

# The Possible Exposure of Children to Extremely Low Frequency Magnetic Fields in the Home

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**Abstract**— This paper aims to analyze common magnetic field exposure situations to children in the home, to determine possibly relevant sources. Part of the data presented here derives from measurements performed in projects in Finland and Italy. In the home, the important sources of children’s exposure are electrical systems and devices. In conclusion we can say that it is quite easy to find exposure levels that exceed  $0.3\text{--}0.4\ \mu\text{T}$  in the home.

## 1. INTRODUCTION

Extremely low frequency (ELF) magnetic fields (MF) are considered as suspected carcinogens (Group 2B IARC), based on consistent epidemiological data on childhood leukemia, although the biological evidence is considered weak. An increase in risk was observed at exposure levels exceeding  $0.4\ \mu\text{T}$ . The International Commission on Non-ionizing Radiation Protection (ICNIRP) has published guidelines for limiting exposure to time-varying EMFs (1 Hz–100 kHz) [1].

These guidelines include basic restrictions and reference levels for the protection against acute adverse health effects. Suspected chronic effects such as leukemia however are not considered, as

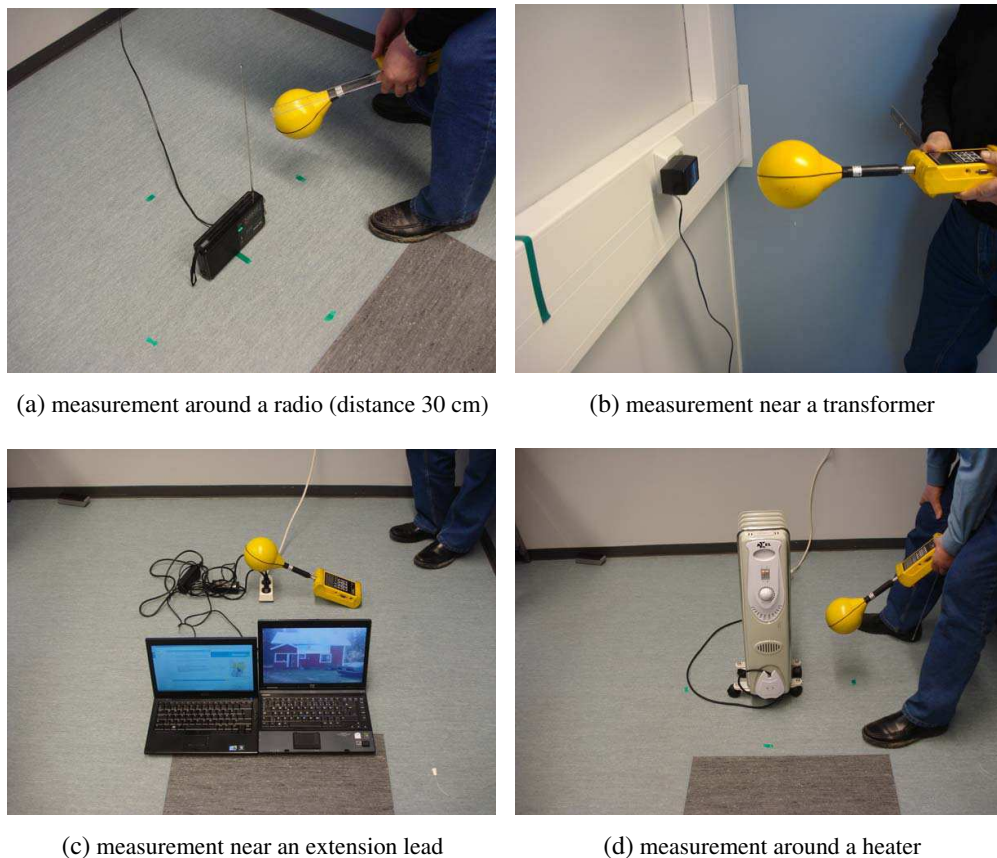


Figure 1: Examples of measurements around different devices.

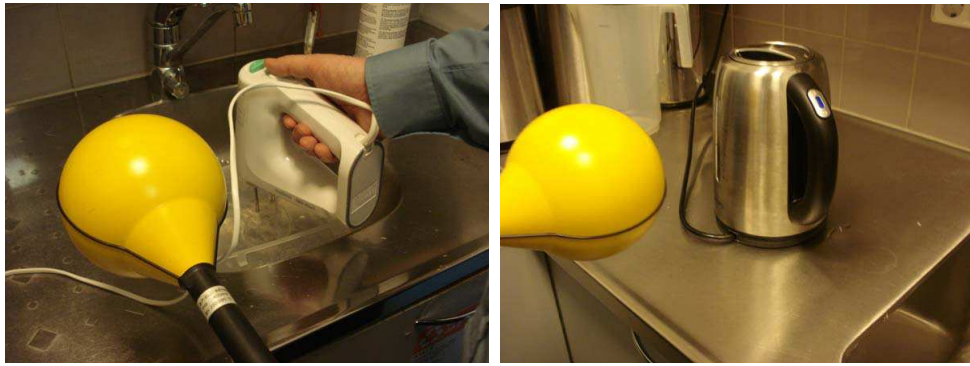


Figure 2: Examples of measurements near a food mixer and an electric kettle.

Table 1: Measurement results taken around devices.

Device	point 1, $\mu\text{T}$	point 2, $\mu\text{T}$	point 3, $\mu\text{T}$	point 4, $\mu\text{T}$
Radio	0.25	0.31	0.33	0.30
CD-player	0.24	0.23	0.23	0.23
MP3-player	0.24	0.23	0.23	0.23
Charger-camera	0.24	0.24	0.24	0.24
Charger + phone 1	0.24	0.24	0.24	0.24
Charger + communicator 1	0.24	0.24	0.23	0.23
Charger + phone 2	0.24	0.24	0.24	0.24
Charger + phone 3	0.24	0.24	0.24	0.24
Phone 3. radio	0.24	0.24	0.24	0.24
Charger + phone 4	0.24	0.24	0.24	0.24
Charger + phone 5	0.24	0.24	0.23	0.23
Charger + Ipad (support structure)	0.24	0.24	0.23	0.23
Extension lead 1 + 2 PCs	0.24	0.24	0.24	0.24
Extension lead 2 + 2 PCs	0.24	0.24	0.23	0.23
Extension lead 2 + 2 PCs + heater	0.24	0.24	0.24	0.24
Heater	0.24	0.24	0.24	0.25

according to the ICNIRP, the causal relationship with electro-magnetic fields (EMF) is not established [1]. The ICNIRP reference levels for general public exposure to 50 Hz EMFs [unperturbed root mean square (RMS) values] are 5 kV/m and 200  $\mu\text{T}$ . For occupational exposure, the reference levels (50 Hz) are given as 1000  $\mu\text{T}$  and 10 kV/m [1].

Previously, we have measured the MF exposure, derived from some new devices (e.g., laptops etc). At home however, the important sources of children's exposure are electrical systems and devices. In a detached house, the exposure was measured to be 0.1  $\mu\text{T}$ . In apartments, the maximum exposure was usually  $> 0.4 \mu\text{T}$  (8 apartments), but in those located above the indoor distribution point, the average (max) exposure reached 6.5  $\mu\text{T}$ . In the kitchen, the MF levels were measured at 0.3–0.5  $\mu\text{T}$  and 2.5–4.2  $\mu\text{T}$  in front of the oven and microwave oven respectively. All data was derived from spot measurements obtained using instantaneous RMS meters.

In Italy, the median Time Weighted Average exposure measured using personal meters in 513 homes was 0.03  $\mu\text{T}$  and levels were below 0.4  $\mu\text{T}$  in 97% of the homes sampled. These levels are also most likely representative of the potential exposures of multiple children living in the same house.

This paper aims to analyze common exposure situations to children in the home, to determine possibly relevant sources and part of the data presented here derives from measurements performed in our earlier projects.

Table 2: Results from different devices in the kitchen.

Kitchen Device Measurements	MF, $\mu\text{T}$	distance	place/height
Mixer with whisks. power 1–3	0.40–0.45	20 cm	place 1
Mixer with whisks. power 1–3	0.76–0.85	20 cm	place 2
Mixer with whisks. power 1–3	0.55–0.67	20 cm	place 3
Mixer with dough hooks. power 1–3	0.89–1.05	20 cm	place 1
Mixer with dough hooks. power 1–3	0.56–0.58	20 cm	place 2
Mixer with dough hooks. power 1–3	0.50–0.60	20 cm	place 2
Microwave oven 1	14.00	20 cm	
Microwave oven 2	6.70	20 cm	
Refrigerator 1	0.24	20 cm	height 0.5 m
Refrigerator 2	0.31	20 cm	height 0.5 m
Electric kettle	0.28–0.29	20 cm	sides 1, 2, 3,

## 2. MF MEASUREMENT METHODS

The magnetic field density was measured with a Narda ELT-400 meter (L-3 Communications, Narda Safety Test Solutions, Hauppauge, NY, USA — accuracy  $\pm 4\%$  RMS). This meter has a frequency range of 1 Hz–400 kHz. Figures 1 and 2 show examples of measurements undertaken. Each household device was measured either on its surface or at four points (at a distance of 30 cm) around the device.

## 3. RESULTS

The measurement results around devices (4 points) are shown in Table 1. The Table 2 shows the results obtained from different devices in a household kitchen.

Magnetic fields measured at 0.4–1.1  $\mu\text{T}$  around the mixer and varied between 0.2–0.3  $\mu\text{T}$  around the remaining equipment. In proximity to the microwave ovens, the magnetic flux density was 6–14  $\mu\text{T}$ . All measured values however, were clearly below the recommended values provided by ICNIRP.

## 4. DISCUSSION AND CONCLUSIONS

There are inaccuracies in the measured values, caused for example because the sensor size (diameter 100 mm), the measurement set-up and the background value of the meter (about 0.2  $\mu\text{T}$ ). The measured values however, were at least one order of magnitude lower than the reference values for general populations, as proposed by ICNIRP [1]. Considering the suspected chronic effects of ELF-MF, the proposed threshold (0.4  $\mu\text{T}$ ) can be easily exceeded in the kitchen (e.g., near the microwave oven or the food mixer), but all the other measured devices fell below this level (Table 1). Even if the ELF-MF exposure in children is usually low, various common household situations were identified as inducing ELF-MF levels that easily exceeded 0.4  $\mu\text{T}$ , such as proximity to central domestic electrical systems and also to some devices in the home (e.g., the microwave oven).

Our results suggest that, in usual conditions, ELF-MF levels in the home are largely below the thresholds deemed causative of acute effects. Furthermore, with some attention (e.g., moving away during the use of certain devices), it seems possible to reduce the risk of exposure below the threshold presented for suspected chronic effects.

## REFERENCES

1. International Commission on Non-Ionizing Radiation Protection (ICNIRP), “Guidelines for limiting exposure to time-varying electric and magnetic fields (1 Hz to 100 kHz),” *Health Physics*, Vol. 99, No. 6, 818–836, Dec. 2010.