Extremely Low Frequency Fields and Childhood Leukemia

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Outline

- What are extremely low frequency (ELF) fields?
- Current safety guidelines: Safety Code 6.
- Review of Research Studies
- IARC Classification
- Look into concern mongering for ELF.
  - Is there a concern of ELF fields?
  - Is the concern rational?
- Who is responsible for the concern?
- Determine ways to undo concern.

Childhood Leukemia and ELF Fields

- Childhood leukaemia is a rare disease with approximately 4 out of 100,000 children between the age of 0 to 14 diagnosed every year.
- Average magnetic field exposures above 0.3 or 0.4 μT in residences are rare.
- It may be estimated from the epidemiological study results that less than 1% of populations using 240 volt power supplies are exposed to these levels.
- This may be higher in places using 120 volt supplies.

Concern!

- Concerns have been raised about the possible biological effects of nonionizing radiation since at least the late 1950s with respect to radar and other radio sources.

- More recent concerns have arisen about the potential effects of low-intensity fields including low frequency fields from the electric power systems and the associated devices.

- At low frequencies, the limits are based on induced current densities that would excite nerve firing.

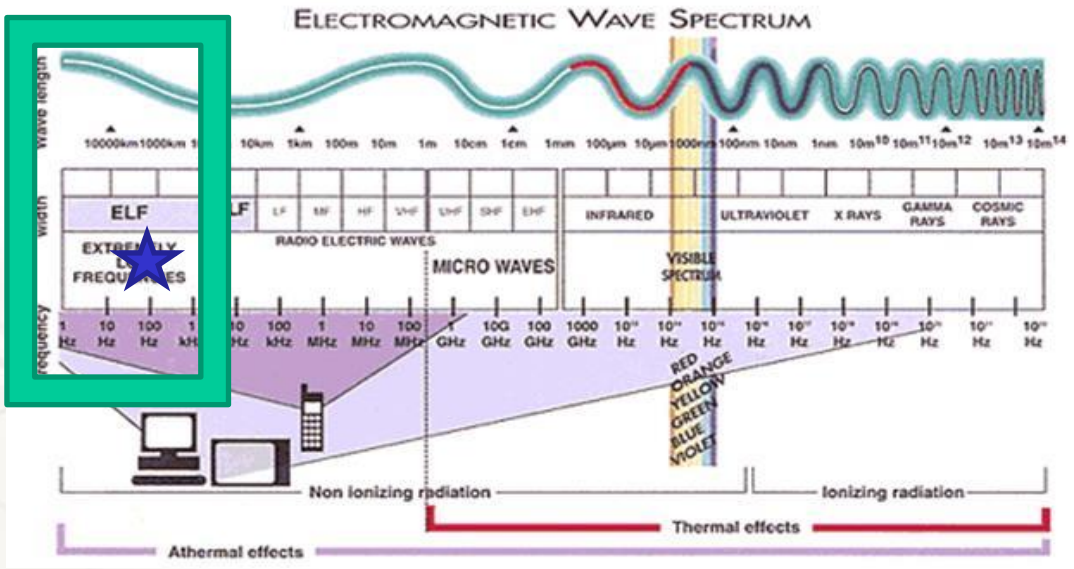
- Because of the difficulties in establishing the direct biological effects of long-term low-level exposures, the lack of an understood mechanism, and difficulties in obtaining reproducible results, the guidelines for expos been set based on relatively short-term exposures (minutes) that show clear-cut damage with the addition of a substantial safety factor.
- These limits have been set based on providing a significant safety factor over exposure levels known to cause damage, where the primary damaging mechanism is **heating** and an increase in temperature.

Interaction Mechanisms

- The most known proposed mechanism for effects from low-level, long-term exposures involves **radicals**, such as super oxide O_2^-, NO_X, and H_2O_2, which is readily converted into the radical OH^-, molecules with unpaired electron spins that are highly reactive.
- These molecules are both signaling molecules and molecules that can cause damage to important biological molecules, such as lipids and DNA.
- Damages, such as aging, cancer, and Alzheimer's, are associated with radical concentrations that are elevated for extended periods of time.

ELF Fields

- Commonly from Power Lines (50-60Hz)
- Not enough energy to cause ionization



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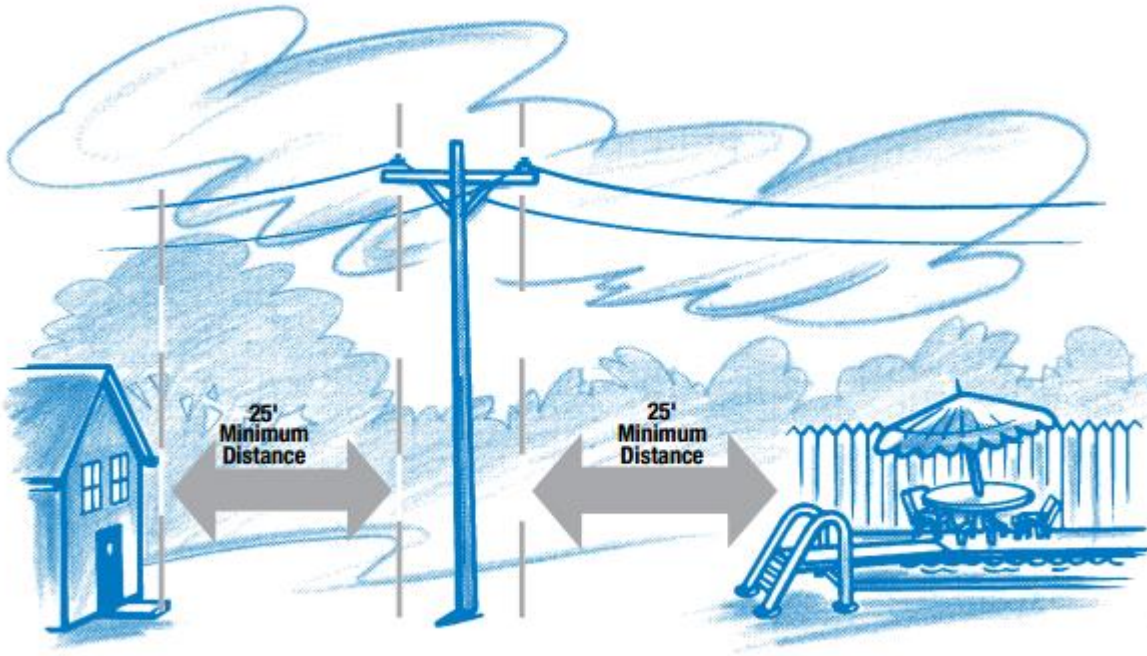
Right of Sight

- Line of Clearance
  - 25ft in the US
  - Designed to pre
  electrocution
- No mention of EM
safety



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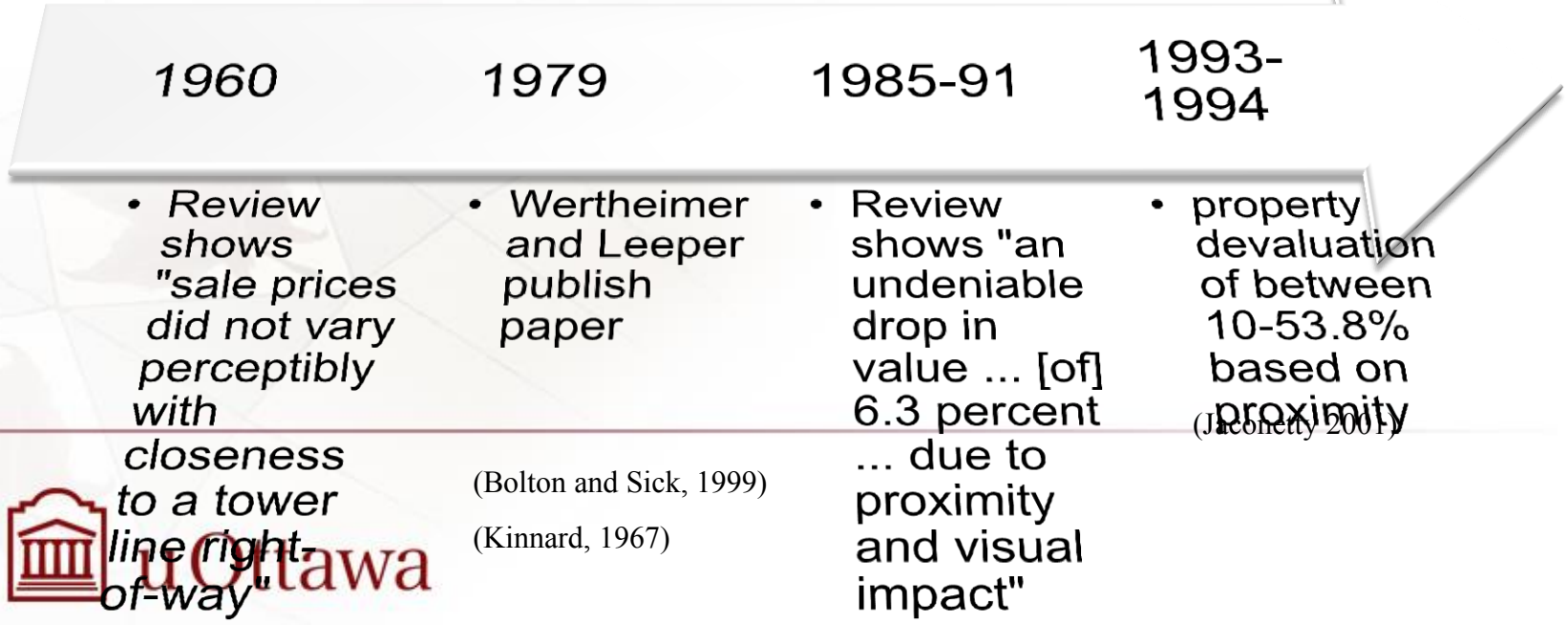
When did it Start?

- 1979 Nancy Wertheimer and Ed Leeper published "Electric Wiring Configurations and Childhood Cancer" for the American Journal of Epidemiology, they found:
  - An excess of electrical wiring […] near homes of children who developed cancer, as compared to the homes of control children
  - The reason […] is uncertain; possible effects of current in the water pipes or of AC magnetic fields are suggested



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Concern Background

- Much of the public concern dates from epidemiological studies that show small, though statistically significant increases in childhood leukemia for children living near power lines and possible increases in brain tumors for heavy use of cell phones.

- The early study by Wertheimer and Leeper* has shown an increase that was just statistically significant in childhood leukemia for children living near power lines.

* N. Wertheimer and E. Leeper, "Electrical wiring configurations and childhood cancer," *Amer. J. Epidemiol.*, vol. 109, no. 3, pp. 273–284, 1979.

- Of the many additional studies since then, about half show small correlations with proximity to power lines and/or weak magnetic fields, and about half do not.

- However, the possibility that there may be a cause and effect for a long-term exposure to low levels of low-frequency electromagnetic fields has led to the classification by the International Agency for Research on Cancer (IARC), an agency of the World Health Organization (WHO), as a possible cause of cancer.

Review of Research Studies

Reviews of the scientific literature on possible health effects from exposure to ELF fields in the frequency range 0 to 300 Hz have been completed by the International Commission on Non-Ionizing Radiation Protection (ICNIRP, 1998), the National Institute of Environmental Health Sciences (NIEHS, 1998), WHO (Repacholi and Greenebaum, 1999), the National Radiological Protection Board (AGNIR, 2001), the Health Council of the Netherlands (2001) and the International Agency for Research on Cancer (IARC, 2002).

The above reviews concluded that there were no established adverse health consequences from exposure to ELF field levels below the limits in the ICNIRP (1998) guidelines.

However, these reviews indicated that there was some consistency in the epidemiological studies on childhood leukaemia which suggested that there might be an increasing risk of disease in children exposed to mean magnetic fields above about 0.3 - 0.4 μT.

IARC Classification

- The International Agency for Research on Cancer (IARC), a specialized cancer research agency of WHO has recently concluded the first step in WHO's health risk assessment process by classifying ELF fields with respect to the strength-of-the-evidence that they could cause cancer in humans.
- In June 2001, an expert scientific working group of IARC reviewed studies related to the carcinogenicity of static and ELF fields. Two pooled analyses of epidemiological studies provide insight into the epidemiological evidence that played a pivotal role in the IARC evaluation (IARC, 2002). These analyses suggested that, in a population exposed to average magnetic fields in excess of 0.3 to 0.4 μT, twice as many children might develop leukaemia compared to a population with lower exposure.

IARC Classification

- To reach a classification of "**probably carcinogenic to humans**", the scientific evidence would be weaker, where the animal evidence can be strong, but the human data is less convincing or lacking altogether.
- Finally for a classification of "**possibly carcinogenic to humans: Class 2B**" the human data should be considered credible, but for which other explanations could not be ruled out.
- In the case of ELF magnetic fields the human studies had a consistency when the data were combined, but selection bias could not be ruled out. In addition, neither the animal or laboratory studies supported the human data. This further strengthens that there may be another explanation for the association between exposure to ELF magnetic fields and childhood leukaemia.

Physical and Chemical Agents Classified for their Carcinogenicity in Humans by IARC

Classification	Examples of Agents
Carcinogenic to humans (usually based on strong evidence of carcinogenicity in humans)	Asbestos Alcoholic beverages Benzene Mustard gas Radon gas Solar radiation Tobacco (smoked and smokeless) X-rays and Gamma radiation
Probably carcinogenic to humans (usually based on strong evidence of carcinogenicity in animals)	Creosotes Diesel engine exhaust Formaldehyde Polychlorinated biphenyls (PCBs)
Possibly carcinogenic to humans (usually based on evidence in humans which is considered credible, but for which other explanations could not be ruled out)	Coffee ELF magnetic fields Gasoline engine exhaust Glass wool Pickled vegetables Styrene

WHO Response and Recommendation

- In response to the IARC classification, WHO issued a fact sheet (WHO, 2001). While the classification of ELF magnetic fields as possibly carcinogenic to humans has been made, it remains possible that there are other explanations for the observed association between exposure to ELF magnetic fields and childhood leukaemia.
- WHO therefore recommends a follow-up, focused research programme to provide more definitive information.
- More studies have been undertaken after that.

What about after?

- 2005 Study showed a 70% increase relative risk for leukemia in children living 250ft away compared to 2000ft away from power lines

	Leukaemia		
Distance to line (metres)	Cases	Controls	RR
0-49	5	3	1.67
50-99	19	11	1.79
100-199	40	25	1.64
200-299	44	39	1.16
300-399	61	54	1.15
400-499	78	65	1.23
500-599	75	56	1.36
≥600 (reference group)	9378	9447	1.00
Total	9700	9700	

CNS=central nervous system.

(Draper 2005)

$$Relative\ Risk = \frac{P_{exposed}}{P_{not\ exposed}}$$

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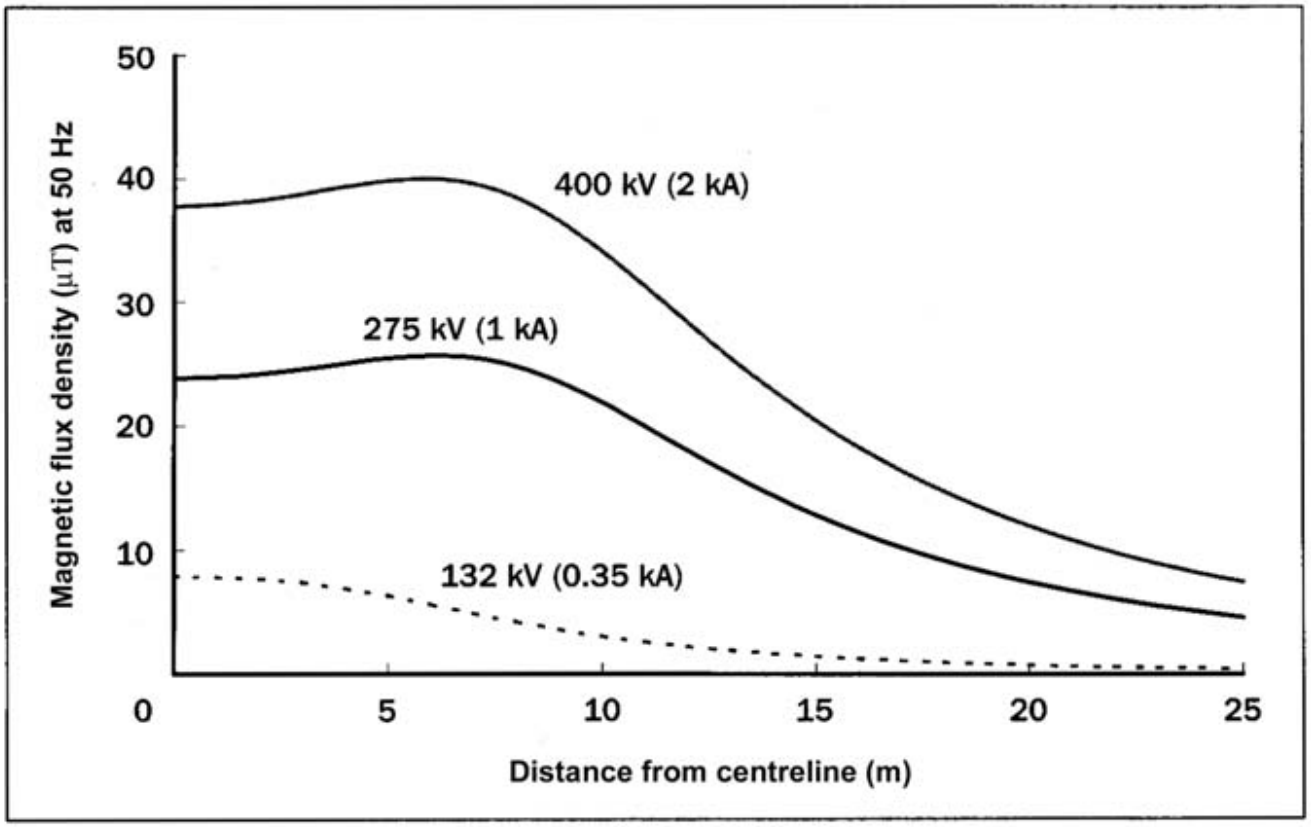
- 2014 Study showed that it is possible to come to a convincing conclusion which explains controversial results and reports dose-response relationship, and provides answers to striking facts such as that epidemiologic results on childhood leukemia are independent from field source or exposure metric of whatever kind with no specific favorite.
- The analysis revealed that the assumption of a causal link between ELF magnetic field exposure and childhood leukemia is no longer plausible and hence that ELF magnetic field's classification as possibly carcinogenic **needs revision**!
- Norbert Leitgeb, Childhood Leukemia Not Linked with ELF Magnetic Fields, Journal of Electromagnetic Analysis and Applications, 2014, 6, 174-183, Published Online June 2014.

Is there a fear?

- Definite scientific link between childhood leukemia and power line proximity
- Strong correlation between the release of the scientific data and the devaluation of homes near power lines

Is the fear rational?



(IARC 2002)

Earths magnetic field is about 31 μT at the equator

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IARC

VOLUME 80
NON-IONIZING RADIATION, PART 1:
STATIC AND EXTREMELY LOW-FREQUENCY
(ELF) ELECTRIC AND MAGNETIC FIELDS

- At ELF fields frequency range, the photon energy is exceedingly small, thus a direct interaction causing breakage of chemical bonds and the resultant damage to DNA is not possible. At power frequencies (50 or 60 Hz), the photon energy is about 10^{-12} of the energy required to break the weakest chemical bond"
- For cancer: Studies on the possible carcinogenic effects of ELF electric and magnetic fields are hampered by complications, or lack of information, at almost every level.
- Firstly, it is apparent that many systems fail to provide any evidence of a treatment-related effect. Secondly, when such effects are observed, other laboratories have often been unable to reproduce the observation."

(IARC 2002)

It May Not Be Impossible After All
Weak Magnetic Fields Can Promote Cancer

Recent Article

- Weak RF fields may indeed be able to promote cancer, according to two leading members of the EMF/RF research community. Frank Barnes and Ben Greenebaum are offering theoretical arguments. They present their ideas in an article which has appeared in the *IEEE Power Electronics Magazine, 2016.*
- We think that there are now both the theoretical bases and sufficient experimental results for further consideration of the possibility that long-term exposures to magnetic fields can lead to both useful applications in treating diseases and to undesired health effects. It is expected that these effects are frequency, amplitude, and time dependent.

Is the Fear Rational

- "We did not find any evidence of an increased risk of childhood leukaemia at residential magnetic field levels < 0.4 μT" (Ahlbom 2000)
- "We found no significant excess risk of childhood ALL associated with time-weighted average summary residential magnetic-field levels of 0.200 μT or greater, nor did we observe any significant dose–response trends."
- Fear deemed irrational!

(Linet 1997)

Is the Fear Rational?

- No clear answer about the dangers of ELF fields.
  - If not generally agreed on, why the general fear?
  - If not decided, can we truly respond to the fear?
- Since no scientifically agreed upon answer, the fear seems disproportionate.
  - Especially since large government or international agencies believe they are safe.

Who is Responsible for the Spread of Fear

- Mostly speculation
  - How it became 'public' knowledge
  - Identify major parties
  - Try and find ulterior motives

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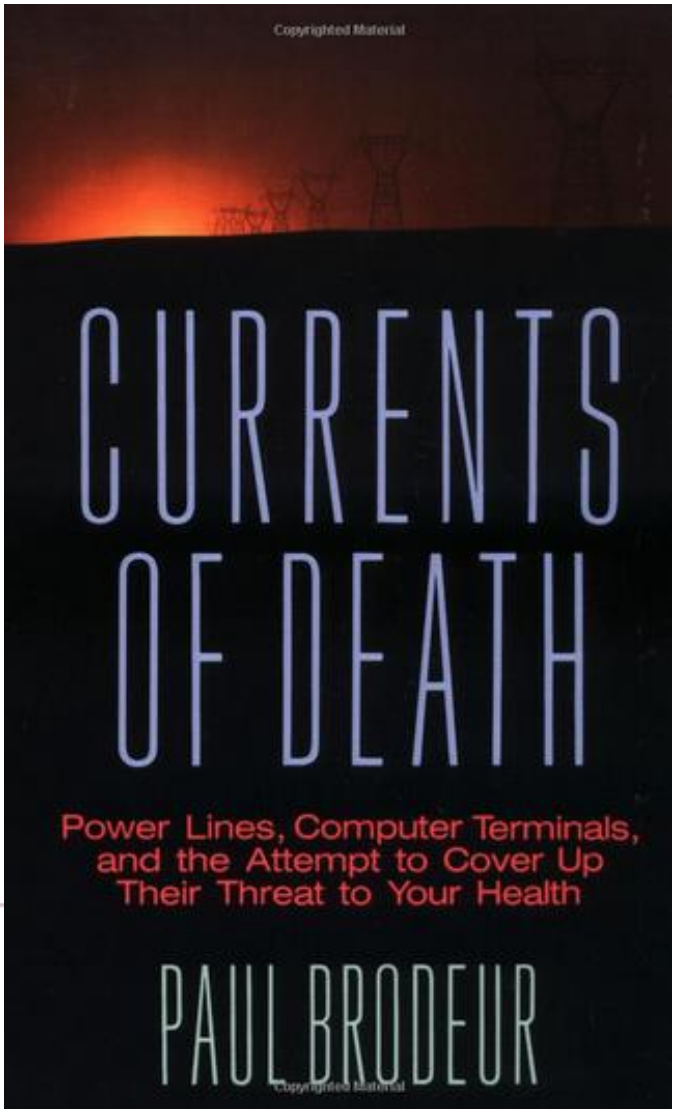
Paul Brodeur

- Writer for the New Yorker (novelist)
- Wrote sensational stories through the 1980's and 1990's relating to real life findings and horrifying results
  - Asbestos
  - Power lines
    - "Currents of Death" in 1989
    - Alleges government and industry conspiracy to cover it up!!!!!!
- Goal was to sell stories, fear and conspiracies sell
  - No ulterior motive or malicious intent discovered



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Major Parties

- Home owners/Real estate agents
  - Concerned about value of their home
    - Advantage regardless of conclusion
      - Home value increases since risk proven false
      - Legal action against government/power company to regain lost value of home
- Parents
  - Concerned about safety of children
    - Advantage regardless of conclusion
      - Children safe if proven false
      - New safeties measures can be put in place if risk identified
- Industry/Energy sector
  - Concerned for liabilities and costs from power disruptions
    - Advantage if proven false
      - No disruption or displacement of power lines if proven false
      - Potential law suits, reorganisation of grid if proven a risk

How to Lessen the Fear?

- Find historical analogs
  - Political
  - Social
- Determine how they overcame fear
- Gather more scientific facts
- Create plan

What to do?

- Waiting it out, not a viable option
  - So we move to plan B, lessen fear
- How to lessen fear?
  - Create formal, scientific report summing all of research
  - Submit to appropriate government and international organisations (WHO, Health Canada etc.), and realtors
    - Provide information pamphlets
    - Protect against law suits
  - Once accepted as correct, create education program.
    - Make it so young adults know understand risk.

Conclusion

- There is a concern about power lines and other sources of ELF fields.
- This concern affects home owners, parents, real estate agencies as well as electricity providers.
- Historical analogs and scientific data may help lessen the concern (fear!).

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