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# Powerlines & Cancer FAQs

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\*\* Frequently Asked Questions (FAQs) on Power-Frequency Fields (EMF) and Cancer

\*\*Summary\*\*

Questions and Answers on the connection between power lines, electrical occupations and cancer: discussion of the biophysics of interactions with EM sources, summaries of the laboratory and human studies, information on standards, and a bibliography.

Most of the concern about power lines ("EMF") and cancer stems from studies of people living near power lines (Question 12) and people working in "electrical" occupations (Question 15). Some of these studies appear to show a weak association between exposure to power-frequency magnetic fields and the incidence of cancer.

However, epidemiological studies done in recent years show little evidence that power lines are associated with an increase in cancer (Question 19), laboratory studies have shown essentially no evidence of a link between power-frequency fields and cancer (Question 16), and a connection between power line fields and cancer remains biophysically implausible (Question 18).

A 1996 review by the U.S. National Academy of Science concluded that: "No conclusive and consistent evidence shows that exposures to residential electric and magnetic fields produce cancer, adverse neurobehavioral effects, or reproductive and developmental effects." (Question 27E)

A 1999 review by the U.S. National Institutes of Health concluded that:  
"The scientific evidence suggesting that [power-frequency electromagnetic field] exposures pose any health risk is weak." (Question 27G).

A 2001 review by the U.K. National Radiation Protection Board (NRPB) concluded that:  
"Laboratory experiments have provided no good evidence that extremely low frequency electromagnetic fields are capable of producing cancer, nor do human epidemiological studies suggest that they cause cancer in general." (Question 27H)

A 2001 review of the epidemiological literature by the International Commission on Non-Ionizing Radiation Protection concludes that:  
"In the absence of evidence from cellular or animal studies, and given the methodological uncertainties and in many cases inconsistencies of the existing epidemiologic literature, there is no chronic disease for which an etiological [causal] relation to [power-frequency fields] can be regarded as established."

The largest studies of childhood leukemia and power lines ever done reported in 1997-2000 that they could find no significant evidence for an association of power lines with childhood leukemia (Q19H through 19K). In contrast, two studies published in 2000 reported that if all the studies for which magnetic fields were measured (or could be calculated) were pooled, a statistically significant association could be found for childhood leukemia in the children with the highest average fields.

On the other hand, a series of studies have shown what life-time exposure of animals to intense power-frequency magnetic fields does not cause cancer or any other health problems. (Q16B)

Overall, most scientists consider the evidence that power line fields cause or contribute to cancer to be weak to nonexistent.

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The full version of this FAQ is available on the web at:  
<http://www.mcw.edu/qcrc/cop/powerlines-cancer-faq/toc.html>

NOTE THAT "faq" is lower-case. UPPER-CASE MAY OR MAY NOT WORK

The USENET version contains only the Table of Contents and a list of recent revisions.

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Preguntas y respuestas sobre líneas eléctricas y cáncer esta disponible en español:  
<http://www.mcw.edu/qcrc/cop/lineas-electricas-cancer/toc.html>

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There are two related FAQs:  
FAQs about Cell Phone Base Antennas and Human Health  
<http://www.mcw.edu/qcrc/cop/cell-phone-health-faq/toc.html>  
Static Electromagnetic Fields and Cancer FAQs  
<http://www.mcw.edu/qcrc/cop/static-fields-cancer-faq/toc.html>

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\*\* Revisions Notes

(v7.9, May/June 2003):

- Blood cells were exposed to a 800 microT 60-Hz field for 24 hours and/or to a chemical mutagen; no evidence of genotoxic injury was found for the field alone, but exposure to the field enhanced the genotoxicity caused by the chemical [G118].
- Blood cells were exposed to a 230-700 microT 50-Hz fields for 12 hours and/or to gamma irradiation; no evidence of genotoxic injury

was found for the field alone, and exposure to the field did not enhance the chromosome injury caused by the ionizing radiation [G119].

- A study of men with both occupational and residential exposure to power-frequency fields found no effects of the exposure on melatonin levels [E43].
- Calculated residential magnetic field exposure was associated with melanoma in women, but not in men; estimated occupational magnetic field exposure was not associated with melanoma [C65].
- Occupational exposure to power-frequency magnetic fields was associated with prostate cancer [D52].
- Human cancer cells were exposed to 2000- 13000 microT fields at 50Hz for 2 or 4 days; above 6000 microT cell division was inhibited and cell death was increased [H70].
- Exposure of human white blood cells to 80 or 800 microT 50-Hz fields did not cause genotoxic injury, and did not significantly enhance genotoxic injury produced by a genotoxic drug; but the 800 microT exposure showed some evidence for enhancement of cell division [G117].
- Exposure of pregnant rats to 5-500 microT 60-Hz fields for 6-20 days had no effect on the mothers or on the offspring [J31].

(v7.8, Jan/Feb-2003):

- Occupational exposure to power-frequency fields was associated with brain cancer, but only if there was also exposure to lead, solvents or pesticide/herbicides [D51].
- Exposure to power line electric fields in the UK was not associated with the incidence of childhood cancer [C64].
- Residence near powerlines in Norway was not associated with an increased risk of birth defects [J30].
- Exposure to a 2000 microT field for 52 weeks did not promote skin cancer in rats [G116].
- Exposure of human volunteers to power-frequency fields had no effect on nighttime secretion of melatonin or other hormones [E35].
- Exposure of human immune system cells to 2-500 microT fields had no effects on their function [H69].
- Exposure of cultured cells to a 1000 microT field caused DNA stand breaks if the exposure was intermittent, but not if the exposure was continuous [G115].
- Two studies of electrical utility workers found no evidence that exposure to power-frequency fields was associated with heart disease [E37, E38].

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\*\* Table of Contents

1. Is there a concern about power lines and cancer?
2. What is the difference between the electromagnetic (EM) energy associated with power lines and other forms of EM energy such as microwaves or x-rays?
3. Why do different types of EM sources produce different biological effects?
4. What is difference between EM radiation and EM fields?
5. Do power lines produce EM radiation?
6. How do ionizing EM sources cause biological effects?
7. How do RF and MW sources cause biological effects?
8. How do the power-frequency EM fields cause biological effects?
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10. What sort of power-frequency fields are common in residences and workplaces?
11. Can power-frequency fields in homes and workplaces be reduced?
12. What is known about the relationship between power line corridors and cancer rates?
13. How big is the "cancer risk" associated with living next to a power line?
  - a. What is the risk of cancer in general?
  - b. What is the risk of childhood leukemia?

14. How close do you have to be to a power line to be considered exposed to power-frequency magnetic fields?
15. What is known about the relationship between electrical occupations and cancer rates?
16. Do laboratory studies indicate that power-frequency fields can cause cancer?
  - a. Do power-frequency fields show genotoxic activity in humans?
  - b. Do power-frequency fields cause cancer in animals?
  - c. Do power-frequency fields show genotoxic activity in cell culture?
  - d. Do power-frequency magnetic fields cause or enhance neoplastic cell transformation?
  - e. Are power-frequency magnetic fields cancer promoters?
  - f. Do power-frequency magnetic fields enhance the effects of other genotoxic agents?
17. Do laboratory studies indicate that power-frequency fields have any biological effects that might be relevant to cancer?
  - a. How do lab studies of the effects of power-frequency fields on cell and tumor growth relate to the question of cancer risk?
  - b. How do lab studies of the effects of power-frequency fields on immune function relate to the question of cancer risk?
  - c. How do lab studies of the effects of power-frequency fields on melatonin relate to the question of cancer risk?
18. Do power-frequency fields show any reproducible biological effects in laboratory studies?
  - a. Do power-frequency fields of the intensity encountered in occupational and residential settings show reproducible biological effects?
  - b. Are there known mechanisms by which power-frequency fields of the intensity encountered in occupational and residential settings could cause biological effects?
  - c. Haven't some new mechanisms been proposed that could explain how power-frequency magnetic fields could cause biological effects?
  - d. Could the presence of transients or harmonics in power-frequency fields provide a biophysical mechanism for biological effects?
19. What about the "new studies" showing a link between power-frequency fields and cancer?
  - a. What about the European (Scandinavian) epidemiological studies showing a link between power lines and cancer?
  - b. What about the studies showing a link between occupational exposure to power-frequency fields and cancer?
  - c. What about the studies showing a link between electrical occupation and breast cancer?
  - d. What about the studies showing a link between pulsed electric fields and lung cancer?
  - e. What about the studies linking the use of electrical appliances with cancer?
  - f. What about Sweden's/Denmark's decision to regulate fields power line fields?
  - g. What about the study showing that it is the interaction between power-frequency fields and the Earth static field that causes cancer?
  - h. What about the 1997 NCI study showing no link between power lines and childhood leukemia?
  - j. What about the 1999 Canadian studies of power lines and childhood leukemia?
  - k. What about the 1999-2000 UK studies of power lines and childhood leukemia?
  - l. Could exposure to power-frequency electric rather than magnetic fields be linked with cancer?
20. What criteria do scientists use to evaluate all the laboratory and epidemiologic studies of power-frequency magnetic fields and cancer?
  - a. Criterion One: How strong is the association between exposure to power-frequency fields and the risk of cancer?
  - b. Criterion Two: How consistent are the studies of associations between exposure to power-frequency fields and the risk of cancer?

- c. Criterion Three: Is there a dose-response relationship between exposure to power-frequency fields and the risk of cancer?
  - d. Criterion Four: Is there laboratory evidence for an association between exposure to power-frequency fields and the risk of cancer?
  - e. Criterion Five: Are there plausible biological mechanisms that suggest an association between exposure to power-frequency fields and the risk of cancer?
21. If exposure to power-frequency magnetic fields does not explain the residential and occupations studies which show increased cancer incidence, what other factors could?
- a. Could problems with dose assessment affect the validity of the epidemiologic studies of power-frequency fields and cancer?
  - b. Are there other cancer risk factors that could be causing a false association between power-frequency fields and cancer?
  - c. Could the epidemiologic studies of power-frequency fields and cancer be biased by the methods used to select control groups?
  - d. Could analysis of the epidemiologic studies of power-frequency fields and cancer be skewed by publication bias?
  - e. Could analysis of the epidemiologic studies of power-frequency fields and cancer be biased by multiple-comparison artifacts?
  - f. Does the evidence that childhood leukemia has an infectious basis mean that the weak association sometimes seen between power-frequency fields and childhood leukemia is an artifact?
22. What is the strongest evidence for a connection between power-frequency fields and cancer?
23. What is the strongest evidence against a connection between power-frequency fields and cancer?
24. What studies are needed to resolve the cancer-EMF issue?
25. Is there any evidence that power-frequency fields cause any effects on human health, such as miscarriages, birth defects, Alzheimer's disease, multiple sclerosis, suicide or sleep disorders?
26. What are some good overview articles?
27. Are there exposure guidelines for power-frequency fields?
- a. What are the guidelines for power-frequency field exposure of the general public?
  - b. What are the guidelines for occupational power-frequency field exposure?
  - c. Are there special exposure guidelines for people with cardiac pacemakers?
  - d. Is a US government agency about to recommend strict limits on occupational and residential exposure to power-frequency fields?
  - e. What does the 1996 report from the U.S. National Research Council say?
  - f. Does a 1998 report from the U.S. National Institute of Environmental Health Sciences (NIEHS) say that power-frequency fields are a "possible" carcinogen?
  - g. What does the 1999 report from the U.S. National Institute of Environmental Health Sciences (NIEHS) to the US Congress say about power-frequency fields and cancer?
  - h. What does the 2001 report from the U.K. National Radiation Protection Board (NRPB) say about power-frequency fields and cancer?
  - j. Does a 2002 report from the International Agency for Research on Cancer (IARC) say that power-frequency fields are a "possible" carcinogen?
  - k. What does the 2002 report from the State of California say about possible human health hazards from exposure to power-frequency fields?
28. What effect do power lines have on property values?
29. What equipment do you need to measure power-frequency magnetic fields?
30. How are power-frequency magnetic fields measured?
31. Do the issues discussed in this FAQ sheet apply to EM fields other than power-frequency fields?
- a. Low-frequency fields other than sinusoidal power-frequency fields
  - b. Static electric and magnetic fields

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32. What about the new study claiming that radon exposure is increased by the presence of electromagnetic fields.
33. What about the reports that some people are sensitive to (allergic to) the presence of electromagnetic fields?
34. Should I buy a house next to a power line?
35. Who wrote this FAQ?

\*\* Bibliography

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2. Reviews of the Epidemiology of Exposure to Power-Frequency Fields
3. Epidemiology of Residential Exposure to Power-Frequency Fields
4. Epidemiology of Occupational Exposure to Power-Frequency Fields
5. Human Studies Related to Power-Frequency Exposure and Cancer
6. Biophysics and Dosimetry of Power-Frequency Fields
7. Laboratory Studies of Power-Frequency Fields and Cancer
8. Laboratory Studies Indirectly Related to Power-Frequency Fields and Cancer
9. Studies of Power-Frequency Fields and Reproductive Toxicity
10. Reviews of Laboratory Studies of Power-Frequency Fields
11. Miscellaneous Items
12. Regulations and Standards for Ionizing and Non-ionizing EM Sources.



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