspected risk factors for SAB, the estimates were barely altered. Moreover, prompted by the findings in this study, Lee et al. reanalyzed the data from the study in which the findings related to TWA exposure led to funding the current study, and confirmed our observed association between MMF and SAB risk. These findings raise the question of the effect of MMF on reproductive outcomes and other health endpoints. The MMF exposure level in our study population was quite comparable to that found in a nationwide survey and our study population was racially/ethnically and socioeconomically diverse. Thus, the findings from our study should have wide implications.”

DeKun Li, “A Population Based Prospective Study of Personal Exposure to Magnetic Fields During Pregnancy and the Risk of Spontaneous Abortion,” unpublished manuscript, May 2001.

G.M. Lee et al., “A Nested Case Control Study of Residential and Personal Magnetic Field Measures and Spontaneous Abortions,” *Epidemiology*, submitted.

Li stressed that 16 mG is not a rare exposure. He noted that approximately 75% of his study population had at least one exposure above this threshold in a 24hour period. Li said that such peak fields are more likely to come from household electrical appliances and transportation sources than from local electrical distribution lines.

The Kaiser Permanente study has cleared peer review and is scheduled to be published in the November issue of *Epidemiology*, Li said. His results were first disclosed at a meeting convened by the California EMF Program on April 25. Kaiser Permanente is the largest and oldest health care provider in the U.S.

“It’s quite exciting if it holds up,” Dr. Nancy Wertheimer said in an interview. “More work needs to be done on thresholds and short term high exposures.” Wertheimer, who lives in Boulder, CO, was a member of Kaiser’s internal peer review team. Wertheimer and Ed Leeper have themselves reported associations between miscarriages and EMF exposures from electrically heated beds and home electrical heating systems.

Others have also seen a miscarriage risk due to magnetic fields from video display terminals (see *MWN*, M/J88 and M/A 92) and from power lines (see *MWN*, M/A92).

“Taken together the EMF studies of spontaneous abortions paint a consistent picture,” said one epidemiologist, who has read the new Li paper but who asked not to be identified. The new study is the first prospective study ever done for

EMF health risks and the first to use maximum magnetic field exposures to gauge risks. A total of 969 women who had been pregnant for less than ten weeks qualified for the study, and the outcomes of their pregnancies were monitored. They wore an EMDEX meter for 24 hours and were then asked if their activities during that particular day were “typical” of the pregnancy.

“One of the strengths of this study was that we measured MF exposure during the relevant period and used personal measurement to capture MF exposure from all sources encountered by a woman,” Li wrote.

Li found that women who were exposed to MMFs of 16 mG or more had 80% more miscarriages compared to those exposed to less than 16 mG—a statistically significant increase. But when women who said that they had worn the EMDEX on an atypical day are eliminated from the study population, the miscarriage risk increases to three times that of the less exposed women. And for pregnancies lost during the first ten weeks of gestation, the risk is close to six times that of the less exposed women. All these results are also significant.

Of the 159 women who had spontaneous abortions, 132 had exposures above 16 mG, and of these 95 said that they had taken measurements on a typical day.

For women who were judged to be more susceptible to environmental insults—those who had already had two or more miscarriages or who had fertility problems—the miscarriage risk is three times higher when they were exposed to 16 mG or more.

This risk rises to close to five times that of the unexposed women for those pregnancies that were lost before the tenth week of gestation, a time when the fetus is most sensitive to environmental insults. Both these risks are statistically significant.

“All this evidence points to an underlying biological effect of the magnetic field rather than bias or a chance finding,” Li said. “If this were a chance finding, you would not expect there to be a difference between typical and atypical exposures and between early and late abortions.”

In the interview, Li said that he was “a little disappointed” by the recent commentary on EMF epidemiology by Dr. David Savitz. A number of researchers have argued for the need to look beyond TWAs to measure biologically relevant EMF exposures.

For instance, in the early 1990s, Drs. Richard Lovely and Bary Wilson of the Battelle Labs in Richland, WA, pointed specifically to MMF exposure as an alternative exposure index (see *MWN*, M/J93). Until Li, no one had followed up their suggestion.

In a previous epidemiological study, Li found that women with fertility problems who used electric blankets during pregnancy had a greater chance of having babies with birth defects (see *MWN*, S/O95). The risk was ten times higher among women who used electric blankets during the first trimester.

September 2001

WHO EMF Project Now Endorses

Policy of Prudent Avoidance

In a major policy shift, the World Health Organization’s (WHO) International EMF Project has endorsed prudent avoidance.

On October 3, the WHO advised that decisions on siting power lines should “consider ways to reduce people’s exposures.” The WHO also recommended that governments and industry should offer the public “suggestions for safe and low-cost ways to reduce exposures.” The advice is contained in a fact sheet on extremely low frequency electromagnetic fields (ELF EMFs) and cancer.

The project’s new outlook follows the decision by an expert panel convened by the International Agency for Research on Cancer (IARC) to classify ELF EMFs as “possible human carcinogens” (see *MWN*, J/A01). IARC, which is based in Lyon, France, is part of the WHO.

Three years ago, in its last fact sheet on ELF EMFs and cancer, the WHO project took a very different view. “There is no need for any specific protective measures for members of the general public,” it stated—beyond meeting the exposure limits recommended by the International Commission on NonIonizing Radiation Protection (ICNIRP). This standard protects against acute health hazards, such as shocks and burns, but does not address cancer risks.

At that time, Dr. Michael Repacholi, who oversees WHO’s work on EMFs, told *Microwave News*: “It is not WHO’s job to be recommending ‘prudent avoidance’ to national governments” (see *MWN*, N/D98).

As late as last year, the EMF project advised that prudent avoidance “may be justified,” but warned that “such actions should not be recommended by national authorities on health grounds.”

Rather, they may be appropriate to deal with individual perceptions of risks (see *MWN*, M/J00).

German Radiation Commission

Endorses Prudent Avoidance

Germany’s Radiation Protection Commission is recommending a policy of prudent avoidance.

In a report released on September 14, the panel—known by its German acronym SSK—states that it has confidence in the ICNIRP standards. But it calls for “minimizing” exposures to both ELF and RF/MW EMFs to the extent “technically and economically reasonable,” especially in locations where people spend extended periods of time.

The SSK recommends that emissions from consumer appliances, including mobile phones, be kept as low as possible and that product labels indicate emission levels.

The SSK also argues for more health effects research. The Federal Environment Ministry, which is revising Germany’s EMF safety rules, requested the report (see *MWN*, S/O97). In July, the ministry announced that it was weighing precautionary exposure limits for mobile phone base stations, but would wait for SSK’s advice (see *MWN*, J/A01).

The SSK’s principal expert on non ionizing radiation is Dr. Jürgen Bernhardt, who is the vice chair—and a past chair—of ICNIRP and a former head of Germany’s Radiation Protection Office.

On July 31, the radiation office’s current director, Wolfram König, advised against the use of mobile phones by children and called for restrictions on base station antennas near schools and hospitals (see *MWN*, J/A01).

JUNE 2000

Strong Electric Fields Implicated in

Major Leukemia Risk for Workers

Long term employees of Ontario Hydro who worked in strong electric fields had much higher risks of leukemia, Canadian researchers have found. Significant risks were also found for non Hodgkin’s lymphoma (NHL) in a related study.

The elevated risks were seen among workers who spent the most time in electric fields above certain thresholds, in the range of 10 to 40 V/m. The largest increases occurred among those with more than 20 years on the job. Senior workers with the greatest time above the thresholds had an eight to tenfold increase in the risk of leukemia—much higher than in past epidemiological studies of electromagnetic fields (EMFs).

“It’s very interesting that there seems to be a threshold effect,” Dr. Anthony Miller, a coauthor of the study, told *Microwave News*. “These studies confirm that electric fields are very important, if not dominant,” Miller said. “I think that’s a very important message.” Both studies were based on data from Miller’s 1996 study of Ontario Hydro employees, which put a spotlight on cancer risks and electric fields (see *MWN*, J/A 96). Formerly at the University of Toronto, Miller is now with the German Cancer Research Center in Heidelberg.

Paul Villeneuve of the University of Ottawa, who led the studies as part of his doctoral dissertation, said, “It’s remarkable that we saw similar threshold effects for both leukemia and NHL.”

The threshold levels were “relatively consistent” in the two studies, he noted.

In an interview, Dr. Lois Green of Ontario Power Generation (formerly part of Ontario Hydro) in Toronto described this work

as the first of its kind. “No one has ever taken a systematic look at threshold effects before,” she said. Most previous studies have focused on cumulative effects or time weighted averages, which Green called “a very limited way to view EMF exposures.” The new work by Villeneuve, Miller and colleagues “shows that there are other important ways of looking at exposure,” she said. “We can’t close the door on this question.”

The new Canadian results stand in sharp contrast with past EMF epidemiological studies, most of which have focused almost exclusively on magnetic fields. Dr. David Savitz of the University of North Carolina, Chapel Hill, told *Microwave News* that the new findings “suggest that those doing future studies reconsider the pessimism about the value of electric field data.”

“Our results suggest that there is no association between exposure to magnetic fields and NHL,” Villeneuve and colleagues write in the April issue of *Occupational and Environmental Medicine*, and no threshold effects were seen with magnetic fields in either study. In the leukemia study, some nonsignificant elevations in risk were observed for workers with higher average magnetic field exposure.

Miller’s 1996 study also described electric fields as the main source of risk, but indicated that the highest risks came from combined electric and magnetic exposure. While the two new studies “tend to confirm the dominance of electric fields,” he said, “I’m not sure they remove any effect for magnetic fields.”

For electric fields, however, Miller now believes that the threshold analysis in the new papers is a more precise way of measuring their impact.

The leukemia study, published in the June issue of the *American Journal of Industrial Medicine*, found that the amount of time spent above these thresholds was a “significant predictor of leukemia risk.” While average exposure was also linked to an increase in risk, Villeneuve and colleagues write, their results indicate “that leukemia risk is more sensitive to exposures above a threshold.”

For workers employed for more than 20 years, the findings were especially striking. Of these, the one third who spent the most time above 10 V/m were ten times more likely than others to develop leukemia, a significant increase. The one third with the most time above 20 V/m had a risk eight times higher than others. These odds ratios, however, had very wide confidence intervals.

The case control study was based on 50 cases of leukemia and 200 controls, drawn from a cohort of over 31,000 male Ontario Hydro employees and retirees. Employment data were linked to a job exposure matrix based on both job title and work site, with personal measurements from over 800 workers, and to incidence data from the Ontario Cancer registry. These data were the basis of Miller’s 1996 study, which was part of a three utility study that included workers at Hydro Quebec (HQ) and Electricité de France (EDF) (see *MWN*, M/A94). The Ontario research used a more detailed exposure assessment—taking into account job location as well as title—than was used for the other utilities.

The NHL study was based on 51 cases and 203 controls from the same study population. It found that the one third of workers who spent the most time in electric fields above 10 V/m had triple the risk of NHL. Those with the most time above 40 V/m were 3.6 times more likely to get the disease.

“Many of us, starting with Genevieve Matanoski around 1986, have long held that we need to look at alternative indices of exposure,” Dr. Indira Nair of Carnegie Mellon University in Pittsburgh told *Microwave News*. Confirmation of this point is “the central importance of these papers,” said Nair. “Until we are able to elucidate a mechanism, studies that include these alternate indices can provide us with understanding which may help us eventually to ‘back into’ the mechanisms.”

Field Exposure in the Electric Utility Work Environment,” *Bioelectromagnetics*, 18, pp.365-375, 1997.

Trevor Dawson, Kris Caputa and Maria Stuchly, “A Comparison of 60 Hz Uniform Magnetic and Electric Induction in the Human Body,” *Physics in Medicine and Biology*, 42, pp.2319-2329, December 1997.

U.K. Panel Discourages Use of Mobile Phones by Children

A high level panel appointed by the U.K. government has recommended that children be discouraged from using mobile phones and that the industry not market phones to children. Although the Independent Expert Group on Mobile Phones, chaired by Sir William Stewart, found that there was no evidence of a health risk, it favored a “precautionary approach” given current “gaps in knowledge.”

“I have got a grandchild of four and a grandchild of two and I would not be recommending that they have mobile phones,” Stewart told the BBC, noting that he would continue to use his own phone. Stewart was science advisor to the prime minister from 1990 to 1995.

The 12 members of the expert group issued their report on May 11. They asked that radiation exposure data for different phones—specific absorption rates (SARs)—be “readily accessible to consumers” and that there be no shortcuts in the planning process for the siting of mobile phone base stations.

Electromagnetic radiation in the news!

Concerning power lines and appliances:

USA Today conducted a survey of 4,567 readers and reported that electromagnetic fields, or EMF's, are the number one environmental concern in America. "EMF's - always present near power lines and working electrical appliances - are linked to such diseases as leukemia and breast cancer."

"The National Council on Radiation Protection and Measurements (NCRP) committee charged with evaluating the potential health effects of electromagnetic fields (EMFs) has completed a draft report that calls for strong action to curtail the exposure of the U.S. population. "It took us nine years but we finally reached agreement," committee chair **Dr. Ross Adey**, of the Veterans Administration Hospital in Loma Linda, CA, told *Microwave News*.

A draft report prepared for the Environmental Protection Agency (EPA) generally endorses a 2 mG exposure limit. It would take effect immediately for new day care centers, schools and playgrounds, as well as for new transmission lines near existing housing. The report was funded by the EPA. Dr. Joe Elder, EPA's program officer for the NCRP study in Research Triangle Park, NC, called the committee's report "the first comprehensive review of the world's literature on EMF health effects."

Microwave News, July/August, 1995

"I have never seen a set of epidemiological studies that remotely approached the weight of evidence that we're seeing with ELF [extremely low frequency] electromagnetic fields. Clearly there is something here."

Martin Halper, EPA Director of Analysis and Support.

"Electromagnetic fields are associated with the development of leukemia, brain cancer and other serious diseases."

Paul Brodeur, writer, *The New Yorker Magazine*, author of *Currents of Death* (Simon and Schuster), and *The Great Power Line Coverup* (Little, Brown).

"...studies on cats, rats, and chick brain cells have shown that low frequency electromagnetic radiation interacts with brain activity and could cause a host of negative symptoms from heightened stress and depression, slowed reaction time, and learning disabilities to miscarriages, fetal deformities, and cancer."

Business Week, Oct. 30, 1989.

"This is really harming people."

Dr. David Carpenter, Dean, School of Public Health, State University of New York, Albany.

When buying a home, it is important to check for EMF's. Homes "sold...for 30% less" when exposed to EMF's, as reported by the *Wall Street Journal*, September 8, 1993.

According to a survey conducted by *Indoor Air Review*, 26% of homes have areas that register EMF fields exceeding 3 milligauss.

"...Sweden has concluded that EMF's do lead to higher rates of cancer...I, frankly was somewhat impressed by the arguments made by the Swedes." - **President Bill Clinton**

Concerning televisions and computer displays (VDTs):

"Most unsettling of all, perhaps, is the fact that the pulsed VLF and ELF magnetic fields found routinely within a radius of about two feet from the average CRT computer terminal can be as strong as, or even stronger than, the sixty-hertz magnetic fields found inside the homes in which Wertheimer and Savitz discovered children to be dying unduly of cancer."

The New Yorker, June, 1989.

"...sit at least ten feet away from the television set."

Time Magazine, July 17, 1989.

A Swedish study has found that weak, pulsed magnetic fields similar to those emitted by VDTs can cause fetal abnormalities in the offspring of pregnant mice. According to Tom Brokaw of NBC News, "the findings no longer rule out the possibility that radiation can affect human fetuses." In Sweden, a major Swedish union (the Swedish Confederation of Professional Employees, or TCO) is seeking more stringent limits, and pressure is being put on the Swedish government to change VDT work regulations to protect pregnant women.

A study released in February, 1991, by the University of Southern California (UCS) in Los Angeles has found an increased rate of leukemia among children who watch black and white televisions.

For information on products to help protect ourselves from electromagnetic fields, visit www.safelevel.com

Read ⁽²⁰⁾

Just read it below:

(Feel free to Copy the whole eBook onto your Word document and send it to all the people that you know! Or just tell them to go to www.safelevel.com and read the free eBook!)

How hundreds of millions of Americans can protect themselves from everyday exposure to electromagnetic fields found at home, school and work!

Electromagnetic fields emitted from alarm clocks, computers and cell phones affect just about every American. Those fields have been classified in the same category as B2 carcinogens, such as DDT, lead, and chloroform!

We would not dream of exposing ourselves or our children to those, yet we carelessly expose ourselves to electromagnetic fields every day!

And here is the good news: since the fields go down very quickly with distance, it is easy to protect oneself from these fields!

Below you will find an article that was published in Medical Electronics, and later on, Appendix 1 has the latest press information that is available.

For updates, visit www.safelevel.com

Article on Electromagnetic Fields published in Medical Electronics:

A Survey of present knowledge concerning low-frequency electromagnetic radiation from power lines, home wiring, appliances, televisions and computer displays

EMFs Linked to health problems

Can electromagnetic fields (EMF) from power lines, distribution lines, home wiring and appliances cause brain tumors, leukemia, birth defects, and other health problems? Numerous studies have produced contradictory results, yet some experts are convinced the threat is real. Dr. David Carpenter, Dean at the School of Public Health, State University of New York, says "This is really harming people." According to Dr. Carpenter, it is likely that 10% to 15% of all childhood cancers come from exposure to residential power lines. The Environmental Protection Agency warns "There is reason for concern" and advises "prudent avoidance." Martin Halper, the EPA's Director of Analysis and Support, goes even further. "I have never seen a set of epidemiological studies that remotely approached the weight of evidence that we're seeing with ELF [extremely low frequency] electromagnetic fields. Clearly there is something here."

Concern over electromagnetic radiation began to explode after Paul Brodeur wrote a series of lengthy articles in the New Yorker Magazine. When the articles were published in June, 1989, Brodeur had already established renown by bringing the previously unknown hazards of asbestos into public view. In this new revelation, Brodeur described how Louis Slesin, editor and publisher of VDT News, had pieced together a fascinating puzzle. For nearly a decade, Slesin had compiled details on studies which linked magnetic fields with cancer. Most experts thought that the results were

erroneous because it seemed inconceivable that such low levels of non-ionizing radiation could cause harm. (21)
 Consequently the studies were branded biased, and instead of praise for their pioneering work, the researchers who conducted these studies were ridiculed and their concerns ignored.

Because of Paul Brodeur's reputation, his New Yorker articles had a catalytic effect on scientists, reporters and concerned people throughout the world. In 1989 and 1990, the EMF issue gained mainstream publicity, with alarming reports appearing in Time, the Wall Street Journal, Business Week, and popular computer publications such as MacWorld. ABC's Ted Koppel aired a full 30 minute show and interviewed Paul Brodeur, while CBS' Dan Rather aired a special segment on an ominous EPA report.

In October, 1989, an article in Business Week quoted a leading scientist as saying that low frequency magnetic fields were biologically active. This acceptance of EMF as having a measurable impact on living cells and organisms represented a major shift in the scientific community from debating whether EMF could cause biological effects to debating, instead, the level of harm caused by the radiation. "It is now clear that 60-hertz and other low-frequency electromagnetic fields can interact with individual cells and organs to produce biological changes," says a 1989 Office of Technology Assessment report. "The nature of these interactions is subtle and complex. The implications of these interactions for public health remain unclear, but there are legitimate reasons for concern."

The word "epidemiology" is often used in conjunction with studies of EMF. "Epidemiology" comes from "epidemic" meaning common to or affecting a great number of people in a community at the same time. An epidemiologist studies the statistical relationship between health problems and suspected causes, but even when a positive relationship is found, such studies do not prove cause and effect, even if it seems obvious. To see why this is important, consider that a rooster will crow at sunrise, and on most mornings the temperature starts to rise. An epidemiological study of roosters crowing would show a positive correlation with subsequent temperature increases that day, but it would be invalid to conclude that the crowing causes the temperature rise. Similarly, there may be a factor other than EMF from power lines which causes cancer, such as traffic density. With so many variables, the cause-and-effect relationship is difficult to establish.

In late 1989, the Wall Street Journal reported that electromagnetic radiation was linked to cancer and leukemia. Even more alarming, the Electric Power Research Institute, the leading arm of the electric utility companies, had "only praise" for the methodology used in a power line study that linked leukemia, prostate and other cancers in young men with chronic exposure to magnetic fields. In November of 1989, the Department of Energy reported that "It has now become generally accepted that there are, indeed, biological effects due to field exposure."

EPA SAYS THREAT IS REAL

By 1990, over one hundred studies had been conducted worldwide. Of these, at least two dozen epidemiological studies on humans indicated a linkage between electromagnetic radiation and serious health problems. In response to public pressure, the Environmental Protection Agency (EPA) began reviewing and evaluating the available literature. In a draft report issued in March, 1990, the staff of the EPA recommended that magnetic fields be classified as a Class B carcinogen. This category is for "probable human carcinogens," and includes formaldehyde, DDT, dioxins and PCBs. However, in a later watered-down revision, the reference to Class B was deleted, and the following explanation was added:

"At this time such a characterization regarding the link between cancer and exposure to EM fields is not appropriate because the basic nature of the interaction between EM fields and biological processes leading to cancer is not understood."

Curiously, this rather unusual logic appears on the very same page as the following: "In conclusion, several studies showing leukemia, lymphoma, and cancer of the nervous system in children exposed to magnetic fields from residential 60 Hz electrical distribution systems, supported by similar findings in adults in several occupational studies also involving electrical power frequency exposures, show a consistent pattern of response that suggests a causal link."

RECENT STUDIES RAISE CONCERN

Until a few years ago, the electric and magnetic fields around power lines, electric motors and household appliances

22
were thought to be harmless. However, on the basis of new studies, scientists are changing their opinions. As reported in the Wall Street Journal, "recent research with human cells and laboratory animals, plus epidemiological studies, all have suggested that the fields do have biological effects, and that they may foster a number of medical problems, including cancer and miscarriage. Leonard Sagan, the radiation expert at the Electric Power Research Institute, says that the latest experiment is important because 'this is humans, not rats, who are apparently showing an effect'."

As early as 1976, scientists in Loma Linda demonstrated that exposure to weak levels of EMF could slow the outflow of calcium in cells from chicken brains. A major study of chicken embryos, sponsored by the Environmental Protection Agency and the U.S. Navy, found a significant increase in abnormal embryos of chickens when exposed to pulsed magnetic fields similar to the type of magnetic fields emitted by VDTs. Of six laboratories, two found a statistically significant increase in abnormal embryos, and three found non-statistically significant increases. Such abnormalities included lower birth weights and birth defects.

One of the earliest studies on the human health effects of EMF was conducted in the greater Denver, Colorado area by epidemiologist Nancy Wertheimer and physicist Ed Leeper. Using data on children who had died before age 19 of cancer between 1950 and 1979, this study found significant excess risks among children who resided in homes close to heavy duty distribution lines. Other studies indicate that these lines typically produce strong magnetic fields.

In 1982, the New England Journal of Medicine published a letter from Dr. Samuel Milham, Jr. describing his study of leukemia deaths in Washington state. His comprehensive study, which examined the data for 438,000 deaths occurring between 1950 and 1979, found that leukemia deaths were elevated in 10 out of 11 occupations involving exposure to EMF. In 1988, epidemiologist Dr. David Savitz set out to disprove the results of the earlier Denver study using a different group of children. Instead, his findings were nearly identical with the first study F indicating elevated risk for all cancers among children living in homes near power lines with magnetic fields at or above 2 milliGauss (mG).

Perhaps the most publicized study was conducted in 1988 by the Kaiser Permanente HMO in Oakland, California, one of the largest health care facilities in the country. Kaiser's researchers tracked 1,583 pregnancies to find out whether pregnant women had been affected by the widespread use of aerial spray to kill medflies. No problem was found with the spraying, but the researchers were surprised to find a statistically significant 73% increase in miscarriages in working women using CRT-style VDTs (cathode ray tube style video display terminals), compared to other working women. The study also found an increase in birth defects, although the result was not statistically significant due to the sample size.

The National Institute for Occupational Safety and Health (NIOSH) captured world-wide headlines in the spring of 1991 when it released the results of its study on the health effects of CRT-style VDTs and miscarriages. The study found no link between VDT use and miscarriages, after studying 730 pregnant directory assistance and general telephone operators. The study concluded that "the use of VDTs and exposure to the accompanying electromagnetic fields were not associated with an increased risk of spontaneous abortion in this study" (emphasis added). The media's immediate interpretation was:

"[the new study] settles a question that has worried women of childbearing age for more than a decade: Can using a video display terminal cause miscarriage? The answer is clearly no..."

Unfortunately, a close examination of the NIOSH report (published March 14, 1991, in The New England Journal of Medicine) shows that the media's interpretation was incorrect, and that the study's conclusions were limited. One group (the study population) of operators used CRT-style VDTs, and another group (the control group) of operators used a different type of video display, with either LEDs (light emitting diodes) or neon glow tubes. Interestingly, measurements of abdominal exposure to ELF magnetic fields were similar for both groups. Hence, the study reached no conclusions about health risks to pregnant women from the ELF radiation emitted by VDTs, although NIOSH attempted to minimize this major flaw by stating that the levels of abdominal exposure to ELF for both groups were in the same range as exposures in the home (i.e., .5 mG to 2.5 mG).

Moreover, the study only dealt with two monochrome models of VDTs manufactured by IBM and Computer Controls, Inc. These VDTs emitted very low frequencies (VLF) in the range of 15 kHz, while a large percentage of video displays sold today produce VLF emissions in the 30 kHz to 85 kHz range. Furthermore, the researchers found that among the same model VDT, VLF levels varied by as much as 1500% (a fifteenfold difference), but the study made no attempt to

determine if the higher levels were associated with increased risks. Finally, the study did not deal with other health risks, such as cancer, from VDTs.

Other studies have yielded alarming results. A Johns Hopkins study showed that the incidence of leukemia among telephone cable workers was 7 times greater than among other telephone company employees. A subsequent study of 1.5 million past and present employees of AT&T found that men working as cable splicers and central office technicians had 1.7 times the risk of dying from leukemia than men working at jobs with less exposure to EMF. This is startling, considering that the field these men are exposed to is, on the average, relatively low (4.3 milliGauss.) As John Monahan of the Food and Drug Administration explains, "the effect is real. It is produced by a low-level magnetic field, but we don't yet know what the important parameters of the field are."

Studies of cells and laboratory animals exposed to EMF show biological effects, including: changes in levels of neurotransmitters F the chemicals which send signals between nerves, changes in levels of calcium found inside or on the surface of cells, embryo abnormalities in chickens, mice and pigs, malignant lymphomas in mice exposed to very high-intensity EMF, slowing of repetitive learning and reduced testical weight in rats, changes in brain chemistry, heightened stress, and changes in the rate of growth and cell division of some cells. The latter effects have implications for the offspring of pregnant women and growing children.

In some experiments, human cancer cells exposed to EMF exhibit increased resistance to attack by the body's cancer fighting white blood cells and the body's immune system. Further, a drop in the levels of melatonin have been reported in people sleeping with electric blankets. Melatonin is a hormone which controls the monthly female cycle and inhibits the growth of certain cancers. Other experiments on humans indicate that EMF can cause fatigue, headache, slower reaction times, slower heart rates and altered brain waves.

A study released in February, 1991 by the University of Southern California (USC) Los Angeles unexpectedly found an increased rate of leukemia among children who watch black and white televisions. While the study is the first to make this link, it is a reminder to keep children as far back from a television as possible. This study also found that exposure to hair dryers, curling irons and electric blankets increased the risk of getting leukemia.

In addition to leukemia in children, more recent studies have linked EMFs with new diseases. Loomis and Savitz of the University of North Carolina reported a doubling of the expected breast cancer rates for women in electrical trades aged 45-54. (Microwave News, Nov/Dec 1993). More recently, a major study linked EMFs with Alzheimer's. Results from two studies conducted in Finland and one in Los Angeles indicate that people with a high occupational exposure to EMF's are at least three times as likely to develop Alzheimer's disease a those without significant exposure. (Network News, Aug/Sep 1994).

Update: See Appendix 1 below for the latest press announcements regarding electromagnetic fields. Here is a brief summary:

The Latest News:

Excerpts from: MICROWAVE NEWS -- A Report on Non-Ionizing Radiation

August 2002

California EMF Program to issue Strongest Health Warning Yet

After spending more than \$7 million over the last eight years, the California Department of Health Services (DHS) will soon issue the strongest warning to date on the potential health risks from exposure to power-frequency electromagnetic fields (EMFs).

Drs. Raymond Neutra, Vrncent DelPizzo and Geraldine Lee, who wrote the report, conclude that they "are inclined to believe" that EMFs are a cause of childhood leukemia, adult brain cancer, amyotrophic lateral sclerosis (ALS) and miscarriages.

July/August 2001

ELF EMFs (electromagnetic fields) are now classified in the same category as DDT, lead, Carbon Tetrachloride and Chloroform, Category 2B possible carcinogens.

IARC Finds ELF EMFs Are Possible Human Carcinogens

A working group assembled by the International Agency for Research on Cancer (IARC) has unanimously concluded that power-frequency magnetic fields are possible human carcinogens. This finding, announced on June 27 in Lyon, France, is based on the consistent association between childhood leukemia and residential exposure to extremely-low-frequency electromagnetic fields (ELF EMFs).

The makeup of the IARC panel spanned all sides of the EMF controversy, from those who openly believe that EMFs promote cancer to industry consultants who are skeptical of any such connection. "We all agreed," said Dr. Larry Anderson. EMFs have now been formally designated "2B Possible Carcinogens." (For a list of the members of the working group and their affiliations, and examples of each type of IARC carcinogens, see below.

"There was a unanimous feeling about it," said Dr. Jan Stolwijk. Dr. Maria

The childhood leukemia studies have had a major impact on all of these prior assessments. The Doll report was heavily influenced by the two recent pooled analyses: one led by Dr. Anders Ahlbom and the other by Dr. Sander Greenland. The IARC panel was similarly swayed, according to both Stolwijk and Dr. Elizabeth Hatch. "The Ahlbom analysis was found to be most impressive," noted Stolwijk. Much more surprising was the IARC panel members' view of the animal data. They came close to finding "limited" support for a cancer association based on the animal exposure experiments.

IARC Carcinogens: Definitions and Examples:

Category 2B: Possible Carcinogen

Evidence: limited in humans and less than sufficient in animals

Chemical and physical agents:

Carbon tetrachloride, chloroform, DDT, ELF EMFs, lead, PBBs. Total number of agents: 236

June, 2001**Maximum EMF Exposure Emerges As Strong Miscarriage Risk**

A new and innovative epidemiological study has found an up to six fold increased risk of spontaneous abortions among women exposed to magnetic fields of 16 mG or greater. The results "should have wide implications," concludes Dr. DeKun Li, who led the study team at Kaiser Permanente's research division in Oakland, CA.

September 2001**WHO EMF Project Now Endorses Policy of Prudent Avoidance**

In a major policy shift, the World Health Organization's (WHO) International EMF Project has endorsed prudent avoidance.

On October 3, the WHO advised that decisions on siting power lines should "consider ways to reduce people's exposures." The WHO also recommended that governments and industry should offer the public "suggestions for safe and low-cost ways to reduce exposures." The advice is contained in a fact sheet on extremely low frequency electromagnetic fields (ELF EMFs) and cancer.

The project's new outlook follows the decision by an expert panel convened by the International Agency for Research on Cancer (IARC) to classify ELF EMFs as "possible human carcinogens" (see *MWN*, J/A01). IARC, which is based in Lyon, France, is part of the WHO.

German Radiation Commission Endorses Prudent Avoidance

Germany's Radiation Protection Commission is recommending a policy of prudent avoidance.

In a report released on September 14, the panel—known by its German acronym SSK—states that it has confidence in the ICNIRP standards. But it calls for "minimizing" exposures to both ELF and RF/MW EMFs to the extent "technically and economically reasonable," especially in locations where people spend extended periods of time.

The SSK recommends that emissions from consumer appliances, including mobile phones, be kept as low as possible and that product labels indicate emission levels.

On July 31, the radiation office's current director, Wolfram König, advised against the use of mobile phones by children and called for restrictions on base station antennas near schools and hospitals (see *MWN*, J/A01).

JUNE 2000

25

Strong Electric Fields Implicated in Major Leukemia Risk for Workers

Long term employees of Ontario Hydro who worked in strong electric fields had much higher risks of leukemia, Canadian researchers have found. Significant risks were also found for non Hodgkin's lymphoma (NHL) in a related study.

The elevated risks were seen among workers who spent the most time in electric fields above certain thresholds, in the range of 10 to 40 V/m. The largest increases occurred among those with more than 20 years on the job. Senior workers with the greatest time above the thresholds had an eight to tenfold increase in the risk of leukemia—much higher than in past epidemiological studies of electromagnetic fields (EMFs).

U.K. Panel Discourages Use of Mobile Phones by Children

A high level panel appointed by the U.K. government has recommended that children be discouraged from using mobile phones and that the industry not market phones to children. Although the Independent Expert Group on Mobile Phones, chaired by Sir William Stewart, found that there was no evidence of a health risk, it favored a "precautionary approach" given current "gaps in knowledge."

"I have got a grandchild of four and a grandchild of two and I would not be recommending that they have mobile phones," Stewart told the BBC, noting that he would continue to use his own phone. Stewart was science advisor to the prime minister from 1990 to 1995.

Electromagnetic radiation in the news!

Concerning power lines and appliances:

USA Today conducted a survey of 4,567 readers and reported that electromagnetic fields, or EMF's, are the number one environmental concern in America. "EMF's - always present near power lines and working electrical appliances - are linked to such diseases as leukemia and breast cancer."

"The National Council on Radiation Protection and Measurements (NCRP) committee charged with evaluating the potential health effects of electromagnetic fields (EMFs) has completed a draft report that calls for strong action to curtail the exposure of the U.S. population. "It took us nine years but we finally reached agreement," committee chair **Dr. Ross Adey**, of the Veterans Administration Hospital in Loma Linda, CA, told *Microwave News*.

A draft report prepared for the Environmental Protection Agency (EPA) generally endorses a 2 mG exposure limit. It would take effect immediately for new day care centers, schools and playgrounds, as well as for new transmission lines near existing housing. The report was funded by the EPA. **Dr. Joe Elder**, EPA's program officer for the NCRP study in Research Triangle Park, NC, called the committee's report "the first comprehensive review of the world's literature on EMF health effects."

Microwave News, July/August, 1995

"I have never seen a set of epidemiological studies that remotely approached the weight of evidence that we're seeing with ELF [extremely low frequency] electromagnetic fields. Clearly there is something here."

Martin Halper, EPA Director of Analysis and Support.

"Electromagnetic fields are associated with the development of leukemia, brain cancer and other serious diseases."

Paul Brodeur, writer, *The New Yorker Magazine*, author of *Currents of Death* (Simon and Schuster), and *The Great Power Line Coverup* (Little, Brown).

"...studies on cats, rats, and chick brain cells have shown that low frequency electromagnetic radiation interacts with brain activity and could cause a host of negative symptoms from heightened stress and depression, slowed reaction time, and learning disabilities to miscarriages, fetal deformities, and cancer."

Business Week, Oct. 30, 1989.

"This is really harming people."

Dr. David Carpenter, Dean, School of Public Health, State University of New York, Albany.

26.

When buying a home, it is important to check for EMF's. Homes "sold...for 30% less" when exposed to EMF's, as reported by the *Wall Street Journal*, September 8, 1993.

According to a survey conducted by *Indoor Air Review*, 26% of homes have areas that register EMF fields exceeding 3 milligauss.

"...Sweden has concluded that EMF's do lead to higher rates of cancer...I, frankly was somewhat impressed by the arguments made by the Swedes." - **President Bill Clinton**

Concerning televisions and computer displays (VDTs):

"Most unsettling of all, perhaps, is the fact that the pulsed VLF and ELF magnetic fields found routinely within a radius of about two feet from the average CRT computer terminal can be as strong as, or even stronger than, the sixty-hertz magnetic fields found inside the homes in which Wertheimer and Savitz discovered children to be dying unduly of cancer."

The New Yorker, June, 1989.

"...sit at least ten feet away from the television set."

Time Magazine, July 17, 1989.

A Swedish study has found that weak, pulsed magnetic fields similar to those emitted by VDTs can cause fetal abnormalities in the offspring of pregnant mice. According to Tom Brokaw of NBC News, "the findings no longer rule out the possibility that radiation can affect human fetuses." In Sweden, a major Swedish union (the Swedish Confederation of Professional Employees, or TCO) is seeking more stringent limits, and pressure is being put on the Swedish government to change VDT work regulations to protect pregnant women.

A study released in February, 1991, by the University of Southern California (UCS) in Los Angeles has found an increased rate of leukemia among children who watch black and white televisions.

As more evidence is compiled, concern about the link between exposure to EMF and human health is growing. Yet the experts agree only on one thing: no one knows the extent, nature and cause of health hazards associated with electromagnetic fields. Should we take comfort in published reports that the evidence is "not conclusive," or should we take steps now to mitigate public exposure to EMF even if the scientific jury is still out? An interesting parallel exists with smoking. In spite of overwhelming evidence, the tobacco industry claims that ". . . it is not known whether smoking has a role in the development of various diseases" (quote from *The Smoking Controversy: Why More Research Is Needed*, published by the Tobacco Institute, November, 1989). Such statements only prove that there will always be experts who disagree, thereby causing widespread confusion. Intelligent people obviously need to sort through the information and reach their own conclusions.

THE NATURE OF ELECTROMAGNETIC RADIATION

An AC electric current is defined as the movement of electrons in roughly the same direction, usually through a wire. This current, in turn, produces two types of fields: an AC electric field and an AC magnetic field, which together are called an electromagnetic field. The AC electric fields result from the strength of the charge and the AC magnetic fields result from the motion of the charge (i.e., the flow of electrons comprising the electric current). The AC electric field represents the force that electric charges exert on other charges, and this force may either repel (as with two positive charges, for example) or attract. The AC magnetic field forms a closed continuous doughnut-shaped loop around the current and radiates at a right angle to the direction of the current.

People can sense an electric field of more than about 20 kilovolts/meter (kV/m) as a slight tingling sensation on their

The field strength of electromagnetic fields can be calculated mathematically. Fields from compact sources containing coils or magnets (transformers, appliances, and computer displays, for example) diminish most rapidly with distance F in proportion with the distance cubed ($1/d^{**3}$; d = distance). Fields from long wire conductors in power lines drop off in proportion with the distance squared ($1/d^{**2}$), provided the currents flowing in opposite directions are well-balanced. The field strength drops off less quickly with secondary distribution lines, since the currents are frequently unbalanced. In practice, it is easier to measure the field strength than to calculate it, since there are usually multiple EMF sources which interact with each other in complex ways.

THEORIES ON HOW EMF AFFECTS BIOLOGICAL SYSTEMS

For many years some scientists and engineers felt that low frequency EMF could not possibly produce significant biological changes or effects. This reasoning was based upon the fact that low frequency EMF cannot break molecular bonds and it generates only a miniscule amount of heat - not enough to heat body tissue. However, this argument has turned out to be incorrect because there are other ways in which fields can interact with individual cells to produce biological changes.

If we recall that magnetic fields can induce an electric current in a nearby conductor, the implication is that AC magnetic fields will induce electric currents in our bodies (although such currents will be very small). That's because our bodies are mostly comprised of a conductive medium (salty water). Some of these currents are similar to what a salamander uses to regenerate a limb, and therefore the artificial creation of these currents in a human body are of concern.

The way in which electromagnetic radiation affects the body is not fully known. A similar state of knowledge applies to the mechanisms behind how aspirin cures a headache or reduces fever, or why asbestos causes cancer. One theory is that EMF causes the cell walls to vibrate, or to resonate, in the same way you can shake a bowl of jello and observe it oscillate back and forth at a certain frequency.

Resonance is not necessarily harmful. The body is composed of many elements that can resonate at different frequencies. The human ear is an example of a part of the body which resonates in tune with its environment. When we listen to the music of a violin, we are hearing a sound vibration of 5,000 cycles per second. The sound from a violin is transmitted by pressure waves in the air, not magnetic radiation. We know that the human body has no difficulty dealing with this kind of sound-induced resonance (unless, of course, the amplitude is very large, as with the sound of a jet engine).

In the case of EMF, resonance with cells occurs when there is a "match" between the wavelength of the radiation and the physical size of the cell. The resonance maximizes the transfer of energy into the cell, and can result in observable biological effects which may be harmful. One observable effect is a disruption in the calcium flow through cell walls. Calcium acts as a messenger that penetrates into the cell, conveying important information and triggering proteins to carry out cell functions. Calcium also plays an important role in regulating certain body functions, such as muscle contractions, heartbeat, development of egg cells and cell division. Since cancer growth depends on cell proliferation, these findings seem to explain why EMF sometimes behaves like agents that promote, rather than initiate, cancerous growths.

Another theory is that the altered calcium flow to the cell reduces the cell's ability to fight cancer. According to Craig Byus, a biochemist at the University of California at Riverside, just because the fields are very small doesn't mean they are innocuous. Cell membranes appear to have a way of amplifying the fields. Due to the poor conductivity of the thin cell wall, small induced currents produce large voltage potentials across the cell membranes, disrupting the chemical balance.

Are weaker fields safer than stronger ones? Logically, our experience with other pollutants would lead us to answer yes, but scientists say this may not be the case because there are "windows" or ranges of biologically active frequencies and field strength. Some experiments show no effect with a strong field, but when the field strength is reduced an effect appears. Other experiments show that above a certain field strength, effects can be observed but no additional effects occur when the field strength is increased.