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Electric floor heating systems

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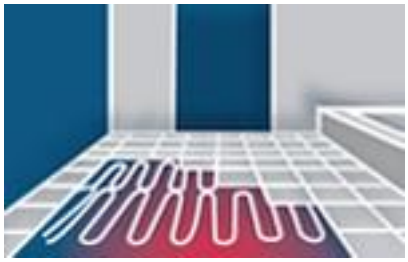

Electric floor heating systems consist of an arrangement of heating cables or heating foils installed in the floor and covered by a top coat. Heat is produced by the flow of electric current through the heating elements. This current may generate low-frequency magnetic fields around the heating elements, the field strength varying according to the type of heating cable used.

State-of-the-art electric floor heating systems produce insignificant magnetic fields. These systems employ two-core heating cables in which the magnetic fields of the adjacent supply and return conductors cancel each other out. On the other hand. in single-core cable floor heating systems, the generally greater distance between supply and return conductors may result in stronger low-frequency magnetic fields during the heat-up phase.

Floor heating systems incorporating two-core heating cables pose no risks in terms of magnetic field exposure.

Single-core heating cable systems: It is not known whether the long-term impact of low-frequency magnetic fields presents a health risk. No effects are expected from short-term exposure to low-frequency emissions from floor heating systems. The following precautions help to minimise exposure to the magnetic fields generated by single-core heating cable systems:

- Whenever possible, heat up rooms while they are unoccupied.
- Do not place mattresses and bed bases directly on the floor - use a bed frame. The additional distance from the floor reduces magnetic field exposure.
- Particular cantonal specifications may exist for electric heaters. Before installing a new floor heating system enquire about them with the relevant cantonal departments.

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1 Technical data

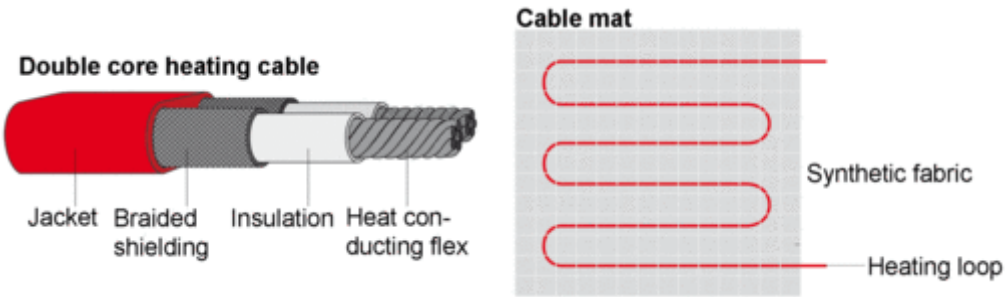
Voltage: 230 V / 400 V
Output / square-metre: 60-300 W for cable mats, 100-250 W for film heating systems [1]
Frequency: 50 Hz

With **heating loops and cable mats** laid freely in the floor, warmth is generated by means of heating cables. The electrically conductive core of these cables normally takes the form of a flexible stranded wire that serves as an ohmic resistance element. When a voltage is applied, the resistance to the flow of current through the stranded wire causes electrical energy to be converted into heat energy. The particular resistance needed to deliver the required heat output at voltages of 230 or 400 V is achieved through the selection of suitable strand sizes and electrical properties. PTC thermistors are used for the return current, unheated connections and power leads. Due to their lower resistance, these generate less heat than the heating cables.
As soon as a heating cable is connected to the mains power supply, the applied voltage generates an electric field.

In addition to the insulation layer, the heating cables may also be sheathed by an electrically conductive metal armouring, which is connected to the protective earth conductor. This armouring improves electrical safety in the event of damage to the cables, while also serving to shield the electric fields. During the heat-up phase, the current flow produces a magnetic field around the conductors. The magnitude of this magnetic field depends on the heating cable design:

- With low-magnetic-field two-core heating cables, the supply and return conductors are close together and carry current in opposite directions. The opposite magnetic fields resulting from this arrangement largely cancel each other out.

- Single-core heating cables carry a single heating conductor, and the supply and return conductors in this type of system may lie far apart. As the magnetic fields of the two conductors cannot fully offset each other, a residual magnetic field persists



Carbon film or foil heating systems consist of two adhesive-bonded polyester sheets that sandwich a heating conductor layer comprising a mix of carbon black and/or graphite. This layer is applied to a separate woven base or directly to one of the polyester sheets. Contact strips at the edge of the film are connected to the supply and return conductors. The flow of current through the carbon film generates heat over the entire sheet area and also produces a low-frequency magnetic field

Both direct and storage electric floor heating systems are available.

- **Storage heating systems** use the thermal mass of the floor to store heat energy. The heating cables are laid in the bottom section of an approx. 10 cm thick screed. The thermal store is normally heated up during the night using off-peak electricity. The stored energy is then passively released to the space as radiant heat during the daytime. Low-frequency magnetic fields occur during the heat-up phase, i.e. normally during the night.
- **Direct systems**, which employ a thin screed as a short-term thermal store, respond more immediately to temperature fluctuations. Energy is passively released as radiant heat with only a short time lag, the short-term thermal store being replenished throughout the daytime as required. Low-frequency magnetic fields occur during the heat-up cycles, i.e. in most cases throughout the day.

2 Exposure to low-frequency magnetic field

A survey commissioned by the FOPH (Federal Office of Public Health) set out to measure the magnetic fields produced by various electric floor heating systems in a grid of 20 cm squares at a height of 50 cm above floor level (Table 1).The systems with two-core heating cables were shown to generate practically no magnetic fields (Figure 1A). Where the power leads are not two-core, however, somewhat higher magnetic fields are observed near the mains connection (Figure 1B). Carbon film heating systems likewise exhibit relatively small magnetic fields (Figure 1C). The strongest magnetic fields were produced by the systems with single-core heating cables (Figure 1D). Though at least 35 times below the threshold of 100 µT (for 50 Hz) recommended by the European Union [2], these far exceeded the magnetic fields normally encountered in dwellings [3].

Table 1: Magnetic fields generated by various electric floor heating systems. Mean of measurements taken in a grid of 20 cm squares 50 cm above floor level; maximum; minimum. *Near mains connection

		Magnetic field (µT		
Type	**Heating cable type**	**Mean**	**Max.**	**Min.**
Storage heating	single-core	0.95	1.38	0.69
Storage heating	single-core	0.50	0.69	0.08
Storage heating	single-core	0.55	0.92	0.09
Storage heating	single-core	1.16	2.08	0.76
Direct heating	single-core	1.28	2.87	0.10
Direct heating	two-core	0.07	0.09	0.03
Direct heating	two-core (except power lead)	0.05	0.54*	0.02
Carbon film heating	heating conductor layer	0.20	0.35	0.09

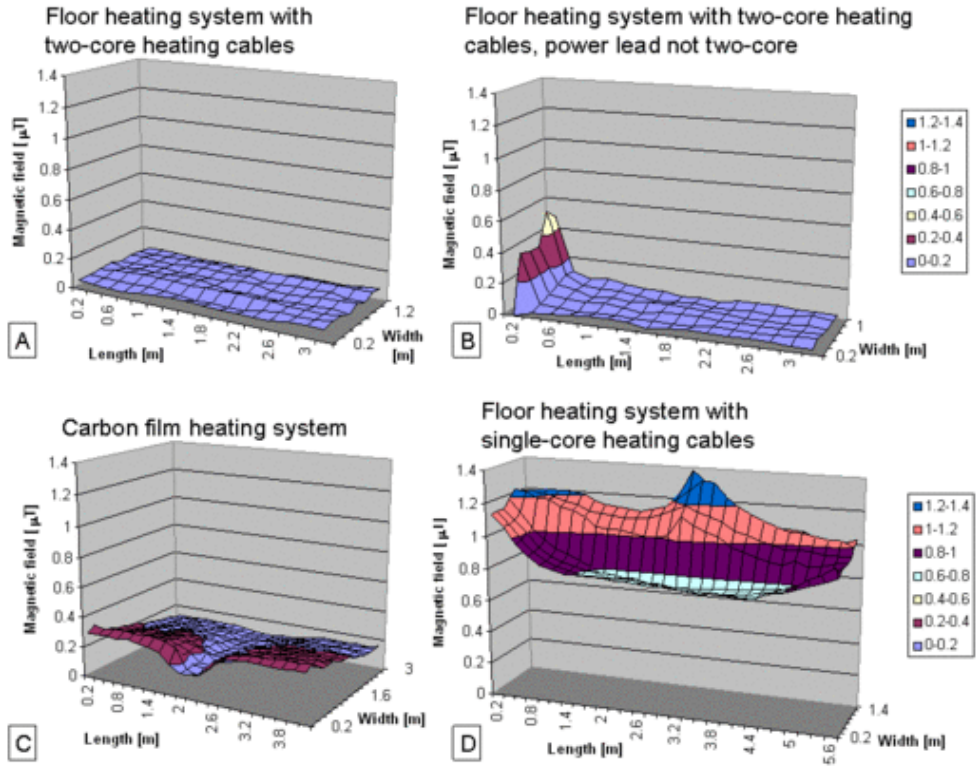


Figure 1: Magnetic fields produced by various floor heating systems during heat-up phase, measured 50 cm above floor level

3 Impact on health

Low-frequency magnetic fields can penetrate and induce electric currents within the human body. Excessive amounts of current may in some cases excite the nerves of the central nervous system. The European threshold values for magnetic fields are therefore set such that the current resulting from magnetic field exposure shall be at most one-fiftieth of the excitation threshold of the central nervous system [2]. The magnetic fields from floor heating systems are much smaller than the threshold value of 100 µT. No effects are expected from short-term exposure as the present threshold values preclude acute damage.

In 2002 the International Agency for Research on Cancer (IARC) classified static and low-frequency magnetic fields as possibly carcinogenic (Group 2B) [4]. This was based on epidemiological studies that suggest that long-term and durable exposure to magnetic fields in the low-dosage area of 1 µT or even lower (< 0.4 µT) could increase the risk of Alzheimer's disease [5, 6] or of childhood leukaemia [7,8]. Personal exposure to magnetic fields generated by electric floor heating systems can be reduced by following the recommendations listed above.

4 Legal Regulation

Electric floor heating systems are classed as low-voltage products and governed, in Switzerland, by the Ordinance on Low-Voltage Electrical Products [9]. This ordinance requires that low-voltage products - both when used properly and, wherever possible, in predictable cases of misuse or in the event of foreseeable malfunctions - pose no danger to either persons or property. Only low-voltage products that meet the essential health and safety requirements specified by the European Low-Voltage Directive (2006/95/EC) may be brought into circulation.

At the time any such a product is brought into circulation, the relevant manufacturer is required to issue a Declaration of Conformity confirming that the product complies with the essential requirements. The essential requirements for specific products are detailed in technical standards; electromagnetic fields produced by household appliances are covered by standard SN EN 62233 [10]. The conformity criteria set out here reflect the thresholds recommended by the EU [2]. The manufacturers themselves are responsible for ensuring that their products comply with the conformity criteria. While Switzerland has no comprehensive system of market controls, the Swiss Inspectorate for High Current Installations (www.esti.admin.ch) carries out random conformity checks on marketed products.

5 Literature

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