E.M.F. AND THE HEALTH OF THE CITIZENS OF NEW HAMPSHIRE

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For several decades much research has been directed at the health hazards of power-lines and electro-magnetic fields.

Magnetic fields are created from the flow of electrical current through wires or electrical devices. As the current increases, so does the strength of the magnetic field. Even local distribution lines – as low as 69 kilovolts – can generate high EM, when demand is high and current flow peaks. Magnetic fields can be substantially higher at the spot where the line turns at an angle.

In 1992, the **U.S. Congress** authorized and funded the **EMF Rapid Program.** Involved were the **NIEHS, NIH** and **DOE**. Their brief was to clarify the potential for health risks from extreme low frequency electric and magnetic fields.

The end result was that the strongest evidence for health risk was for childhood leukemia, and lymphoma in line workers. The **"Rapid"** program recommended that the power industry site power lines to reduce human exposure.

The **IARC** in 2002 classified **ELF/EMF fields** as possibly carcinogenic to humans. The statement was based on pooled studies demonstrating a consistent pattern of a two-fold increase of leukemia in children exposed to magnetic fields above 2-4 M-gauss.

Children have a higher rate of cell division than adults and their immune systems have yet to mature. Their skulls are thinner.

Causation has not been proved, but numerous studies have shown an association and increased statistical significant of the development of leukemia in children living in an environment of more than 3-4 M-gauss.

Because of the lack of strong scientific evidence, many countries and states have adopted **the Precautionary Principle and/or Prudent Avoidance Policy.**

THE PRECAUTIONARY PRINCIPLE
EUROPEAN COMMISSION (2000)

Where action is deemed necessary, measures based on the precautionary principle should be:

- proportional to the chosen level of protection,
- non-discriminatory in their application,
- consistent with similar measures already taken,
- based on an examination of the potential benefits and costs of action or lack of action (including where appropriate and feasible, an economic cost/benefit analysis),
- subject of review, in the light of new scientific data, and
- capable of assigning responsibility for producing the scientific evidence necessary for a more comprehensive risk assessment.

Precautionary approaches, such as the Precautionary Principle, address additional uncertainties as to possible but unproven adverse health effects. Such risk management policies provide an opportunity to take incremental steps with respect to emerging issues. They should include cost-benefit considerations and should be seen as an addition to, and not as a substitute for, science-based approaches in assisting decision-makers to develop public policy.

PRUDENT AVOIDANCE

Whereby even without any demonstrable risk, the most achievable low-cost measure will be taken to reduce EMF exposure.

EPA

If EMF's do contribute to the induction of cancer, the causal relationship will probably turn out to be dependent on many chemical factors and physiological conditions that are currently poorly understood.

WHO – June 18th, 2007*

The main conclusion of the studies published since the **IARC** in 2001 report do not provide evidence to change the classification of ELF/EMF as a 2B or possible carcinogen. This classification was based on limited evidence from epidemiologic studies of magnetic fields and childhood leukemia indicating an approximate doubling of risk associated with exposures **above 3-4 M-gauss.**

***Ref. WHO, Environmental Criteria, June 18, 2007**

Recommended are precautionary measures to reduce exposure that are of no or low cost and do not compromise the health, social and economic benefits of electricity.

Recommended precautionary measures include implementation of very low cost measures in the design and engineering of new facilities and equipment, inclusion of safety, reliability and economic aspects when considering reduction of **ELF** fields from existing sources, and better planning for facilities that are possible sources of ELF/EMF exposure, including shareholder involvement to discuss siting of major facilities.

N.B.

Toxins once approved and often taking many years to ban, or to recognize as seriously harmful:

Arsenic	Mercury
Lead Paint	Dioxin
Asbestos	D.D.T.
Thalidomide	Agent Orange
Carcinogens in cigarettes	

To this point, New Hampshire has not set standards for setbacks from transmission lines. There are no specific rules regarding EMF levels at the edge of transmission rights-of-way (ROW) nor are there federal standards for limiting transmission line EMF.

Other states, however, have tackled this issue. Several states enforce firm limits on EMF while others have adopted siting constraints.

There follows background information on different states and their standards.

Included are standards set by several countries with regard to the siting of lines proximate to schools, etc.

COUNTRIES AND U.S. STATES' MITIGATION POLICIES
REGARDING SITING OF SCHOOLS AND TRANSMISSION LINES

ILLINOIS: Bill that would require utility companies to site transmission lines at least 500 ft. from schools, and would set a 2 M-gauss magnetic field limit for residents.

CALIFORNIA: Have established set-backs for new schools near power-lines. (See previous)

CONNECTICUT: The applicant shall provide the location of, and anticipated MF levels encompassing residential areas, private or public schools, day care facilities, youth camps or pubic playgrounds within 300 ft. of the proposed transmission line.

Also important to know is when utilities plan to increase the amperage or load – and hence the magnetic fields – of pre-existing lines.

At this time there is no law that utilities do not have to inform communities in advance, but there should be laws that require them to do so.

Spain:	No power-lines near schools.
Sweden:	No power-Lines near schools.
Australia:	Routing of lines away from schools.

GLOSSARY:

EMF RAPID: Electromagnetic Frequency Research and Public Information Disseminating System

NIEHS: National Institute of Environmental Health Sciences

NIH: National Institute of Health

DOE: Department of Energy

IARC: International Agency for Research in Cancer

ELF/EMF: Extra-low-frequency electro-magnetic fields

HVAC: High-voltage alternating current

HVDC: High-voltage DIRECT current

Milligauss: Measurement of magnetic activity.

PRECAUTIONARY PRINCIPLE:

Avoidance of unnecessary exposure to power-lines as long as there is scientific suspicion about their harmful side-effects. The precautionary principle states that if an action or policy has a suspected risk of causing harm to the public or the environment, in the absence of scientific consensus that the action or policy is harmful, the burden of proof that it is not harmful falls on those taking the action.

PRUDENT ACTION/AVOIDANCE:

Whereby even without any demonstrable risk, the most achievable low-cost measure will be taken to reduce EMF exposure.

Recommended Setbacks for New Transmission Lines

FERC recommends that new transmission lines should have set back distances equal to the mature height of existing and future native trees outside of the right-of-way.

FERC Recommendation, 2012

"Preventing fall-ins from both inside and outside the right-of-way is easier if utilities consider vegetation management needs when siting new transmission lines and acquiring new easements. Therefore, staff recommends that utilities carefully assess vegetation and growth rates in the area of planned lines in order to establish the appropriate right-of-way width. ***For example, if native trees have a mature height of 100 feet, the easement should cover an area wide enough to ensure that existing and future trees outside of the right-of-way will not fall into the facilities*** **(emphasis added)."**

Source: Report on Transmission Facility Outages during the Northeast Snowstorm of October 29–30, 2011: Causes and Recommendations, prepared by the Staffs of the Federal Energy Regulatory Commission and the North American Electric Reliability Corporation, p. 49.

FERC Recommendation, 2004

"Easement documents should clearly provide the utility with rights to establish and maintain appropriate clearances under and adjacent to the proposed lines while utilizing all appropriate IVM practices. The ROW width should be determined based on the following objective: "No vegetation, or parts of vegetation, shall be allowed to grow or fall into the transmission facilities." ***For example, if native trees have a mature height of 100 feet, the "ideal" initial easement should be wide enough to ensure that existing and future trees (along the side of the ROW) will not, by accident or design, fall into the facilities*** **(emphasis added)."**

Source: UTILITY VEGETATION MANAGEMENT FINAL REPORT, MARCH 2004. FEDERAL ENERGY REGULATORY COMMISSION, UNITED STATES GOVERNMENT. COMMISSIONED TO SUPPORT THE FEDERAL INVESTIGATION OF THE AUGUST 14, 2003 NORTHEAST BLACKOUT, p. 71

TRANSMISSION LINE SAFETY (EMF) - Application requirements[6]	
1.	The number and type of each building within the following distance categories – as estimated from the centerline: 0-25 feet, 26-50 feet, 51-100 feet, 101-150 feet, and 151-300 feet. Types of buildings include homes, apartments, schools, daycare centers, hospitals, and commercial/ industrial buildings.
2.	Detailed magnetic field profiles for each unique structure type or circuit configuration (new and existing)
	with the exception of dead-end structures adjacent to substations.
3.	For routes that would affect existing electric lines, provide magnetic field profiles for the existing lines and a post-construction scenario that incorporates the new and the existing lines.
4.	For routes that would have multiple adjacent underground circuits, provide magnetic field profiles for each set of circuit configurations.
5.	Estimated magnetic field data which includes: • estimate for proposed lines at 80 percent and at 100 percent of peak load for one year post-construction and 10 years post-construction. For existing lines, use present day loadings to estimate the magnetic fields levels. • provide expected current levels for 80 and 100 percent of peak load at one and ten years post-construction.
6.	Provide all assumptions used to model magnetic field levels including: • Pole design diagram that includes the dimensions of pole arms, dimensions of conductor locations, horizontal distance from the pole to the conductors, and the distance of conductors from the ground at the pole. • Height of lowest conductor(s) at mid-span. • Depth from ground surface to circuits, for underground construction.
7.	The Application shall propose and implement where practicable, low-cost efforts to reduce EMF without compromising safety. Suggested mitigations may include but not be limited to: • increase distance between the transmission line and the public's exposure to the magnetic fields; • Increase height of transmission structures which would lower resulting exposure levels; • bring lines closer together *(magnetic fields interfere with one another, producing a lower overall magnetic field level, too close could cause arcing between the lines);* • bury transmission lines to reduce magnetic fields. *(Underground lines can be installed closer together and insulated with rubber, plastic, or oil.)*

5 California Department of Health Services and the Public Health Institute, Electric and Magnetic Fields retrieved at http://www.ehib.org/emf/longfactsheet.PDF

6 Application rules derived from the State of Wisconsin PSC requirements. The State of Wisconsin has not established any limits on EMF levels or setback distances.

Background information on Transmission Siting and EMF

Different states have taken different approaches regarding EMF when siting large transmission projects. The following paragraphs briefly detail how some address EMF exposure when siting lines greater than 69kV[16].

Massachusetts

The Commonwealth of Massachusetts has defined an edge-of-ROW level of 85 mG as a benchmark for comparing different design alternatives. Although a ROW-edge level in excess of this value is not prohibited, it may trigger a more extensive review of alternatives.

New York[17]

New York has a policy that requires transmission lines to be designed, constructed and operated so that magnetic fields at the edges of the ROW will not exceed 200 mG.

Florida[18]

Florida limits magnetic fields at the edge of the ROW to 150 mG for transmission lines with voltages of 69 kV through 230 kV. For lines greater than 250 kV, the limit is 200 mG. Double-circuited 500 kV lines and lines greater than 500 kV may not exceed 250 mG, also at the edge of the ROW.

Wisconsin[19]

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16 It's important to note that EMF is directly tied to the amount of current flowing through a line. Lower capacity lines (69 kV) can show high levels of EMF while some 115kV lines may have lower levels of EMF.

17 State of New York Public Service Commission, *Statement of Interim Policy on Magnetic Fields of Major Electric Transmission Facilities, Cases 26529 and 26559*, Issued and Effective September 11, 1990.

18 Florida Administrative Code 62-814.450.

Wisconsin has not set hard limits on EMF levels but the state has taken the position that the public has a right to know details about EMF levels. The application process requires project proponents to provide the following information:

a) number and type of each building within the following distance categories – as estimated from the centerline: 0-25 feet, 26-50 feet, 51-100 feet, 101-150 feet, and 151-300 feet. Types of buildings include homes, apartments, schools, daycare centers, hospitals, and commercial/ industrial buildings.

b) detailed magnetic field profiles for each unique structure type or circuit configuration (new and existing) with the exception of dead-end structures adjacent to substations.

c) for routes that would affect existing electric lines, provide magnetic field profiles for the existing lines and a post-construction scenario that incorporates the new and the existing lines.

d) for routes that would have multiple adjacent underground circuits, provide magnetic field profiles for each set of circuit configurations.

e) estimated magnetic field data which includes:

- estimate for proposed lines at 80 percent and at 100 percent of peak load for one year post-construction and 10 years post-construction. For existing lines, use present day loadings to estimate the magnetic fields levels.
- provide expected current levels for 80 and 100 percent of peak load at one and ten years post-construction.

f) Provide all assumptions used to model magnetic field levels including:

- Phase ID and angles.
- Pole design diagram that includes the dimensions of pole arms, dimensions of conductor locations, horizontal distance from the pole to the conductors, and the distance of conductors from the ground at the pole.
- Height of lowest conductor(s) at mid-span.
- Depth from ground surface to circuits, for underground construction.

19 http://psc.wi.gov/utilityinfo/electric/construction/documents/transmissionLineAFR.pdf

This information is then available to the public and considered by the Commission in its route selection decisions. In some respects, EMF exposure has become a proxy for property value impact. [20]

California[21, 22]

The California Department of Education requires minimum distances between new schools and the edge of transmission line rights-of-way. The setback guidelines are: 100 feet for 50-133 kV lines, 150 feet for 220-230 kV lines, and 350 feet for 500-550 kV lines. These limits are not based on specific biological evidence, but on the rationale that the electric field drops to background levels at the specified distances.

The California Public Utilities Commission (CPUC), recommends that state investor owned utilities carry out "no and low cost EMF avoidance measures" in construction of new and upgraded utility projects. This means that 4% of the total project cost is allocated to mitigation measures if these measures will reduce magnetic field strength by at least 15%.

Connecticut[23]

The Connecticut Siting Council adopted a precautionary policy, in place since 1993, which includes establishing a standard method to allocate funds for MF mitigation. The Council follows California's cost allotment strategy for no-cost/low-cost MF mitigation of 4% total project cost is to help reduce magnetic field strength by at least 15%.

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20 Kenneth Rineer, personal communication with L. Linowes June 2, 2014).

21 Electric And Magnetic Fields Measurements And Possible Effect On Human Health — What We Know And What We Don't Know In 2000 http://www.ehib.org/emf/longfactsheet.PDF

22 California Department of Education Power Line Setback Exemption Guidance, May 2006. http://www.cde.ca.gov/ls/fa/sf/powerlinesetback.asp

23 Electric and Magnetic Field Best Management Practices For the Construction of Electric Transmission Lines in Connecticut December 14, 2007 http://www.ct.gov/csc/lib/csc/emf_bmp/emf_bmp_12-14-07.doc

As part of the application process, proponents are required to provide design alternatives and calculations of MF for pre-project and post-project conditions, under 1) peak load conditions at the time of the application filing, and 2) projected seasonal maximum 24-hour average current load on the line anticipated within five years after the line is placed into operation.

MF values are to be calculated from the ROW centerline out to a distance of 300 feet on each side of the centerline, at intervals of 25 feet, including at the edge of the ROW at 1 meter above ground level. Calculations shall assume "all lines in" and projected load growth five years beyond the time the lines are expected to be placed into operation, and shall include changes to the electric system approved by the Siting Council and the ISO-NE.

The applicant must also provide the locations of, and anticipated MF levels encompassing, residential areas, private or public schools, licensed child day care facilities, licensed youth camps, or public playgrounds within 300 feet of the proposed transmission line.

Vermont[24]

The State of Vermont[25] Department of Health has adopted the policy of prudent avoidance as initially outlined in the state's Twenty Year Electric Plan (1994) in order to mitigate EMF exposure. Taking no action, according to the department, would not be commensurate with the evidence that some risk may exist.

EMF:

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24 Position Paper On Electric And Magnetic Power Frequency Fields And The Velco Northwest Vermont Reliability Project. Vermont Department Of Health December 15, 2003

25 http://healthvermont.gov/enviro/rad/documents/VELCOtestimony.pdf

26 Electromagnetic fields and public health. World Health Organization (June 2007) http://www.who.int/peh-emf/publications/facts/fs322/en/

V. References

American Medical Association (AMA). 2003. "Effects of Electric and Magnetic Fields." http://www.ama-assn.org/ama/pub/category/13682.html

Australian Radiation Protection and Nuclear Safety Agency (ARPNSA). 2003. The Controversy Over Electromagnetic Fields and Possible Adverse Health Effects: Fact Sheet. http://www.arpansa.gov.au/is_emf.htm

Bennett, Jr., W., Health and Low Frequency Electromagnetic Fields, Yale University Press, 1994.

British National Radiation Protection Board (NRPB) (now Health Protection Agency or HPA). 2004a. Advice on Limiting Exposure to Electromagnetic Fields (0-300 GHz). Documents of the NRPB. 15(2)
http://www.hpa.org.uk/radiation/publications/documents_of_nrpb/abstracts/absd15-2.htm

British National Radiation Protection Board (NRPB) (now Health Protection Agency or HPA). 2004b. Review of the Scientific Evidence for Limiting Exposure to (0 to 300 GHz) Electromagnetic Fields. Documents of the NRPB. 15(3)
http://www.hpa.org.uk/radiation/publications/documents_of_nrpb/abstracts/absd15-3.htm

California Public Utilities Commission. Order Instituting Investigation on the Commission's Own Motion to Develop Policies and Procedures for Addressing the Potential Health Effects of Electric and Magnetic Fields of Utility Facilities. Decision No.
93-11-013, Investigation No. 91-01-012 (Filed January 15, 1991). November 2, 1993. San Francisco, CA.

California Public Utilities Commission. Order Instituting Rulemaking to update the Commission's policies and procedures related to electromagnetic fields emanating from regulated utility facilities. Decision 06-01-042 (Filed August 19, 2004). January 26, 2006. San Francisco, CA.
http://www.cpuc.ca.gov/PUBLISHED/FINAL_DECISION/53181.htm.

California Public Utilities Commission. EMF Design Guidelines for Electrical Facilities. July 21, 2006.
http://www.cpuc.ca.gov/static/energy/environment/electromagnetic+fields/
california+guidelines+for+electrical+facilities+072106+published.pdf

Commonwealth Associates, Inc. and IIT Research Institute, Electric and Magnetic Fields (EMF) RAPID Program Engineering Project 8: FINAL REPORT, Evaluation of Field Reduction Technologies, Volume 1 (Report) and Volume 2 (Appendices), 1997.

Connecticut Department of Public Health (DPH). 2004. EMF Health Concerns Fact Sheet.
http://www.dph.state.ct.us/Publications/brs/eoha/emf_2004.pdf

Health Council of the Netherlands: ELF Electromagnetic Fields Committee. Electromagnetic fields: Annual Update 2001, 2003, 2004, 2005. http://www.gr.nl/pdf.php?ID=1281&p=1

Institute of Electrical and Electronics Engineers (IEEE). 2002. "C95.6-2002 IEEE Standard for Safety Levels with Respect to Human Exposure to Electromagnetic Fields, 0-3 kHz", Prepared by Subcommittee 3, Safety Levels with Respect to Human Exposure ISBN 0-7381-3389-2, 2002.

Institute of Electrical and Electronics Engineers (IEEE). 2002. "C2-2002 National Electric Safety Code", American National Standards Institute, 2002.

International Committee on Electromagnetic Safety (ICES) / International Agency for Research on Cancer (IARC). 2002. Static and Extremely Low-Frequency Electric and Magnetic Fields: http://www-cie.iarc.fr/htdocs/monographs/vol80/80.html

International Commission on Non-Ionizing Radiation Protection (ICNIRP). 1998. "Guidelines for Limiting Exposure to Time-Varying Electric, Magnetic, and Electromagnetic Fields (Up to 300 GHz). http://www.icnirp.org/documents/emfgdl.pdf

Johnson, G.B., Power Research Engineering, Field Management Technologies, EMF Engineering Symposium, 1998.

Minnesota State Interagency Working Group on EMF Issues, A White Paper of Electric and Magnetic Field (EMF) Policy and Mitigation Options, 2002.

National Cancer Institute. Magnetic Field Exposures and Cancer: Questions and Answers. April 21, 2005. http://www.cancer.gov/cancertopics/factsheet/Risk/magnetic-fields

National Institute of Environmental Health Sciences. 2002. EMF Questions and Answers. EMF RAPID Program. http://www.niehs.nih.gov/emfrapid/booklet/home.htm

National Institute of Environmental Health Sciences, Report on Health Effects from Exposure to Power-Line Frequency Electric and Magnetic Fields, 1999.
http://www.niehs.nih.gov/emfrapid/html/EMF_DIR_RPT/NIEHS_Report.pdf

National Research Council. 1999. Research on Power Frequency Fields Completed Under the Energy Policy Act of 1992. http://www.nap.edu/catalog/9587.html

Public Service Commission of Wisconsin. 2001. EMF – Electric and Magnetic Fields Brochure. http://psc.wi.gov/consumerinfo/brochures/electric/6002b.pdf

United States Geological Survey (2007). http://geomag.usgs.gov/intro.php

World Health Organization (2007) Fact Sheet N322, Electromagnetic Fields and Public Health, Exposure to extremely low frequency fields.
http://www.who.int/mediacentre/factsheets/fs322/en/index.html