Dear Mr. Pellatt,

Re: FortisBC Inc. - Certificate of Public Convenience and Necessity (CPCN) for the Naramata Substation & Transmission Line Project No. 3698458
http://www.bcuc.com/ApplicationView.aspx?ApplicationId=150

1. Please accept my Evidence # 32 for reference into subject hearing process:

   Electromagnetic Fields & Cancers:
   Children at risk with residential and school exposure to EMFs.

   by Dr. Magda Havas, presented at Hydro One Workshop on EMFs, Markham Ontario, June 16, 2004

   Source: http://www.stop-emf.ca/hydroone/PresentationEMFHydro_files/frame.htm

   This presentation clearly shows that there are biological effects far below the present WHO/ICNIRP/Health Canada EMF exposure guidelines and/or recommendations!

2. I kindly ask your office staff to have all slides printed out and posted to the BCUC’s subject project link.

3. For intervenors with little knowledge about EMF I strongly recommend to have a brief look at Dr. Havas presentation, especially slide 12 by clicking in the left bar on “Exposure Guidelines vs Effects” which will directly lead to slide 12. This slide explains why FortisBC likes the still present WHO/ICNIRP EMF Exposure Standards and to comply to those. Would the guidelines be lower in the 2 - 10 milliGauss range, FortisBC would not be able/allowed to build new substations and transmission lines close to residential and public building areas! This must be addressed in the hearing’s issue

   4. Project compliance with the WHO and ICNIRP EMF standards,

Respectfully submitted,

Hans Karow, CORE
Electromagnetic Fields & Cancers: Children at risk with residential and school exposure to EMFs.

Presented at Hydro One Workshop on EMFs, Markham Ontario, June 16, 2004.

Magda Havas, B.Sc., Ph.D.
Trent University, Peterborough, Canada
mhavas@trentu.ca

Epidemiological Studies: threshold magnetic field?
Epidemiological Studies: dose-response?
Schuz et al. 2001: Childhood Leukemia
Electromagnetic Fields & Cancers: Children at risk with residential and school exposure to EMFs.

Dr. Magda Havas, Trent University, Peterborough, Canada, mhavas@trentu.ca

Presented at Hydro One Workshop on EMFs, Markham Ontario, June 16, 2004.

Abstract:
We now have more than 20 years of scientific research from around the world showing adverse health effects associated with exposure to electromagnetic fields from our use of electricity. Both children and adults are affected although children appear to be more sensitive. The epidemiological studies from Wertheimer and Leeper (1979) to the most recent meta-analysis dealing with childhood leukemia and residential exposure to electromagnetic fields are presented. There is a consistent 2- to 4-fold increased risk of children developing leukemia when they are exposed to magnetic fields exceeding 2 to 4 mG in their homes. The bedroom seems to be the most critical environment and children under the age of 6 are particularly vulnerable. Evidence of a dose/response relationship, commonly used in chemical toxicology, is evident. Studies of occupational exposure to electromagnetic fields report an increased incidence of adult leukemia, brain tumors, and breast cancer at levels at or above 2 mG, and an increased risk of miscarriages above 16 mG. These studies in combination with laboratory studies lend credence to the concept that extremely low frequency electromagnetic fields are harmful to human health at levels to which we are currently exposed in the home, at school, and in the workplace. Federally we need better standards to protect public health. Buffer zones around high voltage power lines are needed to minimize human exposure. Magnetic field at the edge of the right-of-way should not exceed 2 mG during peak power consumption. Also, mitigation should be in place to minimize ground currents.
Epidemiological Studies: \textit{threshold magnetic field?}

- **Wertheimer & Leeper 1979, USA**
  - wire codes
  - leukemia, lymphoma, brain tumors
  - leukemia \textbf{OR 3.0} (1.8-5.0, 95\% CI)
  - high CC, \textbf{\~2.5 mG}

- **Savitz et al. 1988, USA**
  - \textbf{2.2 mG}, leukemia \textbf{OR 2.8} (0.9-8.3, 95\% CI)

- **Feychting & Ahlbom 1993, Sweden**
  - \textbf{\geq 2 mG}, leukemia \textbf{OR 2.7} (1.0-6.3, 95\% CI)

- **Ahlbom et al. 2000, Meta-analysis**
  - \textbf{\geq 4 mG}, leukemia \textbf{OR 2} (1.27-3.13, 95\% CI)

**NOTE:** OR refers to the Odds Ratio and indicates the magnitude of risk; CI = 95\% confidence interval

Go Back to Stop-EMF.ca
Epidemiological Studies: dose-response?

- *Feychting & Ahlbom 1993, Sweden*, childhood leukemia
  - \( \geq 2 \) mG, **2.7-fold** increase [OR 2.7; 1.0-6.3 95% CI]
  - \( \geq 3 \) mG, **3.8-fold** increase [OR 3.8; 1.4-9.3 95% CI]

- *Gorham 1992, USA*, childhood leukemia
  - 1 mG: lowest cancer incidence
  - 2 mG: **3-fold** increase
  - 3 mG: **4-fold** increase

  - 4 mG: **5-fold** increase
Schuz et al. 2001: Childhood Leukemia in Germany
(514 cases and 1301 controls, former West Germany)

<table>
<thead>
<tr>
<th>Odds Ratio</th>
<th>&lt; 1 mG (95% CI)</th>
<th>1 - &lt;2 mG</th>
<th>2 - &lt;4 mG</th>
<th>&gt; 4 mG</th>
</tr>
</thead>
<tbody>
<tr>
<td>24-h Median Bedroom Acute Leukemia</td>
<td>1</td>
<td>1.15 (0.65-3.67)</td>
<td>1.16 (0.43-3.11)</td>
<td>5.81 (0.78-43.2)</td>
</tr>
<tr>
<td>Night-time (10pm - 6 am) Acute Leukemia</td>
<td>1</td>
<td>1.42 (0.9-2.23)</td>
<td>2.53 (0.86-7.46)</td>
<td>5.53 * (1.15-26.6)</td>
</tr>
<tr>
<td>Night-time ALL</td>
<td>1</td>
<td>1.48 (0.92-2.36)</td>
<td>2.49 (0.80-7.73)</td>
<td>6.19 * (1.29-29.7)</td>
</tr>
<tr>
<td>Night-time &lt; 4 years old</td>
<td>1</td>
<td>1.74 (0.95-3.19)</td>
<td>2.75 (0.60-12.7)</td>
<td>14.9 * (1.2-185)</td>
</tr>
</tbody>
</table>

Dose-response relationship

Odds Ratio (95% CI): 1.33 (0.90-1.97) 2.40 * (1.07-5.37) 4.28 * (1.25-14.7)
Childhood Leukemia: *age & risk?*

- **Feychting and Ahlbom 1993**: Sweden  
  - All Ages (0-15): $\geq 2 \text{ mG}$, OR 3.1*, 95% CI (1.1-8.6)  
  - Ages 5-9: $\geq 2 \text{ mG}$, OR 5.7*, 95% CI (1.0-26)

- **Green et al. 1999**: Canada (Toronto, York, Peel, Durham in Ontario)  
  - OR 4.5* of childhood leukemia (all ages, 0-14)  
  - <6 years old greater risk than 6-14 year olds.

- **Schuz et al. 2001**: Germany, night-time exposure  
  - all ages: $\geq 2 \text{ mG}$, OR 3.2*, (1.33-7.8)  
  - <4 years old greater risk: $\geq 2 \text{ mG}$, OR 4.5*, (1.2-16.7)

* = statistically significant ($P<0.05\%$)
## Occupational Exposure of Father & Childhood Cancers:
*Feychting et al. 2000 (Sweden)*

<table>
<thead>
<tr>
<th></th>
<th>Odds Ratio (95% CI)</th>
<th>Magnetic Flux Density (mG)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1.3-2.1</td>
<td>1.3-2.9</td>
</tr>
<tr>
<td>Total cancer</td>
<td>1.0 (0.8-1.3)</td>
<td>1.0 (0.8-1.2)</td>
</tr>
<tr>
<td>Leukemia</td>
<td>1.6 (1.0-2.5) *</td>
<td>1.4 (0.9-2.2)</td>
</tr>
<tr>
<td>CNS</td>
<td>0.8 (0.5-1.2)</td>
<td>0.8 (0.6-1.2)</td>
</tr>
<tr>
<td>Lymphoma</td>
<td>1.4 (0.6-3.3)</td>
<td>1.3 (0.6-3.1)</td>
</tr>
<tr>
<td>Kidney</td>
<td>1.1 (0.4-2.8)</td>
<td>1.1 (0.4-2.7)</td>
</tr>
<tr>
<td>Neuroblastoma</td>
<td>1.8 (0.6-5.3)</td>
<td>1.5 (0.5-4.6)</td>
</tr>
</tbody>
</table>
### Occupational Exposure of Mother & Childhood Cancers:

*Feychtig et al. 2000 (Sweden)*

<table>
<thead>
<tr>
<th>Disorder</th>
<th>Odds Ratio (95% CI)</th>
<th>Magnetic Flux Density (mG)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1.2-1.8</td>
<td>1.2-2.5</td>
</tr>
<tr>
<td>Total Cancer</td>
<td>0.9 (0.7-1.2)</td>
<td>0.9 (0.7-1.2)</td>
</tr>
<tr>
<td>Leukemia</td>
<td>1.1 (0.7-1.7)</td>
<td>1.2 (0.5-2.4)</td>
</tr>
<tr>
<td>CNS</td>
<td>0.8 (0.4-1.3)</td>
<td>0.8 (0.5-1.4)</td>
</tr>
<tr>
<td>Lymphoma</td>
<td>0.4 (0.1-1.3)</td>
<td>0.4 (0.1-1.2)</td>
</tr>
<tr>
<td>Kidney</td>
<td>1.7 (0.5-5.6)</td>
<td>1.7 (0.5-5.5)</td>
</tr>
<tr>
<td>Neuroblastoma</td>
<td>2.6 (0.5-12.8)</td>
<td>2.8 (0.6-13.3)</td>
</tr>
</tbody>
</table>
Electromagnetic Fields & Cancers: Children at risk with residential and school exposure to EMFs.

Presented at Hydro One Workshop on EMFs, Markham Ontario, June 16, 2004.

Dr. Magda Havas, Trent University, Peterborough, Canada, mhavas@trentu.ca

Presented at Hydro One Workshop on EMFs, Markham Ontario, June 16, 2004.

Electromagnetic Fields & Cancers: Children at risk with residential and school exposure to EMFs.

Meta-Analysis: (19 studies examined) statistical method designed to summarize and simplify a complex set of study results.

...many people believe there are no data to support an association between residential magnetic field exposure and childhood leukemia. To the contrary, the data strongly and relatively consistently support such an association, although the estimated magnitude of the risk is moderate.

If one chooses to use these summary estimates* for interpretation, given the widespread exposure to magnetic fields they suggest perhaps as much as a 15-25% increase in the childhood leukemia rate, which is a large and important public health impact.

*Wire code: RR 1.4 > OHCC, 28% exposure assessment
*Measurements: RR 1.1 per 1 mG


Epidemiological Studies: dose-response?

Schuz et al. 2001: Childhood Leukemia

Go Back to Stop-EMF.ca
Time Allocation: School Age Children

- **bedroom**: (9 h, 38%)
- **home**: (16 hours, 67% of day)
- **Other rooms**: (7 h, 29%)
- **school**: (6 h, 25%)
- **other**: (2 h, 8%)

Epidemiological Studies: threshold magnetic field?

Epidemiological Studies: dose-response?

Schuz et al. 2001: Childhood Leukemia
“Cancer Clusters” in Schools & EMFs

- New York City, NY ('90-92)
  - 3 cases leukemia, 10 mG, moved kindergarten

- Mesa, Arizona ('92)
  - brain cancer, 50 mG, lighting, rewired

- California ('90 to '92)
  - Santa Barbara, 6 cases lymphomas & leukemias, 5X, TL + substation
  - San Francisco, 22 cancers (staff), PL + transformer
  - Fresno, cancer cluster (teachers), HVTL
Electromagnetic Fields & Cancers: Children at risk with residential and school exposure to EMFs.

Presented at Hydro One Workshop on EMFs, Markham Ontario, June 16, 2004.

Dr. Magda Havas, Trent University, Peterborough, Canada, mhavas@trentu.ca

Presented at Hydro One Workshop on EMFs, Markham Ontario, June 16, 2004.

Epidemiological Studies: threshold magnetic field?

Epidemiological Studies: dose-response?

Schuz et al. 2001: Childhood Leukemia

Epidemiological Studies: dose-response?

Epidemiological Studies: threshold magnetic field?

Exposure Guidelines vs Effects

Extremely Low Frequency Magnetic Fields

Magnetic Flux Density (mG)

Exposure Limits

Effects

0 5 10 20 30 1000 16,000

0 5 10 20 30 1000 16,000

0 5 10 20 30 1000 16,000

Exposure Limits

Effects

0 5 10 20 30 1000 16,000

0 5 10 20 30 1000 16,000

0 5 10 20 30 1000 16,000

Exposure Limits

Effects

0 5 10 20 30 1000 16,000

0 5 10 20 30 1000 16,000

0 5 10 20 30 1000 16,000

Exposure Limits

Effects

0 5 10 20 30 1000 16,000

0 5 10 20 30 1000 16,000

0 5 10 20 30 1000 16,000

Exposure Limits

Effects

0 5 10 20 30 1000 16,000

0 5 10 20 30 1000 16,000

0 5 10 20 30 1000 16,000

Exposure Limits

Effects

0 5 10 20 30 1000 16,000

0 5 10 20 30 1000 16,000

0 5 10 20 30 1000 16,000

Exposure Limits

Effects

0 5 10 20 30 1000 16,000

0 5 10 20 30 1000 16,000

0 5 10 20 30 1000 16,000

Exposure Limits

Effects

0 5 10 20 30 1000 16,000

0 5 10 20 30 1000 16,000

0 5 10 20 30 1000 16,000

Exposure Limits

Effects

0 5 10 20 30 1000 16,000

0 5 10 20 30 1000 16,000

0 5 10 20 30 1000 16,000

Exposure Limits

Effects

0 5 10 20 30 1000 16,000

0 5 10 20 30 1000 16,000

0 5 10 20 30 1000 16,000

Exposure Limits

Effects

0 5 10 20 30 1000 16,000

0 5 10 20 30 1000 16,000

0 5 10 20 30 1000 16,000

Exposure Limits

Effects

0 5 10 20 30 1000 16,000

0 5 10 20 30 1000 16,000

0 5 10 20 30 1000 16,000

Exposure Limits

Effects

0 5 10 20 30 1000 16,000

0 5 10 20 30 1000 16,000

0 5 10 20 30 1000 16,000

Exposure Limits

Effects

0 5 10 20 30 1000 16,000

0 5 10 20 30 1000 16,000

0 5 10 20 30 1000 16,000

Exposure Limits

Effects

0 5 10 20 30 1000 16,000

0 5 10 20 30 1000 16,000

0 5 10 20 30 1000 16,000

Exposure Limits

Effects

0 5 10 20 30 1000 16,000

0 5 10 20 30 1000 16,000

0 5 10 20 30 1000 16,000

Exposure Limits

Effects

0 5 10 20 30 1000 16,000

0 5 10 20 30 1000 16,000

0 5 10 20 30 1000 16,000

Exposure Limits

Effects

0 5 10 20 30 1000 16,000

0 5 10 20 30 1000 16,000

0 5 10 20 30 1000 16,000

Exposure Limits

Effects
EMF Policy/Guidelines

- Swedish National Energy Administration, Department of Electrical Safety
  - magnetic fields in schools, daycare centres and playgrounds
  - should not exceed 2-3 mG

- National Institute of Environmental Health Sciences (NIEHS) 1998
  - classified EMF (power frequency) as "possible carcinogen"
  - advocate “Prudent Avoidance”

- International Radiation Protection Association (IRPA): power frequency
  - should not exceed 1000 mG for 24-hour period.
Recent Decision in California
PG&E 230 kV transmission line

1. California PUC Administrative Law Judge ruled favorably on a new 230 kV transmission line.
2. She has not only required PG&E to underground the line but
   - To bury it up to 12 feet (6 extra) to reduce EMFs
   - To use a field-canceling triangular duct arrangement
   - To spend more than the required 4% of the budget ($12 B) to do so.
3. She has opened a new state-wide Order Instituting Investigation (OII) to evaluate the last decade of EMF studies.
Conclusions:

**Childhood Cancer & Power Frequency Magnetic Field Exposure**

1. Magnetic fields (extremely low frequency): “possible carcinogen” (NIEHS, 1998)
2. 2-4 mG threshold level associated with childhood leukemia (home)
3. Other cancers (nervous system tumors & lymphomas) possible
4. Younger children at greater risk than older children
5. Night-time exposure important
6. Parental exposure to electromagnetic fields may be important
7. School environment contributes to daily exposure
8. Guidelines inadequate to protect public health: range is 2-3 mG (Sweden) to 1,000 mG (IRPA)
9. Prudent avoidance: establish buffer zone around high voltage power lines that does not exceed 2 mG during peak energy use.
10. Minimize ground currents associated with power delivery.