

GLOSSARY

Glossary of terms used when discussing exposure to electric and magnetic fields

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This glossary defines and discusses terms used when discussing exposure to electric and magnetic fields.

ALTERNATING CURRENT (AC)

An electric current that changes direction and strength of flow at regular intervals (as compared with direct current (DC), which flows only in one direction).

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 honour the French scientist Ampere.

AREA SOURCES

Objects that produce magnetic fields that 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. See “operator sources”, which affect smaller areas.

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 (that is, for the four figures 5, 7, 8, 9, the average is 7.25 derived by: $5 + 7 + 8 + 9 = 29$, $29 \div 4 = 7.25$).

BACKGROUND LEVELS

The amounts of EMF (see EMF) found (that are not attributable to an obviously specific source) in a typical environment of an industrialised 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).

CALIFORNIA EMF PROGRAM

A programme of policy analysis, exposure and health research completed in 2004 from which this glossary comes. Its web site is <http://www.dhs.ca.gov/ehib/emf>

CHANCE

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

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.

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.

DISTRIBUTION LINES

Power lines (often on wooden poles) that carry electricity from substations to neighbourhoods 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. At this writing there is no consensus as to what attribute of the “EMF mixture” delivered in what way would constitute a “dose”. Epidemiological disease associations have been with occupations and locations where magnetic field flux densities (see below) have been high but it is not clear if these measurements merely serve as a surrogate for something else about the EMF mixture or characteristics of the persons in those occupations or locations.

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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 that 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. Electric fields are measured in units of volts per metre (V/m).

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 ionising radiation (radiographs and γ rays).

ELF

Extremely low frequency electric and magnetic fields refers to fields whose oscillations back and forth occur at rates between 1 and 300 times per second. Fields produced by power lines (50 or 60 times a second) are one example.

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 emphasise that the epidemiological associations seen with living near power lines or working with electricity could be attributable to 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.

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 you drink it.

EXPOSURE METRIC

A single number chosen to summarise 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)

ELF fields are at the end of the electromagnetic spectrum. They range between 3 to 3000 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 in 100 trials, expressed as a percentage. 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 flux density that is related to field strength (see below).

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 that 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 USA, the electric power frequency is 60 Hz. Named to honour Heinrich Herz a 19th century physicist.

INTENSITY

Strength of a field. Also used to refer to flux density (see below).

IONISING RADIATION

Electromagnetic radiation with photon energy high enough to break molecular bonds and damage genetic material. Radiographs and γ rays are two examples of ionising radiation.

LATERAL PROFILE

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

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 years) 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.

MAGNETIC FLUX DENSITY (B) AND MAGNETIC FIELD STRENGTHS (H)

In vacuum (or air) $B = \mu_0 H$. For standard international units $\mu_0 = 4\pi \times 10^{-7} \text{H/m}$. B is expressed in Tesla and H in Ampere turn/m or A/m. Hence in vacuum or air a flux density of $1\text{T} = 796 \text{ kA/m}$.

For centimetre, gram seconds units $\mu_0 = 1$, B is expressed in gauss and H in oersted. Hence in vacuum or air a flux density of 1 gauss = 1 oersted. In laymen’s terms, the flux density (the thing measured by the Gauss metres used in epidemiological studies) can be thought of as the number of lines of magnetic force passing through a unit of area at right angles to the direction of the field. The field strength at that point is the tug on a hypothetical magnet at that point.

MEAN

See average.

MELATONIN

A hormone secreted by the pineal gland associated with establishing a person’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 the “flux density” of 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 that is often used. So, a typical California living room is measured at 0.7 milliGauss or 0.07 microTesla. Depending on the current running on an electrical power line a person must walk tens to hundreds of feet from the line before the magnetic field would fall to 0.7 milli Gauss. Table 1 provides some examples of mG measurements.

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 seem 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. As 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).

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”.

OPERATOR SOURCES

Objects that 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 it is agreed that this degree of “unusualness” is enough to reject the null hypothesis, it can be concluded 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 a person is exposed to as they move 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 relation 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

Table 1 Examples of magnetic fields in the home in mG*

	mG at one 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

*Data taken from: L Zaffanella, School Exposure Assessment Survey, California EMF Program, interim results, Nov 1997.

contains very little energy, unlike a microwave photon, which has a lot more energy. γ Ray and x ray photons contain even more energy, enough to break apart atoms and molecules (see: ionising radiation).

POLARISATION

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

POWER FREQUENCY

Frequency of the alternating current used for transmission and distribution of electric power. Power frequency is 60 Hz in North America and Brazil; it is 50 Hz in Europe and 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 <http://www.niehs.nih.gov/emfrapid>

RECALL BIAS

Bias resulting from the tendency of a class of people 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 seem to be associated with miscarriage.

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 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 people for a study. Epidemiological studies depend on a reliable comparison between people with a disease and a reference population as to their exposure. If the people 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 people by telephone excludes all people who do not have a phone and some people 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 travelling on a path with little or no resistance (that is, 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.

STATIC FIELD

An electric or magnetic field whose intensity does not vary over time. The earth's geomagnetic field that influences a compass needle, or the field that emanates from a typical horseshoe magnet are examples of static fields.

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 show the average of magnetic field levels over a specific amount of time. This is one method used to summarise 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 geographical 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 honour the Italian scientist Volta.

WIRE CODE

A method used to classify homes according to the type and distance of nearby power lines. They were originated by Wertheimer and Leeper in the 1970s as a surrogate for magnetic field exposures in adjacent houses. They are imperfectly correlated with in-house measurements because they do not predict fields from home wiring and appliances, but they are associated with cancer risk in some studies.

WHO

World Health Organisation has an EMF programme whose web site is: <http://www.who.int/peh-emf/project/en/>

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This is an edited version of a glossary that appears on the California EMF Program web site at www.dhs.ca.gov/ehib/emf and is produced here with the permission of Raymond Richard Neutra MD Dr PH, Chief, California EMF Program.

THE JECH GALLERY

Social paediatrics: empowering childhood

Social paediatrics deals with health and disease determinants. The social and economic environment in which children are born, live, and develop determines their opportunities for a healthy diet, education, and care, which allows them to satisfy their physical, mental, emotional, and social needs for growth, development, and quality of life. Unfortunately, in many parts of the world these conditions do not exist, and this is an expression of social injustice.

This photograph, taken in Argentina and forming part of a series, reflects an aspect of a universal reality of children living in poverty and in social exclusion. The selected images were taken within the framework of the social conflict denominated as “piquetes”, an expression of the social claim of those who were excluded as a consequence of the neoliberal policies implemented in the region. The mass media generally depicts stigmatising images of aggressive protestors with sticks in their hands, surrounded by wheels in flames. These photos attempt to show the other face, or “the why” of the protest: children demanding a better quality of life, work, health, education, housing, and dignity.

The series of photographs is called “Pequeños piqueteros” (Little “piqueteros”).

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Children asking for better health and quality of life (photo credit: Xavier Kriscautzky, Argentina).