Buying an "EMF Safe" Property

3. Substations and transformers

Substations (or transformers) in urban areas can be found as frequently as every 150 metres or so apart. They are not regarded as objects of beauty even by the electricity companies that own and maintain them, and as there does exist a risk of electrocution if someone gets in and touches the wrong thing by mistake, they are usually hidden behind some form of barrier, with a 'Danger of Death' sign prominently on display.

The substations themselves, if not visible, will be small box-like objects, hidden behind a wall or fence. Sometimes there are railings around a rather dull looking grey metal object.

Substations come in different sizes. The one pictured above is a small substation which will feed an electricity supply to a relatively small number of residential properties. Larger ones may feed an industrial estate, a mixture of commercial and residential properties, a large institution such as a hospital, etc. Many schools have their own substation in the grounds. Some buildings, which are used for residential or workplaces have internal substations, often situated on the ground floor or basement. This can result in the people in the building being exposed to very high levels of electromagnetic fields.

There are some enormous substations on the outskirts of towns which are full of electrical equipment and lots of small transformers covering quite a large area of ground. It would not be a good idea to live within 100 metres of one of these, especially downwind. Work done at Bristol University has shown that the high electric fields around EMF-producing sources, such as the collection of transformers shown at the top of page 2, attract all sorts of airborne pollutant particles, including those associated with cancer, which may be in the air. They then charge these up, making them more dangerous, as they become 'sticky' and are more likely to attach themselves to skin or lungs. Depending on the prevailing wind (south westerly across most of Britain a lot of the time, when there are not too many hills or buildings nearby to distort the wind

direction), the particles can be blown some kilometres from the transformers themselves. If the property you are interested in is in an area where there is pollution from local industry or busy roads such as motorways, there could be an increased risk of toxic particle and aerosol contamination.

In rural areas, transformers are sometimes small(ish), usually grey, boxes attached to a pole of the 11 kV line that brings the electricity to the area.

The fields from these transformers fall off very rapidly and are usually negligible further than 3 metres away - the fields from the overhead wires are usually more concerning, and the 11 kV wires should not pass within 20 metres of the house.

Larger substations are associated with higher EMFs. The nearer they are to a property, the higher the levels of magnetic fields are likely to be inside.

Substations are not hazardous just because they are substations. It is because they are surrounded by electromagnetic fields that the equipment they contain produce, that they have to be treated with caution. The notices attached to substation and transformer enclosures by the electricity companies give warning of the potential for electric shocks, and are intended to keep members of the public away from the installations themselves. It is the invisible, yet pervasive, electric and magnetic fields that extend beyond the equipment housing that we also need to be aware of.

The use of electricity produces electric and magnetic fields, together referred to as electromagnetic fields (EMFs). Electric fields are measured in volts per metre (V/m) and magnetic fields in the UK are usually measured in microtesla (μT). Gauss is the unit that is used in America. The equipment to buy or hire described on page 6 measure in microtesla, or nanotesla (1,000 nanotesla to the microtesla).

Some businesses, offices, flats, houses have substations in the basement of the building. It is ***very*** important to find out if this is the case, as the field levels in the floor above the substation will usually be subject to *very high* magnetic fields [Refs 1, 2, on page 6]. These are likely to affect the health of people who are susceptible, see the article on www.powerwatch.org.uk "Powerfrequency EMFs and Health Risks" and the fields can also cause computer 'wobble' which can make operators feel ill and is against Health and Safety at Work regulations.

The electricity supply to substations and transformers comes either from overhead powerlines (which will be visible) or from underground cables. If you are thinking about buying a property near to a substation or transformer, or want to investigate the area near your local substation, the local electricity board is able to provide you with a plan of the cable layout, to see how close the main cables are to you. They are not always accurate, but their actual position can easily be detected using a powerfrequency field meter, such as the PRO or 3030B, from EMFields, described on page 6. It is possible that the electricity company will only supply plans of cables to a property's owner, so some negotiation may be necessary if you haven't purchased the property yet. The cables may well run under pavements, in passages running by the side of a garden and/ or house, or the side of rural roads, and give surprisingly high magnetic field readings when you take measurements directly above them. If there is a buried cable under the pavement in front of a house where there is a very small garden, or no garden at all, the fields in the room(s) at the front of the house, especially on the ground floor, could be high.

The only way to get a reliable idea of the field from cables is to measure them. It is very difficult to calculate the estimated level because of the possible variability, due to trench size and depth and layout of the cables. Easy-to-use, accurate instruments designed for the layperson to get instant readings are readily and cheaply available to hire (see the PRO on page 6).

The level of EMFs is likely to vary throughout the day. It will be higher at times of peak electricity demand. These are likely to be between 7.30 to 9.00 a.m. and 3.30 to 7.00 p.m. during the week, in a residential area where the majority of residents are at work or at school. This may change during school holidays. Weekend peak times are likely to be different. In winter, the levels will be higher than in the summer, due to the extra power demand for heating. This may include overnight demand for night storage heaters. It is important to allow for this difference in field levels when you take readings. If the electricity company takes readings for you (in some areas this is a possibility), they may not be taking readings at these peak times.

Electric fields are reduced dramatically by most structures, brickwork, woodwork, railings, etc. Trees and bushes, especially evergreen or 'sappy' trees absorb much of the electric fields. The bushes themselves do not seem particularly affected by these; if there are any bushes around the substation, and they are not in the best of condition, they are more likely to be affected by the poor quality of soil and the lack of horticultural attention around substation structures, than the EMFs they are exposed to.

Magnetic fields go through practically everything. Magnetic fields will extend from the substation to a distance that partly depends on the way the equipment inside is laid out. The only thing that reduces magnetic fields is distance from the source.

Often a substation, even next to a house plot, is separated from the house and/or garden by a passage or garage. Walking through high fields is less likely to cause serious health problems, although some research indicates that regularly being exposed to rapid, large changes in magnetic field exposure can increase the risk of miscarriage.

For most people, it is where you spend a lot of time relatively unmoving that it is advisable to have low fields. If there is a substation adjacent to the house, perhaps a bedroom, it is very important to measure the field levels. Until you have done so, put any beds in the room as far as possible from the substation, with the bedhead at the furthest point. Remember the critical level for magnetic field levels (which cannot be reduced by screening) is below 0.1 microtesla in bedrooms and 0.15 microtesla in play or sitting areas.

Do not build a patio, a child's play area, or anything else where you or members of your family will want to spend a lot of time, next to a substation wall, or next to underground cables. Do not put a pram where a baby sleeps next to a substation enclosure. Ideally, areas in the garden, which are used for play or relaxing should have fields of less than 0.2 microtesla. Thorny bushes (such as roses, etc.) planted in the garden next to a substation can keep people, especially children, away from areas of high field levels. Do not plant a tree that turns out to be an ideal place for a tree house, or bushes that make a good 'den'!

Substations are connected together, to ensure supply delivery. To provide a consistent voltage, they can be connected in such a way that a high 'net' current is produced. This is current that is coming from one substation and returning to another. Such a current does not have an opposite and equal balancing current running alongside it and so it can produce high magnetic fields that fall off slowly. Such inter-connection is perfectly legal and an accepted practice. It can create very high magnetic fields in houses, usually with no way of reducing them, as the electricity companies do not believe high magnetic fields are a problem. The ONLY way to find out if this is a problem is to measure the magnetic fields at the house, preferably at a "busy" time - e.g. 8 am or 6 pm. If there is a 'net' current in the street, the magnetic field levels will be similar throughout the property, and most of the other nearby houses, not reducing much with distance from the substation. In our surveys about one quarter of the properties have had net current problems.

High electric field levels near inside walls will be due to house wiring faults not a net current. If you have high electric fields, see the article "House Wiring and EMFs", which will help you to reduce the family's exposure.

'Stray' currents are due to faults in the neighbourhood electricity system that has transferred on to metal gas and/or water pipes and can be detected by holding the EMF measurement meter close to the pipes where they come into the house. In flats, measure close to all water and gas pipes. Stray currents are surprisingly common and can be stopped, but this is not always easy and there is a cost involved.

A study done by Sally Sims and Peter Dent in the Department of Real Estate Management at Oxford Brookes University [3] showed that the visible presence of substations could reduce the number of potential buyers by up to 63%, depending on the type of property concerned.

The only way to know for sure if the property you are interested in is exposed to field levels higher than the precautionary levels recommended by the health research, is to measure them using an appropriate power-frequency meter. For details of how to buy or hire a meter that can do this, see the equipment described on page 6. They are very easy to use, and hiring is inexpensive.

So, if you want to go ahead with the purchase of a property, near or over a substation or near or under a transformer, or if you already live in one, a question people often ask is, *"what can I do to protect my family from electric and magnetic fields?"*

Electric fields are reduced significantly by almost all building materials, with the exception of windows, either double or single glazed. If there are high electric fields coming in from an external source through the window, you can stop them with special screening material hung as a net curtain and earthed. Appropriate material can be purchased from www.emfields.org. Trees and bushes also reduce electric fields that there may be in a garden. Deciduous trees are less good in winter when they lose their leaves. 'Sappy' trees (some pines, cherry, etc) are better than non-sappy trees at reducing field levels. Depending on the rules (if any) where you live, a 6-foot close wire mesh fence behind or in the middle of two rows of tress, could also help considerably.

There is absolutely nothing you can do about magnetic fields. Lead sheets do not reduce fields, and steel sheets are not effective. There is a metal called mu-metal which reduces, but does not eliminate, the fields, but it is very expensive and difficult to use, and there is usually no practical way of effectively reducing magnetic field exposure from substations.

Summary of safety points to do with substations and transformers

- The bigger the substation, the higher the electromagnetic fields are likely to be and the further away a property has to be, to be in low fields. Measure the fields, it is easy and vital to do so.
- A substation serving a residential area only is likely to be lower powered than one which serves a variety of users.
- If there is a substation in the building where you live or work, the field levels on the same floor and the floors above and below could easily exceed the levels at which serious health effects, such as cancer, dementia or depression have been reported.
- Magnetic fields are likely to be lower in areas where gas is available for domestic heating. Off-peak (overnight) electric storage heating causes VERY high currents to flow after midnight in cold weather - these currents increase magnetic field levels in the area by many times the daytime level. This is important if a bedroom is next to a substation or close to overhead or underground 230 / 400 volt distribution cables. This could apply to bungalows or downstairs bedrooms close to a pavement (including in basement flats in cities). Magnetic field levels of 0.3 microtesla and more have been associated with cancer, depression, miscarriages, Alzheimer's Disease etc.
- 'Net' currents and 'stray' currents are unpredictable, and can only be detected by measuring the field levels.
- Find out where the cables running from the substation go, especially if they may pass close to your house or garden.
- Check the area for high fields due to net currents by measuring the magnetic fields at times of the day when people are using electricity; 7.30 - 9.00 am and 5.00 - 6.30 pm are good times to measure. If there is no gas in the area, 1.00 a.m. (i.e. after midnight) is a good time to measure in cold weather when most off-peak heating systems will have switched on. Houses on corners seem to be more affected by these fields than others.
- Building materials and some trees reduce electric fields, but magnetic fields travel through pretty well everything.
- If you have a property, or decide to buy a property near a substation, plant thorny bushes between the nearest part of the plot and the substation to keep family members (and animals) at a safe distance.

- Land, garden and buildings downwind of the prevailing wind direction will be exposed to more toxic particles from high voltage lines of 33 kV or higher, than those upwind.
- Do not build a patio, play area, or other sitting area next to a substation.
- Do not put a pram (or tent) next to a substation.
- Substations close to the house make properties harder to sell.

References

[1] **Thuroczy G** et al – 2008, *Exposure to 50 Hz magnetic field in apartment buildings with built-in transformer stations in Hungary* Radiat Prot Dosimetry 131(4):469-73
[2] **Ilonen K** et al – 2008, *Indoor transformer stations as predictors of residential ELF magnetic field exposure* Bioelectromagnetics 29(3):213-8
[3] **Sims** S & **Dent** P - 2005, Urban Studies Journal, April
http://usj.sagepub.com/cgi/content/abstract/42/4/665

Equipment for measuring electric and magnetic fields

PRO meter (to buy or hire)

ELF 3030B (to buy only)

To measure both electric and magnetic fields, you can hire or buy the PRO power-frequency meter (designed by Powerwatch) or you can buy (but not hire) the ELF 3030B (Gigahertz) meter.

The PRO measures 1 - 2000 V/m electric fields and 0.01 - 19.99 microtesla magnetic fields.

The ELF 3030B measures 1 - 2000 V/m electric fields (the same as the PRO meter), and 1 to 1999 nanotesla (0.001 - 1.999 microtesla) magnetic fields.

With either of these meters you can measure the EMFs in your property or the property you are considering buying, outside in the garden, inside your car and in other places of concern (schools, nurseries, workplace, etc.) from substations and other external sources of power frequency EMFs.

Contact: EMFields, 2, Tower Road, Sutton, Ely, Cambs. CB6 2QA www.emfields.org 01353 778814; meters are sent by 1st class recorded delivery.

Publications

The Powerwatch Handbook
Alasdair & Jean Philips - A Piatkus publication

Has chapters on EMFs and health; EMFs in the outside environment; telephones; EMFs in the home and the workplace; EMFs when out and about; pregnancy, children and EMFs; what to do if you're electrosensitive, a detailed scientific appendix, and an extensive resources section. £7.50 + £2.50 p&p.

Influence of High-frequency Electromagnetic Radiation at Non-thermal Intensities on the Human Body 2001 - A review of work by Russian and Ukrainian researchers

A 31 page detailed scientific review, in English, including references, examining experimental studies of the effects of electromagnetic radiation (including therapeutic effects) on biological subjects, including humans. £6 + £2.50 p&p.

Worksheet Substations and Transformers (2 Sides)

What size is the substation you are concerned about? ……

How many properties does it serve? ……

Does it supply:

Shops?	Yes / No
Industrial premises?	Yes / No
Large establishments?	Yes / No

Do any of these need a 24 - hour supply of electricity? Yes / No

Do local houses use night storage radiators? Yes / No
(More likely if there is no gas supply)

Do the cables to and / or from the substation pass close by the property?

……. Metres

Has the property got a very small (or no) front garden Yes / No

Is the property on a corner? Yes / No

Is there a 'net' current? (see text page 4) Yes / No

Is there a 'stray' current? (see text page 4) Yes / No

Maximum field level measured at the nearest point of the property to the substation, transformer or cables.

Garden

Electric field …… V/m

Magnetic field …… microtesla

Property

Electric field …… V/m

Magnetic field …… microtesla

What time of day was the measurement taken? ……. a.m. / p.m.

Is this likely to be the highest reading of the day? Yes / No

Is this likely to be the highest reading of the year? Yes / No

Is the property price appropriately discounted? Yes / No

Could there be a problem with obtaining a mortgage on this property? Yes / No

Are the magnetic field levels lower than 0.2 microtesla

In the garden? On the patio? In the conservatory / sun lounge?

Children's play area?

If any part of the garden is above 0.2 microtesla, draw a plan in the space below to show where this high field area extends to.

In the house?

List any rooms in the house that are above 0.2 microtesla.

……
……

Are any of these places in bedrooms? Yes / No

Where people are likely to spend any length of time? Chairs, etc. Yes / No