



## Scientific Facts on Static Fields

**Source document:**

WHO (2006)

**Summary & Details:**

GreenFacts (2006)

**Context** - Do static magnetic or electric fields used for instance in medical imaging pose health risks?

Medical imaging devices (such as MRI scanners), trains, and television sets are examples of man-made equipment that can generate static magnetic or electric fields.

In some areas of research and medical imaging, stronger and stronger static magnetic fields are being used.

What is known so far about potential health consequences?

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This Digest is a faithful summary of the leading scientific consensus report produced in 2006 by the World Health Organization (WHO):  
*"Environmental Health Criteria 232 : Static Fields"*

The full Digest is available at: <http://www.greenfacts.org/en/static-fields/>

**i** This PDF Document is the Level 1 of a GreenFacts Digest. GreenFacts Digests are published in several languages as questions and answers, in a copyrighted user-friendly Three-Level Structure of increasing detail:

- Each question is answered in Level 1 with a short summary.
- These answers are developed in more detail in Level 2.
- Level 3 consists of the Source document, the internationally recognised scientific consensus report which is faithfully summarised in Level 2 and further in Level 1.

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## 1. What are static electric and magnetic fields?

Electric and magnetic fields are invisible lines of force generated by phenomena such as the Earth's magnetism, thunderstorms, and the use of electricity.

When such fields do not vary with time they are referred to as static.

- A static **electric field** is the force field created by the attraction and repulsion of electric charges that are fixed in space ("static electricity").
- A static **magnetic field** is a force field created by a magnet or by the steady flow of electricity, for example in appliances using direct current (DC).



Compass detecting the Earth's magnetic field

Such static fields are different from fields that change over time, such as those generated by appliances using alternating current (AC) or by cell phones etc.

## 2. What are the sources of static electric fields?

**Static electric fields** occur naturally in the atmosphere, particularly under thunderclouds, and can lead to lightning strikes.

Friction, for example from walking on a carpet, can generate strong static electric fields and lead to sparks.



Static electric fields of screens  
[see Annex 1, p. 6]  
Source: WHO

The use of direct current (DC), for instance in some rail systems, can also produce static electric fields, and so can televisions and computer screens<sup>1</sup> [see Annex 1, p. 6] .

## 3. What are the sources of static magnetic fields?

The Earth's natural magnetic field is perceived by certain animals that use them for orientation. Man-made **static magnetic fields** are generated wherever DC currents are used, such as in electric trains or industrial processes such as aluminium production. These can be more than 1 000 times stronger than the Earth's natural magnetic field.

Recent technological innovations have led to the use of magnetic fields up to 100 000 times stronger than the Earth's magnetic field.

They are used in research and in medical applications such as magnetic resonance imaging (MRI) which provides three-dimensional images of the brain and other soft tissues. Scanned patients and machine operators can therefore be exposed to very strong magnetic fields.

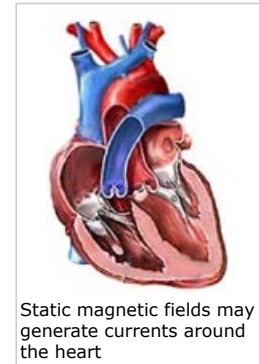


MRI scanner  
Source: McKnight Brain Institute

## 4. How may static magnetic fields interact with the body?

4.1 **Static magnetic fields** could interact with the body in the following ways. They could:

- generate electric fields and currents around the heart, and slightly impede the flow of blood,
- affect metallic implants and possibly some biological molecules and cell structures in the body, and
- possibly interfere with some chemical reactions in the body.



4.2 The interactions of biological tissue with a **static magnetic field** depend on the physical properties of the field, such as the strength and direction of the field at a given location inside the body. Interactions with the body that are likely to be of most consequence for health occur when there is **movement** in the field because of body motion or blood flow.

The use of increasingly stronger machines in medical imaging makes interactions with the body more likely. It has become a priority to gain a better understanding of these interaction mechanisms, through computer modelling as well as experimental observations.

## 5. How may static fields affect cells or animals?

5.1 Studies on cells are useful for understanding interaction mechanisms between biological tissue and static magnetic fields. They can indicate what sorts of effects might be investigated in animals and humans. Studies on static magnetic fields suggest a range of possible effects, but the validity of most findings has not been tested by other researchers so far, so no firm conclusions can be drawn about possible effects on human health.

5.2 In the few studies on the effects of static electric fields on animals that have been carried out, no negative health effects have been noted, other than the perception of body hair movement or small electric shocks.

For **static magnetic fields**, a large number of animal studies have been carried out, indicating:

- Interactions with the organ of balance in the inner ear, causing discomfort when moving in strong magnetic fields.
- Electric charges generated around the heart and major blood vessels.
- Possible effects on blood cells and on the endocrine system. However, the validity of these results has rarely been tested by other researchers and thus the findings remain inconclusive.

Moreover, few studies have examined possible long term effects of exposure, particularly in relation to cancer. Conclusions on such effects can not be drawn at present.

## 6. How may humans be affected by static fields?

6.1 **Static electric fields** do not enter the body. However, they cause an electric charge on the body surface which can result in movement of body hairs or spark discharges, such as those experienced when touching a doorknob after walking on a carpet.

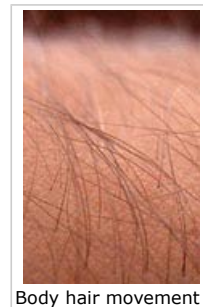
A range of possible health effects of **static magnetic fields** has been studied, such as possible effects on the brain, blood pressure, and body temperature as well as possible therapeutic effects. Apart from vertigo and nausea reported by people moving in a field, there is no conclusive evidence of any significant effects, nor can such effects be ruled out.

6.2 Studies on health effects due to exposure in the workplace almost exclusively focused on workers exposed to moderate static magnetic fields generated by equipment using large DC currents, such as aluminium smelters. Among such workers, increased risks of various cancers have been reported, but results are not consistent across studies. These workers are exposed to a variety of other potential hazards, which makes the exact cause of any observed effects unclear. The data available so far is inadequate for a health evaluation.

## 7. What are the health risks associated with static fields?

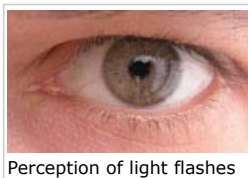
On the whole, the data for exposure to **static electric fields** suggest that the only negative health effects are the direct perception of body hair movement and small shocks. Long term effects of static electric fields have not been investigated.

For **static magnetic fields**, short-term exposure to very strong fields does seem to induce a number of measurable effects in the body. Computer simulations suggest possible effects on the heart of electric currents induced by blood flowing through a strong magnetic field, although this has not been experimentally verified.



Body hair movement

Moving within a very strong static magnetic field can create sensations of vertigo and nausea, and sometimes a metallic taste in the mouth and the perception of light flashes. Although only temporary, such effects may adversely affect people, which raises safety concerns for workers executing delicate procedures (such as surgeons performing operations using MRI).



Perception of light flashes

Other short term effects of static magnetic fields have been reported, but since the experiments have not been repeated by other researchers in order to test the validity of the results it is difficult to draw any firm conclusion. Furthermore, there is not enough evidence to reach any conclusion on long term effects such as cancer.

## 8. Should the public and workers be protected from the effects of static fields?

National authorities should set up programs to protect both the public and workers from possible negative effects of static fields.

- In the case of **static electric fields**, since the main effect is discomfort from electric discharges to the body, it could be sufficient to provide information on exposure to large electric fields and how to avoid them.
- In the case of **static magnetic fields**, however, a series of precautionary measures are recommended to limit the exposures of workers and the public, through standards and enclosures. Additional research funding and data gathering are needed.

## 9. What further research is needed on the possible health effects of static fields?

9.1 No further research concerning biological effects from exposure to static electric fields is recommended, since neither significant exposure nor health effects are very likely.

9.2 For static magnetic fields, research carried out to date has not been systematic and has often been performed without appropriate methodology and exposure information.

Recommendations for research on exposure to static magnetic fields:

- **Computer models** should be developed to study effects on women and fetuses, as well as effects on vision, balance, and the heart.
- **Laboratory tests on cells** should look into interactions with enzymes and genetic material.
- **Laboratory tests on animals** should investigate possible effects on cancer and development, as well as effects of very strong fields.
- **Tests on human volunteers** should address possible effects on balance, head and eye coordination, memory, reaction speed, behaviour, as well as on the heart and blood circulation.
- **Studies on human populations** should assess delayed and chronic effects experienced by highly exposed workers (if feasible), taking into account reliable exposure measurements and possible effects on pregnancy.

## 10. Conclusion

Electric and magnetic fields are invisible lines of force generated by phenomena such as the thunderstorms, the Earth's magnetism, and the use of electricity.

Man-made **static electric fields** are for instance produced by friction, television screens, or the use of direct current (DC) in some rail systems. Though static electric fields can be perceived through body hair movement and small shocks, no other negative health effects have been observed and no further research is recommended.

Man-made **static magnetic fields** can be more than 1 000 times stronger than the Earth's natural magnetic field, in the case of industries using direct current (DC), and up to 100 000 times stronger in the case of new technologies such as magnetic resonance imaging (MRI). The Earth's weak magnetic field is perceived by some animals that use it for orientation. In people moving in very strong static magnetic fields vertigo and nausea have been reported, but there is no conclusive evidence of other significant health effects, nor can such effects be ruled out. The use of increasingly stronger fields makes interactions with the body more likely and further research is needed to investigate possible health effects of strong fields and long-term exposure.

National authorities are advised to set up programs to protect both the public and workers from possible negative effects of static fields, and to fund research to fill gaps in the knowledge

## Annex

### Annex 1:

#### Static electric fields of TV sets and computer screens

"Computer screens and television sets work on similar principles. Both produce static electric fields and alternating electric and magnetic fields at various frequencies.

However, screens with liquid crystal displays used in some laptop computers and desktop units do not give rise to significant electric and magnetic fields.

Modern computers have conductive screens which reduce the static field from the screen to a level similar to that of the normal background in the home or workplace.



At the position of operators (30 to 50 cm from the screen), alternating magnetic fields are typically below  $0.7 \mu\text{T}$  in flux density (at power frequencies). Alternating electric field strengths at operator positions range from below  $1 \text{ V/m}$  up to  $10 \text{ V/m}$ ."

Source & © WHO ([www.who.int](http://www.who.int) [see <http://www.who.int/peh-emf/about/WhatisEMF/en/index3.html>])

## **Partner for this publication**

The Levels 1 & 2 are summaries written by GreenFacts with financial support from the International EMF Project [see <http://www.who.int/peh-emf/en/>] of the World Health Organization (WHO).