Australian Government

Australian Radiation Protection and Nuclear Safety Agency

Strategies to Reduce Magnetic Field Exposure (Mitigation)

Introduction

While increased risk of childhood leukaemia remains as a possible effect of magnetic field exposure, some precautionary measures to reduce magnetic field exposure are generally considered appropriate. Such measures need to be assessed on a case by case basis taking into account cost, effectiveness, and possible impact on other hazards.

Sources

ELF Magnetic fields are produced wherever electric current flows through conductors. The fields will be strongest:

- close to the conductors,
- where currents are greatest,
- where conducting wires are coiled as in transformers and motors.

The magnetic fields from electrical wiring will disappear when no electrical power is being drawn. The magnetic fields will persist around transformers while they are connected to the electrical supply, even if the equipment is not in use and no current is drawn from the secondary circuit.

Measurements

Substantial reductions in magnetic field exposure can be achieved through appropriate design. However, when it comes to reducing the magnetic fields from existing installations it is important to base actions on reliable measurements. It can be very difficult to predict the magnetic fields accurately around the complex wiring of houses and business premises. Suitable instruments are available for under $1,000 or from instrument hiring companies. Measurements can help identify the actual source of the magnetic field that is of concern, as a highly visible source, such as a substation or transmission line, may not always be the cause.

> *Example:*
> *In a house 120 metre from a high voltage transmission line, the residents are concerned about high magnetic fields. Measurements reveal the magnetic field to be around 2 milligauss (0.2 microtesla). However, further investigation shows the fields outside are less than 0.5 milligauss before rising closer to the transmission line. The source of magnetic fields in the house is found to be the house wiring rather than the transmission line.*

Furthermore, measurements may reveal that no action is warranted or that simple relocation of activities can achieve the desired reduction in exposure. Where the magnetic field is dominated by a single, well-defined source, calculations may provide a useful screening tool.

Geometry, Current and Balance

The magnetic fields diminish as one moves away from the conductors but the fields extend furthest from sources that have the biggest physical dimensions, such as long power-lines. From compact sources like small transformers, the magnetic fields diminish rapidly with distance.

Example:
The transformer in a bedside clock-radio produces a strong magnetic field near the pillow on the bed. Moving the clock to the back of the bedside table reduces the magnetic field at the pillow by a factor of ten or more.

In most electrical circuits, electricity flows in opposite directions in two closely spaced wires. In these cases the magnetic fields produced by the two wires are in opposite directions and nearly cancel out. Often, magnetic fields in residences will be highest when the electric current flows in wires that are not closely spaced. This may happen when the wires are deliberately separated, as at the meter board, or when a fault or unusual wiring configuration results in current flowing along earthing connections to water pipes or earth stakes.

Prevention is better than cure
Any steps taken to alter existing electrical installations are likely to be costly but significant reduction in magnetic fields may often be achieved economically if changes are made at the design stage.

Example:
A main wiring cable needs to run beneath the floor of an apartment to the diagonally opposite corner. At the time of installation, the route can be modified to run around the perimeter of the residence, using the sides away from bedrooms and living rooms. The cost increase for extra cable and installation fittings is small.

Minimisation Measures
Distance – separating electrical wiring and people is often effective at reducing magnetic field exposure. The smaller the physical dimensions of the source, the more effective will be any separation that can be achieved. Moving even a metre away from a small transformer may reduce magnetic fields by factors of 10 or 100 but moving metres away from a long power line may make little difference. Moving the balanced, closely spaced, pair of conductors used in domestic wiring by even tens of centimetres may reduce fields substantially. Focussing on increasing distance from the heaviest current consumption devices is likely to be the most effective.

A common location for a fuse and meter box in many houses is on the outside wall immediately adjacent to a bed inside the house. Meter and fuse boxes tend to produce higher magnetic fields than other wiring because of the concentration of wiring and the separation of active and neutral wires. The meter itself and the earth connection may also contribute.

Example:
During the design of a new house, the meter box is placed on the wall of a bathroom or walk-in wardrobe rather than on the wall of a bedroom. This measure is likely to reduce long-term average exposure to magnetic fields.

Some appliances that are used for long periods, such as refrigerators, or large TV sets may also produce elevated magnetic fields, particularly at the back of the appliances. Avoiding placement of such appliances adjacent to beds or other high occupancy places can reduce exposures. In schools where many computer monitors are used, student seating may be arranged so students away from the back of monitors. It should be noted that the magnetic fields will pass essentially un-reduced through ordinary building materials and a bed on the other side of a wall from an appliance may be forgotten but still significantly exposed.

> *Example:*
> *A bed is unavoidably located on the opposite side of a wall from a refrigerator. Inserting a bed-head and shelf results in the bed being moved 25 cm from the wall. Depending on the relative heights of bed and refrigerator motor, the magnetic field at the head of a sleeping person may be considerably reduced.*

Balance

Following good wiring practices and avoiding unnecessary earthing points will help keep equal and opposite currents in adjacent conductors and keep nearby fields small. Particular care should be given to lighting circuits with two or more switching points where physical layout may encourage separation of the active and neutral wires and hence produce a large current carrying loop around all or part of a room. The earth, itself, is a conductor and an earth connection is provided for reasons of electrical safety. Ensuring that the neutral connection is in good condition, and that the conductor is of comparable size to the active, will reduce the chance of excessive currents flowing through the earth connection. However, currents may flow to earth because of wiring faults in nearby houses and these faults may be difficult to locate or remedy. In this case, specific measures to control earth currents, such as the insertion of insulating sections of pipe, may be required. It is very important that electrical safety not be compromised in implementing any such measures. The route of the earthing cable or pipe may also be relocated to reduce the exposure from any earth current.

Geometry

The factors of geometry and balance both take effect when designing the layout of multiple wiring circuits, particularly three-phase circuits in commercial premises or multiple occupancy residential buildings. All cables of each individual circuit should be physically grouped closely together, or even twisted, rather than grouping all the active cables together, all the neutral cables, or all of each phase together. In particular, the running of active and neutral in separate conduits or wiring trays should be avoided.

When undesirably high magnetic fields result from separated aerial spans of cable, significant reduction in magnetic fields at any given distance may be achieved by replacement of the separated cables by an aerial bundled cable (ABC). Best results will be achieved when good balance is achieved between the currents in the three phases.

> *Example:*
> *In a series of terrace houses in a narrow, inner-suburban street, the 240 volt street wiring is located very close to the upper storey rooms of the houses. The magnetic fields in the front upstairs rooms are much higher than normal. Replacement of the street wiring span by an aerial bundled cable substantially reduced the magnetic field throughout the rooms, particularly in the rear portion. The cost of such a measure will be thousands of dollars but may be considered worthwhile depending on the number of houses and children of various ages involved. Other factors including aesthetics of the street-scape may be important.*

Cancellation

The residual magnetic fields from even a well-balanced and closely spaced circuit can be further reduced by proper placement of additional circuits with the correct phasing and geometrical arrangement. The success of such measures may depend on the two circuits having similar usage patterns - being both on or off together and having similar and consistent loads.

Reducing Current

Reducing electricity consumption, and hence the current in a circuit, will produce smaller magnetic fields and provide other economic and environmental advantages. However, such reductions in consumption are often not practical.

Noting that it is the current rather than the power that determines the magnetic field, attention may also need to be given to low voltage circuits where a transformer has reduced the voltage in a circuit but increased the current flowing. On the other hand, elimination of earth currents in such circuits should be easy and twisting of the wires and other geometrical measures may be used to reduce the magnetic fields.

Shielding

Some materials will shield magnetic fields but their use will usually be limited by cost or practical considerations. Nevertheless, specialist shielding materials may significantly reduced exposures from compact sources like major power cables or transformers. Shielding of complete rooms from external sources of magnetic fields is unlikely to be feasible. Specialist engineering advice should usually be sought before installation of shielding.

Target Areas

Given the reasons behind the minimisation, most attention should logically be given to areas where people, particularly children and perhaps women of child-bearing age, spend most time. The true connection between magnetic fields and leukaemia is not known and therefore one cannot be sure that reducing average magnetic fields will achieve any reduction in risk. However, where planning to reduce fields is done ahead of installation, significant reductions in magnetic field exposures can be achieved at modest costs. Care must always be taken that other safety measures, such as fire safety, hazards of tripping and falling, and other standard occupational safety measures are not compromised in the efforts to reduce the possibly harmless magnetic fields.