DOMESTIC MAGNETIC FIELDS

PROTOCOLS, MEASUREMENTS AND RESULTS

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ABSTRACT

The quantification of magnetic field exposure has been the subject of considerable debate. A number of surrogates have been used including, spot measurements, wire coding and 24 hour averages. The quantification of domestic magnetic fields including the identification of sources is important if any mitigation is required. The State Electricity Commission of Victoria has developed recording instrumentation and measurement protocols for the survey of domestic magnetic field strengths in the Melbourne area.

A range of domestic locations in the Melbourne metropolitan area is chosen to test the influence of external installations and the effect of appliance usage and energy consumption on the domestic magnetic field environment.

INTRODUCTION

The importance of residential magnetic fields has been the subject of considerable debate throughout the last decade. Several residential epidemiological studies of childhood cancer and magnetic fields suggested there may be an association, but the measures of exposure used were not entirely rigorous and criticised in several reviews.

The SECV has previously carried out a spot measurement survey of residential magnetic fields in the Melbourne metropolitan area and gained a good knowledge of the range of values involved. The magnetic fields debate has widened in its consideration of what it is that constitutes exposure. The equipment described below was designed to provide additional information regarding the variation, likely sources and level of residential fields.

SPOT MEASUREMENT SURVEY

This survey selected homes in the metropolitan area of Melbourne using a randomisation technique. The measurement protocol provided for measurements in each room and at common occupier locations. The measurements were taken under "high" load and "low" load conditions. These can be most simply described as the the condition of the house during low activity of the occupants for low load and a typical evening meal time where lights are on and appliances operating for high load. Measurements were taken under the nearby street line and near the water meter.

The results of this survey showed that the energy consumption in the house had a significant effect on the magnetic field levels in the house. Histograms in Figures 1 and 2 show the distribution of magnetic field levels for each condition together with the average values for low and high load conditions.

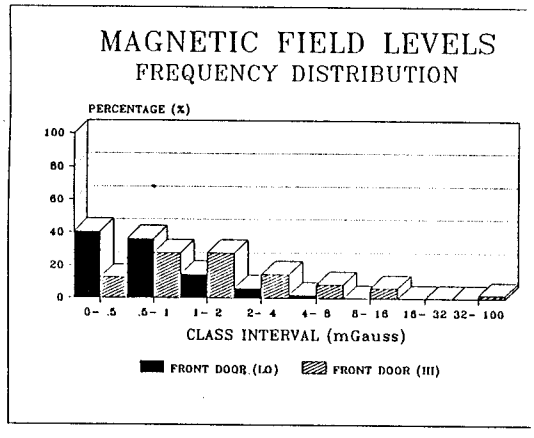

Figure 1 Effect of house energy usage on magnetic fields at the front door

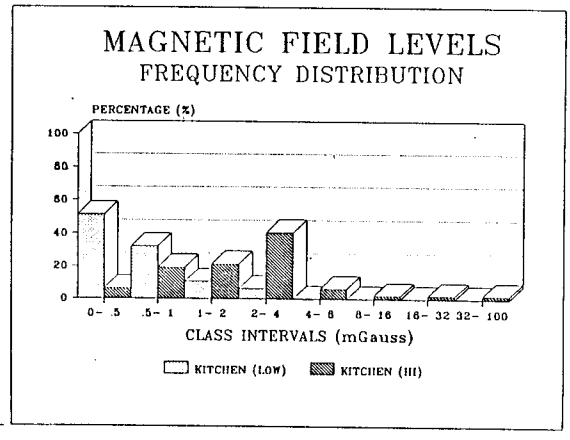

Figure 2 Effect of house energy usage on the magnetic fields in the kitchen

Australia uses the Multiple earthed neutral system (MEN) for residential distribution of electricity. With this system the possibility exists for a fraction of the neutral return current to flow via earth. The influence of this current on the magnetic fields in the house is determined by the path of the current. To a great extent this is determined by the location and the type of the domestic water supply system used in that location and whether the MEN earth is bonded to the water pipe or not.

From a study of earth return currents it has been found that the majority of earth return current flows through the water and gas pipes. The magnitude of this current has been investigated in another project and estimated to be an average value of 5% of the household current.

INSTRUMENTATION DEVELOPMENT

The spot measurement survey using different house load conditions highlighted the need for knowledge of the range of variation of fields during normal activity in the house. Instrumentation was developed for this purpose. The requirements for the instrumentation included the need to record magnetic fields in up to three locations simultaneously and also record up to four currents. At each measuring point there are three coils mounted orthogonally and data is collected from each coil prior to combining to find the resultant value. Individual directional data can be analysed if required.

With the datalogger selected it is possible to vary the sampling rate between 1.0 seconds and several hours. The memory capacity allows for a recording time of 1 day at a sampling rate of 60 seconds.

Provision was included for the instrument to be pole mounted in streets. For this application a single measuring point (three orthogonal coils) is attached to the pole 1 metre above the ground. Results are shown in Figures 3 and 4 where the instrument has been used in street locations for up to 5 days. The cyclic variation of the results is indicative of supply to a domestic area.

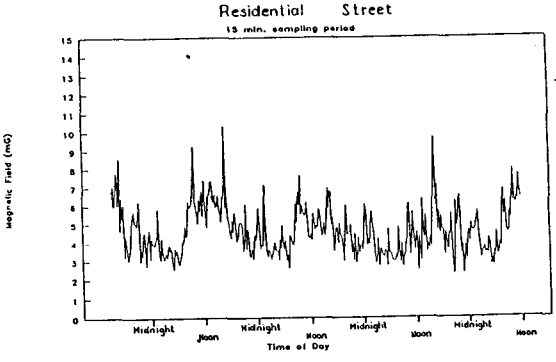

Figure 3 variation of magnetic over several days

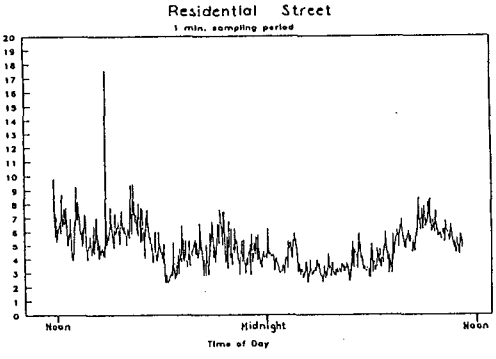

Figure 4 variation of magnetic fields over one day

The rapid variation of the field level combined with the daily cyclic variation could have ramifications for studies relying on spot measurements to quantify exposure. The time of measurement may introduce significant misclassification errors both from the point of view of short term variation and daily cyclic loading.

MEASUREMENT PROTOCOLS

For the measurement of residential data the measuring units will be located in the main living area, the main bedroom and the near the front door. Simultaneously measurements are also taken of the active, neutral and earth return currents.

A calibrating load will be operated for short periods at a range of locations throughout the house to measure the sensitivity of the household measuring locations to household power consumption. This load draws 10 amp and will cycle on and off each 10 seconds. The cyclic pattern will be visible in the recorded results and will give a measure of the contribution of the power consumption to the the overall magnetic fields.

Data is collected using sampling rates of 2 seconds during use of the calibrating load, 1 minute and 10 minutes. The short sampling time will collect details of the peaks and allow evaluation of the contribution provided by the house wiring. The 1 minute time will show the variation over a day and the longer sampling rate will show the cyclic pattern over several days including a weekend.

Household data regarding the electrical energy usage is recorded and use and type of electrical appliances for the measurement period is logged by the resident for factoring into the analysis of the data.

Details of street lines are noted for each location to test surrogates of magnetic field levels. This data includes the electrical proximity to the supply transformer as measured by the number of houses served by the transformer beyond the house selected for measurement. Other factors included with this data are the distance of the house to the lines and the function of the distribution feeder at that point, if present.

CONCLUSION

From the spot measurement survey it was determined that the sources that contribute to the residential magnetic field levels include the local distribution circuits, both low voltage and distribution voltage, the use of electrical energy in the home and contributions from the earth return currents. The relative importance of these sources depends on their relative strengths at the measuring point. To investigate the importance of components datalogging instrumentation has been developed and used with measurement protocols to try to evaluate the relative strength of each source.

The magnetic fields being measured in this survey and the assessment of the residents exposure relate to the long term pattern of the fields. The assessment of peak exposures must relate to appliances, their usage pattern and the strength of the associated magnetic field.

REFERENCES

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"Measurements of ELF Magnetic Field Levels in Occupational and Domestic Situations" R J Owen ARPS Adelaide 1990