

***Appendix Eight***  
Glossary

## GLOSSARY

**alternating current (AC):** An electric current that changes direction and strength of flow at regular intervals (as opposed to direct current (DC), which flows only in one direction).

**alternative hypothesis:** A hypothesis different from the "null hypothesis" (see definition below). In our case, the null hypothesis is that EMF have no effect on health and the alternative hypothesis is that they are harmful. Another alternative hypothesis could be that they are beneficial.

**amperes:** Unit used to measure current (the flow of electrons past a point per unit of time, analogous to "gallons per minute"). Often abbreviated as "amps." Named to honor the French scientist Ampere.

**area sources:** Objects that produce magnetic fields which affect a large area of space (greater than several tens of square feet). Some area sources are power lines, school power supply cables, heating equipment and power transformers.

**attributable risk:** The proportion of disease cases in a specific "exposed" population that are caused by the exposure under study (as opposed to Population Attributable Risk, see below).

**attribute:** Physical properties, or characteristics, of electric and magnetic fields. Some such attributes are frequency, intensity, and transients. The corresponding attributes for a sound wave are pitch, volume, and sudden volume changes.

**average** (also referred to as the **mean**): The figure obtained by dividing the sum total of a set of figures by the number of figures (i.e. of 5,7,8,9, the average is 7.25-derived by:  $5+7+8+9=29$ ,  $29$  divided by  $4=7.25$ ).

**background levels:** The amounts of EMF found (that are not due to an obviously specific source) in a typical environment of an industrialized society.

**bias:** When the result of a study deviates from the truth because of a systematic flaw in the way a study was conducted. Confounding (see definition) is a special, common case of bias. Other common examples are selection bias, recall bias and misclassification bias (see definitions in this glossary).

**cancer:** A term applied to a variety of different diseases characterized by abnormal new growth of tissue and the spread of that tissue to new locations within the body.

**carcinogen:** A cancer-causing substance.

**causal relationship:** A causal relationship occurs between two agents when one causes the other. For example, researchers are studying whether there is a causal relationship between EMF and cancer, meaning that they are studying to see if EMF causes, or affects the progress of, cancer.

**chance:** When an event occurs without the systematic influence of identified factors we say it has occurred by chance.

**confidence interval:** A range of numbers used by statisticians to indicate their uncertainty about their estimate of the true value of something. For example, when trying to estimate the percent of the public intending to vote for a particular candidate on the basis of a random sample of the public, the statistician might say: "45% of the public are for candidate X with a confidence interval of 40% to 50%." The true value could be anywhere from 40% to 50% with a best estimate at 45%. Graphically, the best estimate is often indicated by a dot, and the confidence intervals by a line extending from the dot, upward and downward ending respectively at the upper and lower confidence boundaries. Note: it is not the true value that is subject to uncertainty. It is our estimate of the value.

**confounder or confounding factor:** A cause of something being studied ( i.e a disease) whose effect on that disease is mixed up with the effect (or non-effect) of another factor because the “confounder” is associated with that other factor. See “confounding”.

**confounding:** Epidemiologists use the term when the impact of two risk factors are associated with the same exposure and must be disentangled. Heavy alcohol consumption and smoking are both known to cause esophageal cancer. If people who drink also tend to smoke, then the effect of drinking will confound the effect of smoking and vice versa. Therefore one must correct for this confounding in the way the data are analyzed. Sometimes the non-effect of a factor which conveys no risk at all is confounded with the true effect of another factor. For example, it has been suggested that people who live near power lines also live on busy streets with lots of traffic and air pollution. This argument suggests that the effect of air pollution on childhood leukemia was confounded with the non-effect of the power lines, and the power lines were falsely implicated instead of the air pollution. Two conditions must pertain for an agent to be a strong confounder of the EMF effect on the various diseases discussed in the California EMF Risk Evaluation. That agent must be strongly correlated with EMF exposure and it must have an effect on the studied disease that is even stronger than the apparent effect of EMF. If it is weakly correlated with EMF exposure it must have an effect on disease that is very strong indeed if it is to falsely make EMF appear to cause that disease.

**current:** The flow of electric charges through a conductor (such as a power line). Currents produce magnetic fields.

**decision analysis:** A technique used to map out the possible consequences that could flow from alternative courses of action, assessing how likely those consequences are, and how serious the various consequences are. By assigning a common scale to compare seriousness (for example dollar values), each stakeholder can assess what is the best course of action for that stakeholder. When stakeholders prefer different courses of action after doing this analysis they must resolve their differences through a political process.

**degree of certainty:** In the California EMF Risk Evaluation, a number on a scale of 1 to 100 which approximately describes how certain the reviewers are that magnetic fields increases the risk of cancer or other diseases.

**direct current (DC):** A steady current that flows only in one direction. Direct currents do not induce currents in stationary objects as alternating current (AC) fields do. The current from batteries is an example of direct current.

**disability adjusted life years (DALYs) lost:** Reflects the burden of a particular disease by combining the mortality and morbidity (disease) effects into a single number. The DALYs lost are calculated by adding the years of life-expectancy that are lost due to premature death to the number of healthy life years lost due to disability. Life years lost to disability are multiplied by a fractional number to reflect that disability is less severe than death. Thus depression is a condition that rarely if ever causes death directly, but induces many years of suffering and disability and therefore many DALYs lost but not as much as a neonatal death which accounts for 70 life years lost.

**distribution lines:** Power lines (often on wooden poles) that carry electricity from substations to neighborhoods and buildings.

**dose:** The amount of an agent that reaches a particular target organ over a specified period of time. For example, the dose of a medicine is the quantity of medication taken per day.

**dose-response:** The relationship between the dose (see definition above) and the effect it produces.

**effect modifier:** A factor whose presence modifies the effect of another factor on a disease ( or other outcome of interest). For example asbestos is known to cause lung cancer, but the effect of asbestos is much stronger in persons who also smoke. Smoking modifies the effect of asbestos on lung cancer.

**electric fields:** The force field which surrounds a charged particle; an area of space in which, because of the presence of an electric charge, other electric charges are subject to a force toward or away from the first. This force decreases with the distance between the two charges.

**electromagnetic spectrum:** The full range of frequencies of electromagnetic fields. The spectrum is broken down into the following categories: extremely low frequency (ELF), very low frequency (VLF), radio frequency (RF), microwave, visible light, and ionizing radiation (x-rays and gamma rays).

**EMF:** Electric and magnetic fields.

**EMF Mixture:** The varying combination of attributes (see above) that are related to the power grid that might be bioactive. The term is used by the California EMF Program to emphasize that the epidemiological associations seen with living near power lines or working with electricity could be due any one or some combination of these attributes. Some proposed mitigations affect all the attributes, while other proposed mitigations affect only some attributes. Laboratory experiments based on only one attribute do not necessarily assess the effect of the entire mixture.

**epidemiology:** The quantitative study of the occurrence of health states and disease states in human populations.

**exposure:** The amount of some agent that one comes in contact with over a certain time period. Exposure is different than dose. For example, a person who swims is exposed to water, but the dose of the water absorbed is nil, unless one drinks it.

**exposure metric:** A single number chosen to summarize a series of instantaneous exposures over an interval of time. Examples are the average of all those exposures, the maximum exposure experience over the interval, and the sum of all those exposures (the cumulative exposure).

**extremely low frequency (ELF):** Extremely low frequency fields are at the end of the electromagnetic spectrum. They range between 3 to 3,000 Hz. Power frequency (60 Hz) magnetic fields are of extremely low frequency.

**field intensity:** The strength of a field.

**frequency (of an alternating current, voltage or field):** The number of times per second that the current and the resulting field reverses direction (number of "cycles" per second)..

**frequency (of an event):** The number of times that an event occurs out of a 100 trials, expressed as a percent. For example, if we toss a coin 100 times and we get "head" 47 times, we say that the frequency of this event is 47%.

**Gauss:** A unit for expressing the strength of a magnetic field.

**gaussmeter:** An instrument used to measure magnetic field strength.

**geomagnetic fields:** Steady (DC) magnetic fields caused by the earth.

**grounding:** Connecting an object that conducts electricity, such as a wire or the metal frame of an appliance, to an object with zero potential to conduct electricity (such as the earth). The low voltage neutral circuit of a building is connected to the ground, often via plumbing pipes.

**harmonic:** A frequency which is a multiple of the frequency under consideration. For example, in music, the "high C" (1662 vibrations per second) is a harmonic of the "middle C" (554 vibrations per second). Harmonics can be an attribute of EMF.

**Hz (hertz):** The unit of frequency for the back and forth movements of alternating currents and their resulting magnetic fields corresponding to one cycle per second. In the United States, the electric power frequency is 60 Hz.

**IARC categories:** International Agency for Research on Cancer (IARC) categories are a classification system that expresses to what degree the agency is confident that something is carcinogenic.

**intensity:** Strength of a field.

**ionizing radiation:** Electromagnetic radiation with photon energy high enough to break molecular bonds and damage genetic material. X-rays and gamma rays are two examples of ionizing radiation.

**lateral profile:** A diagram illustrating how the strength of the magnetic field varies with the distance from a power line.

**leukemia:** Considered a cancer of the blood. Describes any of the various diseases found in bone marrow that results in unrestrained production of white blood cells.

**lifetime added risk from exposure:** The probability of an exposed person contracting or dying from a given disease in a lifetime (assumed to be 70-year) minus the lifetime probability of unexposed persons contracting or dying from that disease in their lifetime.

**magnetic field:** The force field created by an electric current. This force field is an area of space, in which, because of the presence of an electric current, other electric currents are subject to a force toward, or away from, the first. The force decreases with the distance between the two currents.

**magnetic field exposure standard:** A magnetic field level that should not be exceeded in a specified area.

**mean-** see average

**median:** The middle number in an ordered set of data, above and below which there is an equal amount of numbers (i.e. of the numbers 3,5,7,8,9, the median is 7).

**melatonin:** A hormone secreted by the pineal gland associated with establishing one's daily wake/sleep (circadian) rhythm. This rhythm regulates biological processes, such as sensitivity to stimuli, and hormone secretion.

**mG (milliGauss):** One thousandth of one Gauss. Gauss is a unit used for measuring magnetic fields. A milliGauss is useful to measure magnetic field levels commonly found in the environment. One milliGauss = 10 micro Teslas, another magnetic field strength unit which is often used. So, a typical California living room is measured at 0.7 milliGauss or 0.07 microTesla. The following chart provides some examples of mG measurements.

Examples of Magnetic Fields in the Home in mG		
	mG at 1 foot	mG at three feet
coffee machine	0.09 - 7.30	0.00 - 0.61
portable heater	0.11 - 19.60	0.00 - 1.38
computer monitor	0.20 - 134.7	0.01 - 9.37
Television	1.80 - 12.99	0.07 - 1.11
can opener	7.19 - 163.02	1.30 - 6.44
desktop light	32.81	1.21

**microTesla:** (see milliGauss)

**misclassification bias:** Bias resulting from assigning subjects to the wrong group with regard to their exposure status. For example, if exposed subjects are erroneously placed in the non-exposed group, any possible difference in the incidence of a disease between the two groups is decreased and the relative risk is artificially lowered. If the amount of misclassification is 'differential', that is, consistently greater for one category of subjects than for another, the risk may appear stronger than it truly is.

**mode:** In a series of values, the value that occurs most often. Note the difference between mode, mean and median. The mean (or "average" - see above for the definition) is strongly influenced by a few very high values. The median (see definition above) is a 'middle-of-the-road' value, but is not necessarily common. For example, the mode of residential magnetic fields is about 0.5 mG. This means that the field in most houses is about 0.5 mG. Since a few houses have much higher fields, the average is higher than the mode (about 1 mG). Although 0.5 mG is a common value, it is also somewhat extreme - very few houses have fields much lower than that. Therefore, the median is also higher than the mode (about 0.7 mG).

**morbidity:** Rate of disease.

**mortality:** Rate of death.

**net currents:** Unbalanced currents in building wiring or on power lines that cause strong magnetic fields. Normally, when wiring is connected correctly, currents of similar levels flow in opposite directions and the magnetic fields they produce "cancel each other out." However, improper wiring can cause one wire to contain a much stronger current than the other. Consequently, the disparate currents produce magnetic fields of different strength that cannot "cancel each other out." The residual field can be thought of as produced by hypothetical "net current".

**non-participation bias:** A source of bias similar to selection bias (see definition) Even if subjects are selected in an unbiased way, if a significant number choose not to participate and these subjects share some significant attribute, the remaining subject pool does not represent the population from which they are drawn and this may affect the result of the study.

**null hypothesis:** The hypothesis that 'nothing special is going on'. In this case, that EMF exposure has no bearing on health.

**odds ratio:** An approximate measure of relative risk (see definition). For example, an odds ratio has been used to compare the observed rate of EMF exposure in children diagnosed with leukemia and in healthy children. If the rates are the same, the odds that sick children are exposed to EMF fields is the same as that of healthy children and the odds ratio = 1.0. If the odds of being exposed is much higher in sick children than healthy children the odds ratio will be bigger than 1.0, suggesting that exposure may have something to do with the disease. (Note: the OR is normally used in case-control studies, where the health endpoint is ascertained first and the exposure status later. The relative risk is different: that is indeed the ratio of the disease rate in two groups with different exposure. The two, OR and RR measure APPROXIMATELY the same thing, only when exposure is rare.)

**operator sources:** Objects which are sources of EMF, but whose fields extend appreciably only over a few feet and therefore may affect the operator of that object, but normally not other people. Some examples are electric pencil sharpeners or computer monitors.

**oscillations:** Movements back and forth; vibrations.

**p value:** A number between 0 and 1 measuring how likely it is that a test statistic as extreme as or more extreme than the one given by the evidence will be observed if the null hypothesis is true. Suppose we perform a statistical test on a set of data and we get a result with a p-value of 0.001. This means that, if the null hypothesis were true and we obtained a new set of data, there is only one chance in 1000 that a more extreme test statistic would be obtained. In other words, the evidence available to us is very 'extreme' or unusual. If one agrees that this degree of 'unusualness' is enough to reject the null hypothesis, one can conclude that there is significant evidence to support the alternative hypotheses that a causal effect, confounding or consistent bias has been operating.

**personal exposure measurements:** Magnetic field measurements that attempt to measure the magnetic field level an individual is exposed to as he or she moves through their environment. These measurements may be expressed as the time-weighted average (over the course of a 24-hour period), as the maximum exposure received during that period, as the percentage of time spent over a given minimum, or some other definition of exposure.

**phase:** The time relationship between the oscillations of two alternating currents. For technical reasons, electric power is often transmitted using three wires, each of which has a current that is one third of a cycle behind the other (three-phase current). For normal household consumption, only one of these three wires is connected to the user (single phase current), but for industrial applications, the current carried by all three wires may be required.

**photon:** The smallest amount in which an electromagnetic field can be divided. The energy of a photon is proportional to the frequency. An ELF (extremely low frequency) photon contains very little energy, unlike a microwave photon, which has a lot more energy. Gamma ray and X-ray photons contain even more energy, enough to break apart atoms and molecules (see: ionizing radiation).

**polarization:** Polarization is one of several attributes of magnetic fields. It is the shape created by the tip of an EMF vector during a single cycle.

**population attributable risk:** The proportion of cases of a particular disease in the entire population that is attributable to those who are exposed to a risk factor in that population. This proportion depends both on how many people are exposed and how big a risk is conveyed by that exposure (as opposed to attributable risk that pertains only to the exposed people, see above).

**population attributable risk percent:** The percentage fall in the overall rate of a disease if exposure to an agent contributing to that disease rate were removed. This depends both on the size of the added risk in the exposed population and how common that exposure is. If exposure is rare, even a hefty increase in risk among the few exposed people will not have much of an effect on the overall rate of disease in the general population.

**power frequency:** Frequency of the alternating current used for transmission and distribution of electric power. Power frequency is 60 Hz in North America; it is 50 Hz elsewhere.

**power grid:** The power grid encompasses a network of long-distance, high-voltage transmission lines, substations, and distribution lines carrying electricity that will eventually be distributed to customers of local utilities.

**probability:** The estimate of the frequency of an event (see definition above). For example, the probability of guessing the outcome of a coin toss is 50%.

**RAPID program:** The Federal government's EMF Research and Public Information Dissemination (RAPID) Program that ended in 1998. Their web site is [www.niehs.nih.gov/emfrapid](http://www.niehs.nih.gov/emfrapid).

**recall bias:** Bias resulting from the tendency of a class of subjects to recall relevant events better than other subjects. For example, women who have suffered a miscarriage may search the memory for any possible factor that they suspect may have affected their pregnancy, while other women may have forgotten what they regard as insignificant details. As a result, innocent events may appear to be associated with miscarriage.

**relative odds:** Equals the ratio of the odds of obtaining a certain body of evidence if the "alternative hypothesis" (see definition) is true and the odds of obtaining the same body of evidence if the "alternative hypothesis" is not true. Another term for the "Odds Ratio".

**relative risk or risk ratio:** The risk of disease in the population exposed to a specific risk factor divided by the risk of the same disease among unexposed people. If exposure has nothing to do with the disease, the two rates are the same and the relative risk is 1.0 (which is equal to a proportion of 1:1). If the exposed group has a higher rate of disease, the relative risk is greater than 1, suggesting that exposure MAY have something to do with the risk of disease.

**right-of-way:** The area of land immediately surrounding high voltage utility lines that utility companies need to access for power line maintenance and repairs.

**risk:** The probability that an event (usually an unwanted event) will occur.

**risk difference or rate difference:** The rate of disease in an exposed group minus the rate of disease in an unexposed group.

**selection bias:** Bias resulting from a faulty way to select subjects for a study. Epidemiological studies depend on a reliable comparison between subjects with a disease and a reference population as to their exposure. If the subjects chosen for a study are not representative of the corresponding population, the comparison becomes flawed and the association between disease and exposure becomes biased. For example, selecting subjects by telephone excludes all subjects who don't have a phone and some subjects who, for a variety of reasons, are harder to contact by phone. This exclusion may (or may not) result in the exposure status of the subjects in the study being quite different from that of the population they are supposed to represent.



**short circuit:** Occurs when a current bypasses the appliance by traveling on a path with little or no resistance (i.e. frayed insulation allowing the "hot" and "neutral" wires to touch, and current to flow with a large spark). A large current can then result, which produces a lot of heat and could present a fire hazard.

**social justice policy framework:** A way of judging policy options that focuses on whether they violate duties, rights, and the protection of the most vulnerable with much less concern for costs.

**spot measurements:** Magnetic field measurements taken at various individual locations throughout a room or area.

**time-weighted average (TWA):** The average of various magnetic field measurements, each of which is given more or less weight according to how much time a person is likely to spend in the spot where that measurement was taken. The term is used more generally to indicate the average of magnetic field levels over a specific amount of time. This is one method used to summarize exposure to exposure to magnetic fields (see "exposure metric").

**three-phase distribution lines:** A common configuration of the wires to facilitate the transmission of large amounts of energy. Transmission lines and large distribution lines usually use a three-phase configuration.

**transients:** Sudden (less than a thousandth of a second) changes in magnetic fields.

**transformer:** A device used to convert electrical currents of one voltage into currents of a different voltage.

**transmission lines:** Power lines (usually metal towers) that carry high-voltage electricity between geographic areas, often from a power generation facility to a substation in a community.

**utilitarian policy framework:** A way of judging policy options that focuses on intended and unintended results of each option, as well as their costs. Often a common scale (such as a dollar value) is applied to the results and a cost benefit analysis is carried out. The utilitarians (an early 19th century ethical school of thought) resolve differences between stakeholders by taking the solution that offers the most good for the most people at the least cost. This solution can sometimes be very disadvantageous to groups in the numerical minority. The utilitarian framework is not very focused on duties and rights.

**voltage:** Electric potential or potential difference (the difference in "electrical pressure" between two different points of an electrical circuit). This is analogous to the differences in pressure that force water to flow through a pipe. Voltage is measured in "volts," named to honor the Italian scientist Volta.

**wire code:** A method used to classify homes according to the type and distance of nearby power lines.

*"Examples of Magnetic Fields in the Home in mG" data taken from: L. Zaffanella, School Exposure Assessment Survey, California EMF Program, interim results, Nov. 1997.*