ELF Magnetic field distribution around power lines in an urban area

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Abstract

A number of epidemiology studies have drawn attention to an increase in incidence of leukaemia and other cancers among children living close to sources of ELF magnetic fields. By comparing the studies a lower limit for such an effect was estimated to be $250mAm^{-1}$.

Magnetic field measurements were made around power lines running at 275kV, 132kV and 33kV. Fields above $250mAm^{-1}$ were found as far away as 60m from a 275kV line and 15m from a 132kV power line. Fields near a 33kV power line were below $250mAm^{-1}$

The maximum magnetic field near an electric blanket was $1Am^{-1}$ and a maximum field of $3.9Am^{-1}$ was measured in an electric train.

Introduction

The work of Savitz (1988), Wertheimer and Leeper (1979) and others has drawn attention to an increase in the incidence of leukaemia amongst children living in close proximity to sources of extra-low-frequency (ELF) magnetic fields. Contradictory work has been published by Fulton et al (1980) in which no increase in leukaemia was found in children living in elevated fields. By comparing the various studies and reworking the data it was concluded that, on balance, it was likely that an increased risk did exist for children living in such fields. It was concluded that the lower limit of the magnetic field strength for such an effect was approximately $250mAm^{-1}$ although it could possibly be lower. The $250mAm^{-1}$ level was used as a threshold to determine whether there was a group of the population potentially at risk in the urban environment of Aberdeen.

One advantage that Scotland has over other parts of the world when considering the effect of ELF magnetic fields, is that there are no power transmission lines greater than 275kV. The main power line into the Aberdeen area runs at 275kV but at the outskirts of Aberdeen drops to 132kV and then to 33kV. Before dropping to 132kV, the power line passes through a suburban area and it was there that most of the measurements were made.

The work of Savitz (1990) has drawn attention to the fact that, within most homes, there are many sources of ELF magnetic fields in everyday use. One of particular interest in Aberdeen was electric blankets, particularly electric over blankets. These can be in use for upto 8 months of the year in Aberdeen and some people will, for some of the time, sleep with them switched on. Measurements were taken in the areas close to both types of blanket and around various electrical items found in the home.

Although it was felt that no problems really existed once the overhead power line kV had dropped to 33kV, one situation was identified as being of interest where the overhead line was only at 15kV; this was the field which was created inside electric trains. The magnetic fields were measured inside a train on the Aberdeen to London route. The line is not electrified until Edinburgh, about one third of the journey, thus allowing comparative measurements to be made.

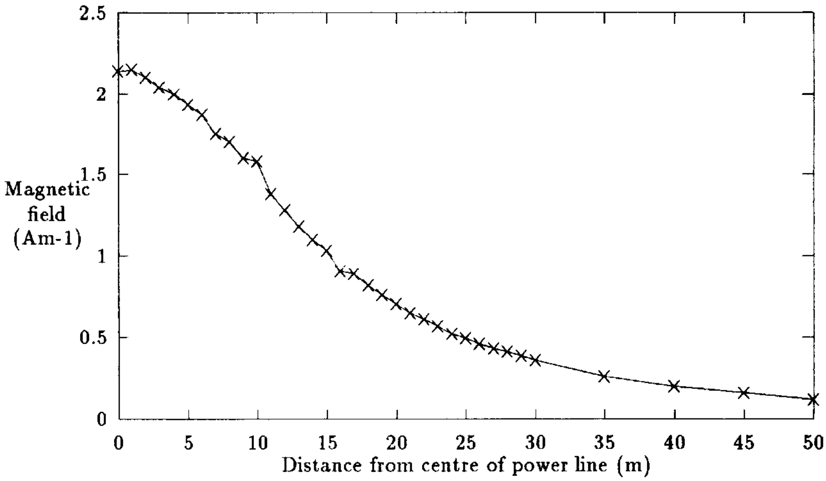

Figure 1: Magnetic field at right angles to a 275kV power line.

Measurements around power lines

Measurements were made at right angles to the power lines in autumn and summer. The summer measurements are shown in Figure 1. These were taken under a 275kV line on a warm day (for Aberdeen) at 1500 hours. Even in this situation, the distance from the centre of the line to the $250mAm^{-1}$ field strength boundary was upto 36 metres. Similar measurements made in autumn showed that this boundary could extend as far as 60 metres on a cold autumn evening. The strength of the field obviously depends on the current flowing through the power lines, but it was not possible to obtain numerical figures for the current. Only a subjective assessment could be made that, as the ambient temperature fell, more current would flow. Figure 2 shows measurements taken at right angles to 275kV, 132kV and 33kV power lines Measurements taken over a week, shown in Figure 3, were made directly beneath the power line each day and showed that the field strength could vary by a factor of two. It is thought that similar measurements made in the evening could well show a much bigger variation. Although insufficient measurements were made to establish where an average magnetic field strength of $250mAm^{-1}$ would be situated it would not be being too pessimistic to assume a distance of 45 metres from the line. Even on this suburban housing scheme where the houses are quite widely spread, there were many well within this 45 metre distance. The cables pass twenty metres from an area health clinic and over the local primary school playground.

In the U.K. no legislation currently exists to limit the distance power cables must be from the houses.

Measurements close to electric blankets

The measurements were made with the probe positioned between a person and the blanket and at 0.1, 0.2 and 0.3 metres from it. Care was taken that no other local source of ELF magnetic field was present. Several different types of blanket were tested and all had magnetic fields in excess

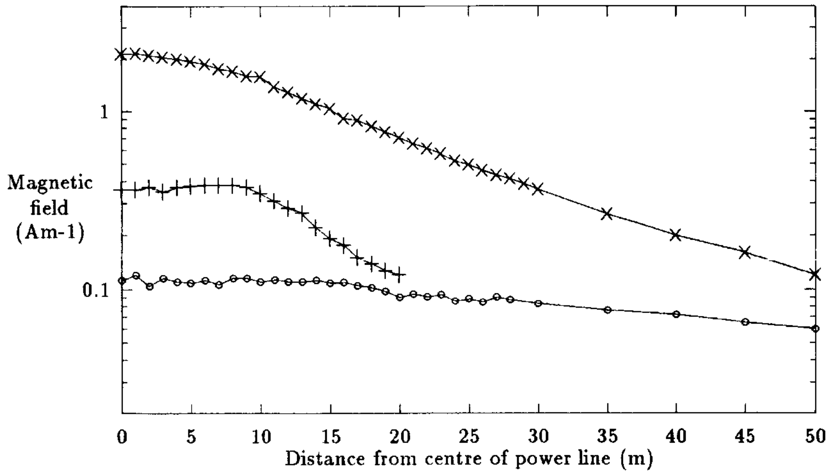

Figure 2: Magnetic fields at right angles to 275kV (×), 132kV (+) and 33kV (○) power lines.

of $250mAm^{-1}$. Some rose to as high as $1Am^{-1}$. The field value depended on the inter-wire spacing and the map of the wires in the blanket. In some areas the magnetic fields were found to cancel. No blankets were tested where a conscious effort had been made by the manufacturer to try to cancel the magnetic fields. The information supplied with the blankets was insufficient to easily determine which would have the higher fields and which would not.

Magnetic field levels in trains

The levels measured during the non-electrified part of the journey were low and subjectively appeared to vary with the speed of the train. The maximum field recorded at seat level was $40mAm^{-1}$ but this rose to $50mAm^{-1}$ at floor level. Once the line was electrified the magnetic field became, as one might expect, much more stable. The maximum field was recorded with the probe at right angles to the axis of the railway carriage. Measurements made on an occupied seat had a maximum of $3Am^{-1}$ and measurements on an empty seat a maximum of $3.9Am^{-1}$ The field fell to approximately $2Am^{-1}$ at floor level and $1.4Am^{-1}$ in the central corridor 1.4 metres from the floor. Although these fields are high, one would have to travel on many train journeys to be exposed to an average field of over $250mAm^{-1}$ from this source. However many long distance commuters could spend 2 hours per day in these fields, and the drivers, of course, would spend much longer. The long exposures are limited to adults and little positive evidence has been established linking increases in leukaemia or other cancers in adults from exposure to fields of this order of magnitude.

Conclusion

More effort should be put into measuring ELF magnetic fields as they occur in a multitude of situations at, occasionally, surprisingly high levels. In the first instance those countries which

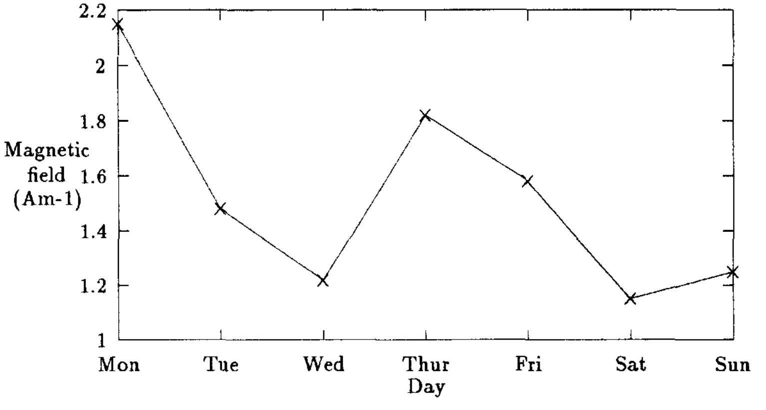

Figure 3: One week survey of the magnetic field directly beneath a 275kV power line.

do not have restrictions on the proximity of power lines to housing should seriously consider introducing them.

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