Electricity substations and health

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Electricity substations, like overhead power lines and electrical appliances in the home, are sources of extremely low frequency (ELF) electromagnetic fields.

The electric and magnetic fields in the vicinity of electricity substations are well below the levels associated with established health effects. A large number of studies have so far failed to establish adverse health effects associated with exposure to low level electromagnetic fields – with the exception of a possible doubling of the risk of childhood leukaemia. So far, other health effects – such as adverse pregnancy outcome – have not convincingly implicated typical environmental exposure to ELF electromagnetic fields.

Bodies such as the Government-backed SAGE and the independent group Powerwatch have recommended precautionary approaches. EU legislation, derived from pre-existing guidelines on exposure to non-ionising radiation, is in train.

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1 Health effects

Electricity substations, like overhead power lines and electrical appliances in the home, are sources of extremely low frequency (ELF) electromagnetic fields. There has been a good deal of research into the biological effects of these fields, some of which was covered in Library Research Paper 94/119, *Overhead power lines and health*. The paper has a particular focus on concerns that exposure to low-level electromagnetic fields might double the risk of childhood leukaemia. It also covers established health effects associated with much higher exposure:

> Buildings act as effective shields from electric fields, reducing their strength by factors of between 10 and 100. This is not the case for magnetic fields, which are also the main source of concern from a health standpoint.
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> [...]
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> Health concerns focus on the magnetic fields which can induce circulating electrical currents in the body. Sufficiently large currents can interfere with central nervous system functions such as the control of movement and posture, memory, reasoning and vision. An example of the latter is provided by reports of faint, flickering, visual sensations induced in volunteers being exposed to power frequency magnetic fields above 15,000 microteslas. Exposure to intense electric and magnetic fields can induce electrical currents which could cause headaches as well as nerve and muscle stimulation.
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> One source of concern has been rumours of an adverse effect on pregnancy outcome due to the low intensity electromagnetic fields surrounding VDUs. Taking all research into account, there is no indication that spontaneous abortions (miscarriages) are associated with VDU use, and similar reassurance with respect to congenital malformations has been provided by a smaller number of studies which have been performed on this.

The paper concludes: “it is only possible to observe that higher than normal exposure to electromagnetic fields might increase the, albeit very small, risk of childhood leukaemia.”

More recently (5 November 2010) an article in *BMC Public Health* provided this summary of the current state of knowledge:

> Since 1979, more than 20 epidemiological studies have investigated the possibility that exposure to power frequency magnetic fields may be a risk factor in the development of childhood leukaemia. A number of the studies have been pooled in four meta-analyses which point to an approximate doubling of risk at average residential levels of 0.3-0.4 microtesla (μT).

However, the article also points out that the strength of this evidence is thought to be weak in comparison with other known cancer risks, such as the link between leukaemia and ionising radiation (chiefly X-rays and radioactivity), and notes that the International Agency for Research on Cancer (IARC) currently classifies power frequency EMFs as possible (rather than proven) causes of human cancer.[1]

In an accessible overview of the subject, the World Health Organization notes the significant body of research into the effects of exposure to low level electromagnetic fields (such as exist in the vicinity of an electricity substation). Taking the example of pregnancy outcome it goes on:

> Many different sources and exposures to electromagnetic fields in the living and working environment, including computer screens, water beds and electric blankets, radiofrequency welding machines, diathermy equipment and radar, have been evaluated by the WHO and other organizations. The overall weight of evidence shows that exposure to fields at typical environmental levels does not increase the risk of any adverse outcome such as spontaneous abortions, malformations, low birth weight, and congenital diseases. There have been occasional reports of associations between health problems and presumed exposure to electromagnetic fields, such as reports of prematurity and low birth weight in children of workers in the electronics industry, but these have not been regarded by the scientific community as being necessarily caused by the field exposures (as opposed to factors such as exposure to solvents).

2 Precautionary approach

SAGE stands for Stakeholder Advisory Group on Extremely Low Frequency Electric and Magnetic Fields (EMFs). It is a UK group set up in 2004 to consider possible precautionary measures in relation to EMFs.

In a written statement on electromagnetic fields on 19 October 2009, the then Minister, Baroness Thornton summarised the role of SAGE:

> SAGE is a group of stakeholders representing sectors engaged with electricity transmission, regulation, property valuation, academic research and public-concern campaigning. The remit of SAGE is to explore the implications for a precautionary approach to extremely low-frequency electric and magnetic fields (ELF EMF) and to make practical recommendations to Government. This first assessment considered two sources of EMF: high-voltage overhead power lines and electrical wiring and equipment inside the home. SAGE is jointly funded by the Department of Health, the National Grid Company, the Energy Networks Association and the charity Children with Leukaemia.[2]

SAGE published its *Second Interim Assessment 2009 – 2010: Electricity Distribution* on 8 June 2010. This covers sources such as electrical substations and transformers, making a number of technical and practical recommendations for reducing exposure. Among SAGE's recommendations were: "Reasonably practicable efforts be made to site substations distant from homes etc." The government response was published on 21 October 2011:

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1 International Agency for Research on Cancer, *Non-Ionizing Radiation, Part 1: Static and Extremely Low-Frequency (ELF) Electric and Magnetic Fields*, 2002

2 HL Deb 19 October 2009 c48WS

> Where appropriate, the Government will explore with the electricity industry through the Energy Networks Association (ENA) the possibility of reinforcing existing good practice through the development and adoption of an industry Engineering Recommendation.
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> However, any decisions regarding future investment and maintenance of the electricity networks are commercial ones for the DNOs [Distribution Network Operators], and the Government has no place in determining these.

The precautionary approach is well exemplified by Powerwatch which styles itself "an association of skilled people, Directed by Alasdair Philips, maintaining this web site and providing a consultancy service on a commercial basis to businesses and to the general public, and providing technical input to local Councils and Government." Powerwatch has published a *Substations factsheet* which rehearses a range of health concerns as well as providing information on how to obtain meters to measure electromagnetic fields.

3 Legislation

There is at present no UK legislation specific to electromagnetic fields. However, employers have general duties to their employees and the public under the *Health and Safety at Work etc Act 1974*, the *Management of Health and Safety at Work Regulations 1999* and by reference to guidelines from the International Commission on Non-ionising Radiation Protection (ICNIRP).

An EU Directive in 2004 proposed 'action values': the magnitude of directly measurable parameters, provided in terms of electric field strength (E), magnetic field strength (H), magnetic flux density (B) and power density (S), at which one or more of the specified measures in this Directive must be undertaken. Compliance with these values would ensure compliance with the relevant exposure limit values. For power frequency (50 hertz) magnetic fields, the proposed action value was 500 microteslas (μT) for the magnetic flux density. The action values referred to were derived according to pre-existing guidelines used by the International Commission on Non-ionising Radiation Protection (ICNIRP).

The EU Directive 2004/40/EC referred to above was originally due to be transposed into national laws by 30 April 2008. However, this deadline was subsequently postponed for four years, until 30 April 2012.[3] It deals with workers' exposure to electromagnetic fields – a restriction reflecting the situations in which relevant exposures might occur.

More recently (14 June 2011) the European Commission proposed a substantially modified directive, repealing and replacing the earlier one; it takes into account new recommendations by the ICNIRP and the World Health Organization as well as representations from affected industries. It has a proposed transposition deadline of 30 April 2014. In addition to action values, the new directive introduces "orientation values" which correspond to a field level where no adverse health effect should be noticed under normal working conditions and for persons not being part of a group at particular risk. For power frequency magnetic fields the orientation value is set at 1000 microteslas whereas the action value (the maximum directly measurable field for which automatic compliance with the exposure limit value is guaranteed) is 13,300 microteslas. Annex II of the newly proposed directive also states: "The following work equipment or activities are, in normal conditions, considered to expose the worker under the orientation value ... electricity substations."

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[3] http://www.hse.gov.uk/radiation/nonionising/electro.htm

4 Electricity substations

The magnetic fields in close proximity to electricity substations are well below the values given in either the original (2004) directive or its (much) more conservative proposed replacement. Details have been provided by the Health Protection Agency:

> Local area substations are the components of the distribution system which convert electricity at 11 kilovolts to 415 volts and thereby provide the link with the domestic electricity supply. They are sources of magnetic and potentially electric fields.
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> NRPB [the former National Radiological Protection Board] has surveyed representative local area substations in order to characterise magnetic fields along enclosure boundaries. Magnetic field measurements taken at 1 m above ground level revealed an overall magnetic flux density of 1.1 microteslas, with individual substation flux density means ranging from 0.1 to 6.6 microteslas. Highest individual measurements of magnetic flux densities in the range 2 to 10 microteslas were encountered in close proximity to the feeder cables. In all cases, at distances varying between 5 and 10 m from the boundary fence, magnetic fields due to substations were undetectable above between 0.02 and 0.05 microteslas; levels typical of low household magnetic fields associated with the electricity supply system. Along the path of cables and lines, magnetic field strengths of up to 1 microtesla were measured.
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> A National Grid Company survey of suburban substations, with measurements taken at 0.5 m above ground level within 1 m of enclosures, revealed mean magnetic flux densities of about 1.9 microteslas falling by a half over an average distance of 1.3 m, and in the vicinity of housing becoming indistinguishable from the background due to other domestic sources within 5 m.
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> Electric field strength measurements close to local area substations indicate that electric field strengths are often below 1 volt per metre and this is attributed to the shielding provided by the metallic casing on components and cables, and to the enclosure walls. Only where overhead feeder lines occur, are electric fields likely to exceed a few volts per metre. Up to a few tens of volts per metre have been measured beneath associated high voltage supply lines; circuit configurations which are generally rare.
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> The power frequency magnetic fields recorded around local area substations are much less than the ICNIRP reference levels for public exposure of 100 microteslas and 5 kilovolts per metre, which are based on preventing well established biological effects.