

COMMONWEALTH OF KENTUCKY
BEFORE THE PUBLIC SERVICE COMMISSION

In the Matter of:

HAROLD BARKER, ANN BARKER AND BROOKS)	
BARKER V. EAST KENTUCKY POWER)	CASE NO. 2013-00291
COOPERATIVE, INC.)	

NOTICE OF FILING

Notice is given to all parties that the following materials have been filed into the record of this proceeding:

- The digital video recordings of the evidentiary hearing conducted July 1 and July 8, 2014 in this proceeding;
- Certifications of the accuracy and correctness of the digital video recordings;
- All exhibits introduced at the evidentiary hearing conducted July 1 and July 8, 2014 in this proceeding;
- The written logs listing, *inter alia*, the date and time of where each witness' testimony begins and ends on the digital video recordings of the evidentiary hearing conducted July 1 and July 8, 2014.

A copy of this Notice, the certifications of the digital video records, exhibit lists, and hearing logs have been served upon all persons listed at the end of this Notice. Parties desiring electronic copies of the digital video recordings of the hearing in Windows Media format may download copies at:

http://psc.ky.gov/av_broadcast/2013-00291/2013-00291_01Jul14_Inter.aspx

http://psc.ky.gov/av_broadcast/2013-00291/2013-00291_08Jul14_Inter.aspx

Parties wishing annotated digital video recordings may submit a written request by electronic mail to pscfilings@ky.gov. A minimal fee will be assessed for copies of these recordings.

The exhibits introduced at the evidentiary hearing may be downloaded at <http://psc.ky.gov/Home/Library?type=Cases&folder=2013%20Cases/2013-00291>.

Done at Frankfort, Kentucky, this 16th day of July, 2014.

A handwritten signature in cursive script, reading "Linda Faulkner", written in black ink. The signature is positioned above a horizontal line.

Linda Faulkner
Director, Filings Division
Public Service Commission of Kentucky

Harold, Ann & Brooks Barker
5450 Mt. Sterling Road
Winchester, KENTUCKY 40391

Anthony S Campbell
President & CEO
East Kentucky Power Cooperative, Inc.
4775 Lexington Road
P. O. Box 707
Winchester, KY 40392-0707

Honorable M. Alex Rowady
Attorney at Law
Blair & Rowady P.S.C.
212 South Maple Street
Winchester, KENTUCKY 40391

David S Samford
Goss Samford, PLLC
2365 Harrodsburg Road, Suite B325
Lexington, KENTUCKY 40504

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In the Matter of:

HAROLD BARKER, ANN BARKER AND BROOKS)	
BARKER V. EAST KENTUCKY POWER)	CASE NO. 2013-00291
COOPERATIVE, INC.)	

CERTIFICATE

I, Sonya Harward, hereby certify that:

1. The attached DVD contains a digital recording of the Hearing conducted in the above-styled proceeding on July 1, 2014. Hearing Log, Exhibits, Exhibit List, and Witness List are included with the recording on July 1, 2014. The hearing was recorded on two days, July 1, 2014 and July 8, 2014, separately.

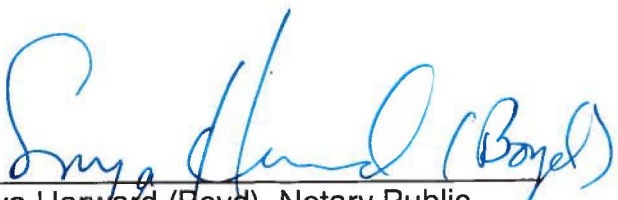
2. I am responsible for the preparation of the digital recording.

3. The digital recording accurately and correctly depicts the Hearing of July 1, 2014.

4. The "Exhibit List" attached to this Certificate correctly lists all Exhibits introduced at the Hearing of July 1, 2014.

5. The "Hearing Log" attached to this Certificate accurately and correctly states the events that occurred at the Hearing of July 1, 2014 and the time at which each occurred.

Given this 10th day of July, 2014.



Sonya Harward (Boyd), Notary Public
State at Large
My commission expires: August 27, 2017



Session Report - Detail

2013-00291_01July2014

Barkers vs. East Kentucky Power Cooperative

Date:	Type:	Location:	Department:
7/1/2014	Other	Public Service Commission	Hearing Room 1 (HR 1)

Judge: David Armstrong; Linda Breathitt; Jim Gardner

Witness: Ann Barker - Complainant; Brooks Barker - Complainant; Kenneth Foster - for EKPC; John Pfeiffer - for Complainant

Clerk: Sonya Harward

Event Time	Log Event
10:02:45 AM	Session Started
10:02:47 AM	Chairman Armstrong introduces Commissioners
10:03:09 AM	Atty. Alex Rowady for Barkers, Complainants
10:03:15 AM	Atty. David Samford for EKPC
	Note: Harward, Sonya Also in attendance for EKPC are Atty. Allyson Honaker and Atty. Sherman Goodpaster.
10:03:27 AM	Atty. Jonathan Beyer for PSC Staff
10:03:36 AM	Public notice not required.
10:03:49 AM	No outstanding motions.
10:04:06 AM	Floor Opened for Public Comments
10:04:42 AM	Harold Barker
	Note: Harward, Sonya Public Comments
10:09:33 AM	Melinda Brewer
	Note: Harward, Sonya Public Comments. Read a letter on behalf of her father.
10:13:32 AM	Public - Exhibit 1
	Note: Harward, Sonya Letter from Jerry Jessie read by daughter, Melinda Brewer, during Public Comments.
10:14:50 AM	Chairman Armstrong comments about additional Public Comments
10:15:09 AM	Witness Brooks Barker takes the stand and is sworn in.
	Note: Harward, Sonya Complainant
10:16:09 AM	Atty. Rowady direct exam of Witness B. Barker
	Note: Harward, Sonya Noted a change to his testimony.
10:17:35 AM	Barker - Exhibit 1
	Note: Harward, Sonya Corrections made to Brooks Barker's filed testimony. Times corrected on audio tape of meeting between Paul Dolloff of EKPC and the Barkers.
10:18:45 AM	Atty. Rowady to Witness B. Barker
	Note: Harward, Sonya Asks Witness to explain the exhibit handed out concerning the corrections to his testimony.
10:20:42 AM	Atty. Samford cross exam. of Witness B. Barker
	Note: Harward, Sonya Asking about the nature of the relief Complainants are asking for in this case.
10:26:26 AM	Atty. Samford to Witness B. Barker
	Note: Harward, Sonya Asking about any prior offers of settlement Witness may know of in this case.
10:27:17 AM	EKPC - Exhibit 1
	Note: Harward, Sonya Offer of Settlement of East Kentucky Power Cooperative, Inc., filed in this case on July 29, 2013.
10:30:43 AM	EKPC - Exhibit 2
	Note: Harward, Sonya Response to East Kentucky Power Cooperative, Inc.'s Offer of Settlement, filed in this case on Sept. 16, 2013.

10:31:32 AM	Atty. Samford to Witness B. Barker Note: Harward, Sonya	Asking about settlement negotiations.
10:33:16 AM	Atty. Rowady Objection Note: Harward, Sonya	Asked that his objection be noted about the line of questioning concerning settlement negotiations.
10:36:51 AM	Atty. Samford to Witness B. Barker Note: Harward, Sonya	Asking about unwillingness of Complainants to make a counter offer or proposal.
10:38:35 AM	EKPC - Exhibit 3 Note: Harward, Sonya	Direct Testimony of Complainants' Witnesses, filed in this case on April 25, 2014.
10:41:37 AM	Atty. Samford to Witness B. Barker Note: Harward, Sonya	Asking when residence was constructed.
10:43:50 AM	Atty. Samford to Witness B. Barker Note: Harward, Sonya	Continuing to reference photo on page 5 of 139 in EKPC-Exhibit 3 to this Hearing.
10:44:52 AM	EKPC - Exhibit 4 Note: Harward, Sonya	Response of Complainants to Data Requests Served by Defendant, filed in this case on May 12, 2014.
10:47:15 AM	Atty. Samford to Witness B. Barker Note: Harward, Sonya	Referencing email attached to EKPC - Exhibit 4 to this Hearing.
10:48:21 AM	EKPC - Exhibit 5 Note: Harward, Sonya	Direct Testimony of Mary Jane Warner, P.E. on Behalf of East Kentucky Power Cooperative, Inc., Exhibit MJW-4, filed in this case on June 2, 2014.
10:55:31 AM	Atty. Samford to Witness B. Barker Note: Harward, Sonya	Asking if Witness has taken any magnetic readings on the line.
10:56:01 AM	Atty. Beyer cross exam. of Witness B. Barker Note: Harward, Sonya	Asking about primary concern regarding upgraded line.
11:00:22 AM	Atty. Beyer to Witness B. Barker Note: Harward, Sonya	Asking about concerns with the existing line before the upgrade.
11:01:53 AM	Commission Staff - Exhibit 1 Note: Harward, Sonya	Transmission Line Right of Way Easement
11:03:44 AM	Atty. Rowady Objection Note: Harward, Sonya	The question calls for a legal conclusion.
11:05:56 AM	Atty. Beyer to Witness B. Barker Note: Harward, Sonya	Asking who should pay the cost of moving the line 250 feet from current location.
11:12:12 AM	Atty. Beyer to Witness B. Barker Note: Harward, Sonya	Referencing EKPC - Exhibit 5 of this Hearing regarding document's current status in the Circuit Court.
11:16:20 AM	Atty. Beyer to Witness B. Barker Note: Harward, Sonya	Asking if Witness thinks the Commission should take into account the EMF levels when a CPCN is requested.
11:19:59 AM	Vice Chairman Gardner cross exam. of Witness B. Barker Note: Harward, Sonya	Asking Witness what proper procedures he believes were not followed.
11:25:08 AM	Vice Chairman Gardner to Witness B. Barker Note: Harward, Sonya	Referencing EKPC - Exhibit 3 to this Hearing, photo on page 5 of 139.
11:27:16 AM	Vice Chairman Gardner to Witness B. Barker Note: Harward, Sonya	Discussing a Staff Opinion that was given regarding the need for a CPCN.
11:28:32 AM	Commissioner Breathitt cross exam. of Witness B. Barker Note: Harward, Sonya	Asking about 250 feet Witness referenced.

11:34:47 AM	Atty. Rowady re-direct exam. of Witness B. Barker	
	Note: Harward, Sonya	Asking about conversations with adjoining land owners.
11:35:39 AM	Atty. Rowady to Witness B. Barker	
	Note: Harward, Sonya	Referencing EKPC - Exhibit 3 of this Hearing, photo on page 5 of 139.
11:37:52 AM	Barker - Exhibit 2	
	Note: Harward, Sonya	Photograph
11:37:53 AM	Barker - Exhibit 3	
	Note: Harward, Sonya	Photograph
11:40:21 AM	Barker - Exhibit 4	
	Note: Harward, Sonya	Photograph
11:43:05 AM	Atty. Rowady to Witness B. Barker	
	Note: Harward, Sonya	Asking if Barker's own enough land to move the line 250 feet and it still remain on their property.
11:45:22 AM	Atty. Rowady to Witness B. Barker	
	Note: Harward, Sonya	Referencing EKPC - Exhibit 4 to this Hearing, regarding attached email.
11:48:03 AM	Atty. Rowady to Witness B. Barker	
	Note: Harward, Sonya	Asking about time period of when Witness began feeling the shock from the line.
11:51:13 AM	Atty. Samford recross exam. of Witness B. Barker	
	Note: Harward, Sonya	Asking about Witness's belief that EKPC is delaying court proceeding in Clark County.
11:53:54 AM	Atty. Samford to Witness B. Barker	
	Note: Harward, Sonya	Referencing Barker - Exhibit 4 to this Hearing.
11:58:57 AM	Atty. Beyer recross exam. to Witness B. Barker	
	Note: Harward, Sonya	Asking what the purpose was for the Clark County court proceedings that were postponed.
11:59:49 AM	Atty. Beyer to Witness B. Barker	
	Note: Harward, Sonya	Asking if there are shocks inside the home from the line.
12:03:52 PM	Witness B. Barker dismissed from the stand.	
12:04:37 PM	Break for lunch.	
12:04:42 PM	Session Paused	
1:11:14 PM	Session Resumed	
1:11:17 PM	Witness John Pfeiffer takes the stand and is sworn in.	
	Note: Harward, Sonya	For the Complainant, Electrical Engineer and owner of Pfeiffer Engineering Co., Inc.
1:12:28 PM	Atty. Rowady direct exam. of Witness Pfeiffer	
	Note: Harward, Sonya	Qualifies the Witness.
	Note: Harward, Sonya	Witness accepts his testimony in this case with a change. Additional information has been obtained.
1:15:59 PM	Atty. Rowady to Witness Pfeiffer	
	Note: Harward, Sonya	Asks Witness to detail the additional information he has obtained to supplement his testimony.
1:18:50 PM	Vice Chairman Gardner interjects a question.	
	Note: Harward, Sonya	Asking when Witness filed his pre-filed testimony.
1:20:20 PM	Atty. Samford cross exam. of Witness Pfeiffer	
	Note: Harward, Sonya	Referencing EKPC - Exhibit 3 to this Hearing. Beginning on page 4 of 139.
1:22:49 PM	EKPC - Exhibit 6	
	Note: Harward, Sonya	NFPA 921, Guide for Fire and Explosion Investigations, 2004 Edition
1:26:41 PM	Atty. Samford to Witness Pfeiffer	
	Note: Harward, Sonya	Referencing EKPC - Exhibit 3 to this Hearing, page 5 of 139.

1:27:56 PM	Atty. Samford to Witness Pfeiffer Note: Harward, Sonya	Referencing EKPC - Exhibit 3 to this Hearing, page 7 of 139. Also quotes from section F.
1:32:07 PM	Atty. Samford to Witness Pfeiffer Note: Harward, Sonya	Referencing EKPC - Exhibit 3 to this Hearing, list starting on page 114 of 139.
1:33:25 PM	Atty. Samford to Witness Pfeiffer Note: Harward, Sonya	Referencing EKPC - Exhibit 3 to this Hearing, page 106 of 139.
1:34:04 PM	Atty. Samford to Witness Pfeiffer Note: Harward, Sonya	Asking if the Witness knows Gabor Mezei, the author of several reports listed, and who is also a Witness at this Hearing.
1:38:09 PM	Atty. Samford to Witness Pfeiffer Note: Harward, Sonya	Asking if Witness has ever conducted a study.
1:39:40 PM	Atty. Samford to Witness Pfeiffer Note: Harward, Sonya	Referencing EKPC - Exhibit 3 to this Hearing, page 8 of 139.
1:43:15 PM	Vice Chairman Gardner Disclosure Remarks	
1:44:11 PM	Atty. Samford to Witness Pfeiffer Note: Harward, Sonya	Referencing EKPC - Exhibit 3 to this Hearing, pages 12-13 of 139.
1:45:06 PM	Atty. Samford to Witness Pfeiffer Note: Harward, Sonya	Continuing to ask about decisions concerning health issues based on 'perception.'
1:48:16 PM	Atty. Samford to Witness Pfeiffer Note: Harward, Sonya	Referencing EKPC - Exhibit 3 to this Hearing, page 14 of 139.
1:50:34 PM	EKPC - Exhibit 7 Note: Harward, Sonya	Direct Testimony of Paul A. Dolloff, Ph.D. on Behalf of East Kentucky Power Cooperative, Inc., Exhibit PAD-4, filed June 2, 2014.
1:54:36 PM	Atty. Samford to Witness Pfeiffer Note: Harward, Sonya	Referencing EKPC - Exhibit 3 to this Hearing, page 14 of 139, regarding a quote on the page and the footnote.
1:54:59 PM	EKPC - Exhibit 8 Note: Harward, Sonya	Cap X2020, Electric and Magnetic Fields (EMP): the Basics
1:57:07 PM	Atty. Samford to Witness Pfeiffer Note: Harward, Sonya	Referencing EKPC - Exhibit 3 to this Hearing, page 14 of 139, paragraph G, regarding EKPC knowingly misleading Barker's with respect to known health risks.
1:59:47 PM	Atty. Samford to Witness Pfeiffer Note: Harward, Sonya	Referencing EKPC - Exhibit 3 to this Hearing, page 20 of 139.
2:05:04 PM	Atty. Samford to Witness Pfeiffer Note: Harward, Sonya	Referencing EKPC - Exhibit 3 to this Hearing, page 38 of 139, and asking for Witness's correction to this part of the report.
2:10:17 PM	Atty. Samford to Witness Pfeiffer Note: Harward, Sonya	Referencing EKPC - Exhibit 3 to this Hearing, page 45 of 139.
2:13:10 PM	Atty. Samford to Witness Pfeiffer Note: Harward, Sonya	Referencing EKPC - Exhibit 3 to this Hearing, page 60 of 139, asking about dangers to those with cardiac pacemakers.
2:15:37 PM	Atty. Samford to Witness Pfeiffer Note: Harward, Sonya	Referencing EKPC - Exhibit 3 to this Hearing, pages 61-62 of 139, still regarding pacemakers.
2:19:56 PM	Atty. Samford to Witness Pfeiffer Note: Harward, Sonya	Referencing EKPC - Exhibit 3 to this Hearing, pages 64-65 of 139.
2:21:50 PM	Atty. Samford to Witness Pfeiffer Note: Harward, Sonya	Referencing EKPC - Exhibit 3 to this Hearing, page 72 of 139, figure 23, asking where he was standing when he took the measurements.
2:24:46 PM	Atty. Samford to Witness Pfeiffer Note: Harward, Sonya	Referencing EKPC - Exhibit 3 to this Hearing, page 87 of 139.

2:29:23 PM	Atty. Samford to Witness Pfeiffer Note: Harward, Sonya	Referencing EKPC - Exhibit 3 to this Hearing, page 96 of 139, regarding phase rotation.
2:31:02 PM	Atty. Samford to Witness Pfeiffer Note: Harward, Sonya	Referencing EKPC - Exhibit 3 to this Hearing, pages 100-101 of 139, regarding angles on the maps.
2:33:26 PM	EKPC - Exhibit 9 Note: Harward, Sonya	PSC Order, dated June 3, 2014, in this case.
2:35:53 PM	Atty. Beyer cross exam. of Witness Pfeiffer Note: Harward, Sonya	Asking when Witness was first contacted by Barkers.
2:36:53 PM	Atty. Beyer to Witness Pfeiffer Note: Harward, Sonya	Asking questions about Witness's report and the cost of moving the line.
2:41:27 PM	Atty. Beyer to Witness Pfeiffer Note: Harward, Sonya	Asking what cost would be to move line now.
2:41:57 PM	Atty. Beyer to Witness Pfeiffer Note: Harward, Sonya	Asking about Witness's background with EMF.
2:43:34 PM	Atty. Beyer to Witness Pfeiffer Note: Harward, Sonya	Asking if line at the Barker's home is an upgrade, replacement , or new line.
2:45:53 PM	Atty. Beyer to Witness Pfeiffer Note: Harward, Sonya	Asking if Witness has experienced the shocks at the Barker residence.
2:46:58 PM	Vice Chairman Gardner interjected a question to Witness Pfeiffer Note: Harward, Sonya	Asking how the shock felt to the skin.
2:49:17 PM	Atty. Beyer to Witness Pfeiffer Note: Harward, Sonya	Asking if Commission should consider EMF levels when approving CPCNs.
2:50:44 PM	Vice Chairman Gardner cross exam. of Witness Pfeiffer Note: Harward, Sonya Note: Harward, Sonya Note: Harward, Sonya Note: Harward, Sonya	Asking about Witness's view of various terms from the statute. "Upgrade" "ordinary extension of existing system in the usual course of business." "Replacement"
2:55:14 PM	Atty. Rowady re-direct exam. of Witness Pfeiffer Note: Harward, Sonya	Asking when Witness was first on the premises.
2:59:11 PM	Barker - Exhibit 5 Note: Harward, Sonya	Four pages of calculations.
3:00:25 PM	Atty. Rowady to Witness Pfeiffer Note: Harward, Sonya	Asking Witness to describe Barker - Exhibit 5 to this Hearing.
3:05:03 PM	Atty. Rowady to Witness Pfeiffer Note: Harward, Sonya	Asking Witness about involvement with EMFs.
3:09:56 PM	Witness Pfeiffer excused from the stand.	
3:10:09 PM	Break	
3:10:22 PM	Session Paused	
3:22:59 PM	Session Resumed	
3:23:02 PM	Chairman Armstrong's Remarks Note: Harward, Sonya	Conclude the Hearing today at 5pm and resume and finish on July 8, 2014.
3:23:31 PM	Atty. Rowady Comments	
3:23:49 PM	Camera Lock Deactivated	
3:24:09 PM	Witness Ann Barker takes the stand and is sworn in. Note: Harward, Sonya	Complainant

3:25:00 PM	Atty. Rowady direct exam. of Witness A. Barker Note: Harward, Sonya	Accepts testimony as filed.
3:26:07 PM	Atty. Samford cross exam. of Witness A. Barker Note: Harward, Sonya	Asking when residence, garage, and carport were constructed.
3:27:20 PM	Atty. Beyer cross exam. of Witness A. Barker Note: Harward, Sonya	Asking what she is requesting of the Commission.
3:28:37 PM	Atty. Beyer to Witness A. Barker Note: Harward, Sonya	Asking for status of proceeding in Clark County court.
3:29:00 PM	Atty. Beyer to Witness A. Barker Note: Harward, Sonya	Referencing EKPC - Exhibit 5 to this Hearing.
3:31:25 PM	Atty. Beyer to Witness A. Barker Note: Harward, Sonya	Asking if Witness was aware of the original 69 kV line when the house was built.
3:32:55 PM	Atty. Beyer to Witness A. Barker Note: Harward, Sonya	Asking how much land Witness owns to the west of the line.
3:34:06 PM	Atty. Beyer to Witness A. Barker Note: Harward, Sonya	Asking Witness to describe the shocks outside the home.
3:35:43 PM	Atty. Rowady re-direct exam. of Witness A. Barker	
3:36:30 PM	Barker - Exhibit 6 Note: Harward, Sonya	Ariel photograph
3:40:31 PM	Atty. Samford Objection Note: Harward, Sonya	Objects to Barker - Exhibit 6, does not represent where transmission lines are.
3:42:35 PM	Atty. Rowady's Response to Objection Note: Harward, Sonya	Changed purpose of Barker - Exhibit 6.
3:43:35 PM	Atty. Rowady to Witness A. Barker Note: Harward, Sonya	Asking about EKPC - Exhibit 5 to this Hearing.
3:48:25 PM	Atty. Rowady to Witness A. Barker Note: Harward, Sonya	Asking when Witness realized that the lines were energized.
3:49:55 PM	Atty. Rowady to Witness A. Barker Note: Harward, Sonya	Asking Witness how many times she raised her concerns about her health with EKPC.
3:51:12 PM	Commissioner Breathitt cross exam. of Witness A. Barker Note: Harward, Sonya	Asking when Witness learned that the line was going from a 69 kV line to a 345 kV line.
	Note: Harward, Sonya	Asking Witness when she came to know that the 138 kV line would be used only as a 69 kV line.
3:53:42 PM	Vice Chairman Gardner cross exam. of Witness A. Barker Note: Harward, Sonya	Asking if new line was built in same place as the old lines.
3:56:22 PM	Vice Chairman Gardner to Witness A. Barker Note: Harward, Sonya	Asking about Barker - Exhibit 6 to this Hearing regarding and a particular home on the map.
3:59:01 PM	Atty. Samford re-cross exam. of Witness A. Barker Note: Harward, Sonya	Asking about a barn on the map that used to be a house.
4:01:14 PM	Witness A. Barker dismissed from the stand.	
4:01:37 PM	Witness Kenneth Foster takes the stand and is sworn in. Note: Harward, Sonya	Professor of Bio Engineering at University of Pennsylvania
4:03:41 PM	Atty. Samford direct exam. of Witness Foster Note: Harward, Sonya	Accepts testimony as filed.
4:04:08 PM	Atty. Rowady cross exam. Witness Foster Note: Harward, Sonya	Asking if Witness has viewed the lines near the Barker's home.
4:07:13 PM	Atty. Rowady to Witness Foster Note: Harward, Sonya	Asking if Witness would say that there was no evidence that correlates human illness to EMF.

4:11:02 PM	Atty. Rowady to Witness Foster Note: Harward, Sonya	Asking if Witness has testified in forums like this Hearing.
4:13:42 PM	Atty. Rowady to Witness Foster Note: Harward, Sonya	Asking if Witness believes in a cost benefit to eliminating a prospective risk at a low cost.
4:17:45 PM	Vice Chairman Gardner cross exam. of Witness Foster Note: Harward, Sonya	Asking about language in statute.
4:18:43 PM	Commissioner Breathitt cross exam. of Witness Foster Note: Harward, Sonya	Referencing page 2 of Witness's pre-filed testimony, his resume, bottom of page, line 22.
4:22:11 PM	Atty. Rowady re-cross exam. of Witness Foster Note: Harward, Sonya	Asking how he became a Professional Engineer.
4:23:30 PM	Atty. Rowady to Witness Foster Note: Harward, Sonya	Asking Witness if the Barker's should have a warning posted for customers that come to their property.
4:24:39 PM	Atty. Samford re-direct exam. of Witness Foster Note: Harward, Sonya	Referencing EKPC - Exhibit 7 to this Hearing.
4:26:21 PM	Atty. Rowady re-cross exam. of Witness Foster Note: Harward, Sonya	Follow-up question about his involvement with the standards established in EKPC - Exhibit 7 to this Hearing.
4:26:58 PM	Witness Foster dismissed from the stand.	
4:27:20 PM	Discussion on when to continue Hearing.	
4:27:55 PM	Hearing Adjourn until Tuesday, July 8, at 9am	
4:27:59 PM	Session Paused	
4:31:51 PM	Session Ended	



Exhibit List Report

2013-00291_01July2014

Barkers vs. East Kentucky Power Cooperative

Judge: David Armstrong; Linda Breathitt; Jim Gardner

Witness: Ann Barker - Complainant; Brooks Barker - Complainant; Kenneth Foster - for EKPC; John Pfeiffer - for Complainant

Clerk: Sonya Harward

Name:	Description:
Barker - Exhibit 1	Corrections made to Brooks Barker's filed testimony. Times corrected on audio tape of meeting between Paul Dolloff of EKPC and the Barkers.
Barker - Exhibit 2	Photograph
Barker - Exhibit 3	Photograph
Barker - Exhibit 4	Photograph
Barker - Exhibit 5	Four pages of calculations.
Barker - Exhibit 6	Ariel photograph
Commission Staff - Exhibit 1	Transmission Line Right of Way Easement
EKPC - Exhibit 1	Offer of Settlement of East Kentucky Power Cooperative, Inc., filed in this case on July 29, 2013.
EKPC - Exhibit 2	Response to East Kentucky Power Cooperative, Inc.'s Offer of Settlement, filed in this case on Sept. 16, 2013.
EKPC - Exhibit 3	Direct Testimony of Complainants' Witnesses, filed in this case on April 25, 2014.
EKPC - Exhibit 4	Response of Complainants to Data Requests Served by Defendant, filed in this case on May 12, 2014.
EKPC - Exhibit 5	Direct Testimony of Mary Jane Warner, P.E. on Behalf of East Kentucky Power Cooperative, Inc., Exhibit MJW-4, filed in this case on June 2, 2014.
EKPC - Exhibit 6	NFPA 921, Guide for Fire and Explosion Investigations, 2004 Edition
EKPC - Exhibit 7	Direct Testimony of Paul A. Dolloff, Ph.D. on Behalf of East Kentucky Power Cooperative, Inc., Exhibit PAD-4, filed June 2, 2014.
EKPC - Exhibit 8	Cap X2020, Electric and Magnetic Fields (EMP): the Basics
EKPC - Exhibit 9	PSC Order, dated June 3, 2014, in this case.
Public - Exhibit 1	Letter from Jerry Jessie read by daughter, Melinda Brewer, during Public Comments.

COMMONWEALTH OF KENTUCKY
BEFORE THE PUBLIC SERVICE COMMISSION

In the Matter of:

HAROLD BARKER, ANN BARKER AND BROOKS)
BARKER V. EAST KENTUCKY POWER) CASE NO. 2013-00291
COOPERATIVE, INC.)

CERTIFICATE

I, Sonya Harward, hereby certify that:

1. The attached DVD contains a digital recording of the Hearing conducted in the above-styled proceeding on July 8, 2014. Hearing Log, Exhibits, Exhibit List, and Witness List are included with the recording on July 8, 2014. The hearing was recorded on two days, July 1, 2014 and July 8, 2014, separately.


2. I am responsible for the preparation of the digital recording.

3. The digital recording accurately and correctly depicts the Hearing of July 8, 2014.

4. The "Exhibit List" attached to this Certificate correctly lists all Exhibits introduced at the Hearing of July 8, 2014.

5. The "Hearing Log" attached to this Certificate accurately and correctly states the events that occurred at the Hearing of July 8, 2014 and the time at which each occurred.

Given this 10th day of July, 2014.



Sonya Harward (Boyd), Notary Public
State at Large

My commission expires: August 27, 2017



Session Report - Detail

2013-00291_08-Jul-2014

Barkers vs. East Kentuck Power Cooperative, Inc.

Date:	Type:	Location:	Department:
7/8/2014	Other	Public Service Commission	Hearing Room 1 (HR 1)

Judge: David Armstrong; Linda Breathitt; Jim Gardner

Witness: David Carpenter, M.D. - for Barkers; Benjamin Cotts, Ph.D. - for EKPC; Paul Dolloff, Ph. D., EKPC; Gabor Mezei, M.D., Ph.D. - for EKPC; Mary Jane Warner - EKPC

Clerk: Sonya Harward

Event Time	Log Event
8:57:47 AM	Session Started
8:57:49 AM	Session Paused
9:04:46 AM	Session Resumed
9:04:58 AM	Chairman Armstrong
	Note: Harward, Sonya Resumes day two of the hearing in this case.
9:05:04 AM	Chairman Armstrong Remarks about Public Comments
	Note: Harward, Sonya Public comments may be made if the Public arrives and they will be worked in between witnesses if necessary.
9:05:26 AM	Witness David Carpenter takes the stand and is sworn in.
9:06:42 AM	Atty. Alex Rowady direct exam. of Witness Carpenter
	Note: Harward, Sonya Witness accepts prefired testimony with a change--found a new publication.
9:08:17 AM	Atty. Rowady to Witness Carpenter
	Note: Harward, Sonya Asks Witness to explain the findings in the new publication. [Later entered as Barker - Exhibit 7 to this Hearing.]
9:10:26 AM	Atty. David Samford cross exam. of Witness Carpenter
	Note: Harward, Sonya Asking about educational experience and degrees Witness holds.
9:19:23 AM	Atty. Samford to Witness Carpenter
	Note: Harward, Sonya Referencing page 2 of Witness's testimony, generally.
9:21:43 AM	Atty. Samford to Witness Carpenter
	Note: Harward, Sonya Generally referencing Witness's responses to data requests. Asking about his response about proceedings he'd been involved in and when his testimony was not allowed.
9:24:15 AM	Atty. Samford to Witness Carpenter
	Note: Harward, Sonya Asking Witness about methodology he used in this case.
9:28:41 AM	EKPC - Exhibit 10
	Note: Harward, Sonya Amended Declaration of Dr. David O. Carpenter, M.D., from United States District Court, District of Oregon, Portland Division, AHM and David Mark Morrison vs. Portland Public Schools.
9:32:07 AM	Atty. Samford to Witness Carpenter
	Note: Harward, Sonya Referencing page 23 of EKPC - Exhibit 10 to this Hearing.
9:33:22 AM	EKPC - Exhibit 11
	Note: Harward, Sonya British Columbia Utilities Commission, Certificate of Public Convenience and Necessity for the Advanced Metering Infrastructure Project, In the Matter of FortisBC Inc., Decision, July 23, 2013.
9:36:10 AM	Atty. Samford to Witness Carpenter
	Note: Harward, Sonya Asking about his knowledge of the Barkers.
9:40:58 AM	Atty. Samford to Witness Carpenter
	Note: Harward, Sonya Asking about standards imposed by Federal or State authority regarding power lines.

9:41:35 AM	Atty. Samford to Witness Carpenter Note: Harward, Sonya	Referencing EKPC - Exhibit 7 to this Hearing, page 2.
9:44:06 AM	Commissioner Breathitt joins the proceeding.	
9:45:23 AM	Atty. Samford to Witness Carpenter Note: Harward, Sonya	Asking Witness why he selected the studies he referenced in his report.
9:51:00 AM	Atty. Samford to Witness Carpenter Note: Harward, Sonya	Asking Witness which of the studies in report establishes a definitive cause and effect relationship between incidents of cancer and exposure to power lines.
9:54:58 AM	EKPC - Exhibit 12 Note: Harward, Sonya	Pennsylvania Public Utility Commission, Harrisburg, PA, Public Meeting held January 14, 2010 regarding Case Nos. A-2009-2082652, A-2009-2082832, A-2009-2088297, A-2009-2088337, A-2009-2088327, A-2009-2088340, A-2009-2088312, and A-2009-2088360.
9:58:46 AM	Atty. Samford to Witness Carpenter Note: Harward, Sonya	Referencing page 112 of EKPC - Exhibit 12 to this Hearing.
10:01:03 AM	Atty. Samford to Witness Carpenter Note: Harward, Sonya	Referencing page 113 of EKPC - Exhibit 12 to this Hearing.
10:01:51 AM	EKPC - Exhibit 13 Note: Harward, Sonya	State of Minnesota, Office of Administrative Hearings for the Public Utilities Commission, In the Matter of the Route Permit Application by Great River Energy and Xcel Energy for a 345 Transmission Line from Brookings County, South Dakota to Hampton, Minnesota, OAH Docket No. 7-2500-20283-2, MPUC Docket No. ET-2/TL-08-1474, Findings of Fact, Conclusions and Recommendations.
10:04:44 AM	EKPC - Exhibit 14 Note: Harward, Sonya	Opinion of the Supreme Court of the State of Washington, Case No. 87679-7, filed March 7, 2013.
10:06:27 AM	EKPC - Exhibit 15 Note: Harward, Sonya	[In French] Decision, Quebec, Regie De L'Energie, D-2012-127, R-3770-2001, Oct. 5, 2012. (Last page of this exhibit has a translation of paragraph [413] on page numbered 97.)
10:09:28 AM	EKPC - Exhibit 16 Note: Harward, Sonya	Sage EMF Design, Environmental Consultants, from a web page accessed on July 7, 2014.
10:11:10 AM	EKPC - Exhibit 17 Note: Harward, Sonya	Health Council of the Netherlands, The Minister of Housing, Spatial Planning and the Environment (VROM), BioInitiative Report, Sept. 2, 2008.
10:12:49 AM	EKPC - Exhibit 18 Note: Harward, Sonya	Australian Centre for Radiofrequency Bioeffects Research (ACRBR), "ACRBR Position Statement on BioInitiative Report," by Croft, Abramson, Cosic, Finnie, McKenzie, and Wood, dated Dec. 18, 2008.
10:14:09 AM	EKPC - Exhibit 19 Note: Harward, Sonya	Comar Technical Information Statement: Expert Reviews on Potential Health Effects of Radiofrequency Electromagnetic Fields and Comments on the Bioinitiative Report, The Committee on Man and Radiation (COMAR).
10:16:02 AM	EKPC - Exhibit 20 Note: Harward, Sonya	Picking Cherries in Science: The Bio-Initiative Report, from a webpage, posted by Lorne Trottier on Feb. 15, 2013.
10:18:21 AM	EKPC - Exhibit 21 Note: Harward, Sonya	BioInitiative 2012, The Round-Table Proposal - Why It Is Obsolete, dated Feb. 7, 2013.

10:23:00 AM	Atty. Samford to Witness Carpenter Note: Harward, Sonya	Asking about the study the Witness offered as a change to his testimony. [Later entered as Barker - Exhibit 7 to this Hearing.]
10:26:21 AM	Chairman Armstrong Note: Harward, Sonya	Asking Witness how many countries included in the World Health Organization.
10:27:31 AM	Atty. Jonathan Beyer cross exam. of Witness Carpenter Note: Harward, Sonya	Asking Witness's opinion about the impact of EMF exposure to implanted medical devices.
10:28:03 AM	Vice Chairman Gardner cross exam. of Witness Carpenter Note: Harward, Sonya	Asking about the issue of tissue heating.
10:30:09 AM	Vice Chairman Gardner to Witness Carpenter Note: Harward, Sonya	Asking Witness about standard of 4 concerning the elevated risk of cancer.
10:31:11 AM	Vice Chairman Gardner to Witness Carpenter Note: Harward, Sonya	Referencing EKPC - Exhibit 7 to this Hearing.
10:37:34 AM	Vice Chairman Gardner to Witness Carpenter Note: Harward, Sonya	Asking if there is there absolute proof of a link between smoking and cancer, and between cancer and exposure to power lines.
10:39:02 AM	Commissioner Breathitt cross exam. of Witness Carpenter Note: Harward, Sonya	Asking about measurement of milligauss taken inside the Barker's home.
10:43:55 AM	Atty. Rowady re-direct exam. of Witness Carpenter Note: Harward, Sonya	Asking about Witness's testimony in various cases.
10:46:42 AM	Atty. Rowady to Witness Carpenter Note: Harward, Sonya	Asking Witness about KY Legislature not having standards set regarding EMF and who should set them.
10:52:02 AM	Witness Carpenter is dismissed from the stand.	
10:52:12 AM	Break	
10:52:18 AM	Session Paused	
11:06:06 AM	Session Resumed	
11:06:14 AM	Atty Rowady Note: Harward, Sonya	Asks Commission about the admittance of the study Witness Carpenter discussed at the begining of his testimony concerning new evidence he had found.
11:06:34 AM	Barker - Exhibit 7 Note: Harward, Sonya	Occupational exposure to extremely low frequency magnetic fields and brain tumor risks in the INTEROCC study, by Turner, et. al.
11:07:02 AM	Chairman Armstrong will rule on admittance of Barker - Exhibit 7 at end of Hearing. Note: Harward, Sonya	[Exhibit was later accepted into the record.]
11:07:04 AM	Witness Gabor Mezei takes stand and is sworn in.	
11:08:35 AM	Atty. Samford direct exam. of Witness Mezei Note: Harward, Sonya	Witness accepts prefiled testimony with no changes.
11:09:07 AM	Atty. Rowady cross exam. of Witness Mezei Note: Harward, Sonya	Asking Witness about his education/degrees.
11:10:03 AM	Atty. Rowady to Witness Mezei Note: Harward, Sonya	Asking about human exposure to carcinogens and the locations of the power lines at the Barker's home.
11:11:05 AM	Camera Lock Deactivated	
11:14:12 AM	Atty. Rowady to Witness Mezei Note: Harward, Sonya	Asking about there being numerous studies concerning the increased rate of childhood Leukemia in children.
11:18:40 AM	Atty. Rowady to Witness Mezei Note: Harward, Sonya	Asking if there is evidence that provides an association between EMF and cancer, Alzheimer's, and Leukemia.

11:20:18 AM	Atty. Rowady to Witness Mezei Note: Harward, Sonya	Asking if, in his experience, power companies try to avoid close placement of power lines to homes.
11:22:36 AM	Atty. Rowady to Witness Mezei Note: Harward, Sonya	Asking about Witness's association with or knowledge of a study done about the association between EMF and brain cancer in 2008.
11:25:47 AM	Vice Chairman Gardner cross exam. of Witness Mezei Note: Harward, Sonya	Asking about Witness's opinion about some of Witness Carpenter's statements and his approach.
11:32:07 AM	Vice Chairman Gardner to Witness Mezei Note: Harward, Sonya	Asking Witness if he does studies or is directly involved in studies.
11:33:19 AM	Commissioner Breathitt cross exam. of Witness Mezei Note: Harward, Sonya	Asking how much of his 20 years of experience has been in the area of EMF studies.
11:38:31 AM	Atty. Samford re-direct exam. of Witness Mezei Note: Harward, Sonya	Asking about Group B carcinogens.
11:39:59 AM	Vice Chairman Gardner re-cross exam. of Witness Mezei Note: Harward, Sonya	Asking for clarification about limitations existing because of childhood Leukemia.
11:40:34 AM	Witness Mezei dismissed from the stand.	
11:40:45 AM	Witness Benjamin Cotts takes the stand and is sworn in.	
11:42:03 AM	Atty. Samford direct exam. of Witness Cotts Note: Harward, Sonya	Witness accepts prefiled testimony with no changes.
11:42:29 AM	Atty. Rowady cross exam. of Witness Cotts Note: Harward, Sonya	Asking Witness about working for same company as Witness Mezei and his company's fields of study.
11:43:34 AM	Atty. Rowady to Witness Cotts Note: Harward, Sonya	Asking about Witness's visit to the site.
11:47:17 AM	Atty. Rowady to Witness Cotts Note: Harward, Sonya	Continuing to ask about numbers he used in his modeling.
11:48:29 AM	Atty. Rowady to Witness Cotts Note: Harward, Sonya	Asking for the milligauss readings the Witness obtained on his visit to the site.
11:51:22 AM	Atty. Rowady to Witness Cotts Note: Harward, Sonya	Asking about importance of Witness knowing the maximum flow in line discussed here.
11:54:17 AM	Atty. Rowady to Witness Cotts Note: Harward, Sonya	Asking Witness about micro shocks at the Barker's home.
11:55:45 AM	Vice Chairman Gardner cross exam. of Witness Cotts Note: Harward, Sonya	Asking Witness why international standards were developed.
11:56:42 AM	Vice Chairman Gardner to Witness Cotts Note: Harward, Sonya	Asking Witness if there a formula based on distance and EMF.
11:59:39 AM	Atty. Samford re-direct exam. of Witness Cotts Note: Harward, Sonya	Asking about current that can be created by parking a semi truck at the Barker home.
	Note: Harward, Sonya	Asking about possibility of an infant being electricuted at site.
12:01:49 PM	Atty. Rowady re-cross exam. of Witness Cotts Note: Harward, Sonya	Asking if his view is from an Engineering perspective.
12:04:39 PM	Atty. Rowady to Witness Cotts Note: Harward, Sonya	Asking Witness if there is a concern for someone with a pacemaker in regards to the power lines.
12:06:10 PM	Atty. Rowady to Witness Cotts Note: Harward, Sonya	Asking if readings of milligauss at the Barker home are more than in a typical home.

12:08:14 PM	Atty. Rowady to Witness Cotts Note: Harward, Sonya	Referencing Table 3 of Witness's prefiled testimony.
12:11:03 PM	Witness Cotts dismissed from the stand.	
12:12:02 PM	Break	
12:12:14 PM	Session Paused	
1:14:54 PM	Session Resumed	
1:14:58 PM	Witness Mary Jane Warner takes the stand and is sworn in.	
1:15:51 PM	Atty. Samford direct exam. of Witness Warner Note: Harward, Sonya	Accepts prefiled testimony with changes, given out as EKPC - Exhibits 22 and 23 to this Hearing.
1:16:33 PM	EKPC - Exhibit 22 Note: Harward, Sonya	Witness's corrected response to Item 22 to data requests by the Complainants.
1:17:19 PM	EKPC - Exhibit 23 Note: Harward, Sonya	Map. Exhibit MJW-4, Alternate Routes. Witness's correction to response to item 58 of data requests by the Complainants.
1:18:26 PM	Witness Warner Note: Harward, Sonya	Also sponsoring testimony of Mr. Drury, due to his retiring last year.
1:19:00 PM	Atty. Rowady cross exam. of Witness Warner Note: Harward, Sonya	Referencing EKPC's response to item 54 of data requests from Complainant.
1:20:08 PM	Barker - Exhibit 8 Note: Harward, Sonya	Page from EKPC's response to item 54 of data requests from Complainant.
1:24:19 PM	Barker - Exhibit 9 Note: Harward, Sonya	East Kentucky Power Cooperative, Transmission Line Siting Data List, Smith - Sideview 345kV, Sheet for Comments.
1:28:30 PM	Atty. Rowady to Witness Warner Note: Harward, Sonya	Continuing to ask about the Open House EKPC held concerning the proposed power lines to be built.
1:33:20 PM	Atty. Rowady to Witness Warner Note: Harward, Sonya	Continuing to ask about discussions regarding moving the lines further from the Barker house, and the timeline of these discussions regarding the lesser cost to make the change before the new lines were constructed.
1:36:58 PM	Atty. Rowady to Witness Warner Note: Harward, Sonya	Referencing pages 11 and 12 of Witness's direct testimony.
1:41:50 PM	Barker - Exhibit 10 Note: Harward, Sonya	Map
1:44:48 PM	Atty. Rowady to Witness Warner Note: Harward, Sonya	Discussing Barker - Exhibit 10 to this Hearing regarding the new line.
1:46:04 PM	Atty. Rowady to Witness Warner Note: Harward, Sonya	Referencing page 11 of Witness's direct testimony.
1:46:28 PM	Atty. Samford Note: Harward, Sonya	Witness referencing MJW-2 of her testimony.
1:47:14 PM	Barker - Exhibit 11 Note: Harward, Sonya	Map
1:48:15 PM	Atty. Rowady to Witness Warner Note: Harward, Sonya	Asking about new line on the map labeled Barker - Exhibit 11 to this Hearing.
1:52:19 PM	Atty. Rowady to Witness Warner Note: Harward, Sonya	Asking Witness if she's ever been involved in a CPCN application.
1:57:44 PM	Barker - Exhibit 12 Note: Harward, Sonya	Notice of Intent to Construct Proposed Transmission Lines

2:00:31 PM	Atty. Rowady to Witness Warner Note: Harward, Sonya	Asking about modifications needed to change the line from 69 kV to 138 kV.
2:02:42 PM	Atty. Rowady to Witness Warner Note: Harward, Sonya	Asking about Witness Cott's testimony and his use of "operation at normal capacity."
2:04:49 PM	Atty. Rowady to Witness Warner Note: Harward, Sonya	Asking Witness if she agrees that there was enough space to move the line.
2:06:18 PM	Atty. Rowady to Witness Warner Note: Harward, Sonya	Asking Witness if the Smith to North Clark project required a rate increase.
2:08:18 PM	Atty. Rowady to Witness Warner Note: Harward, Sonya	Asking about EKPC's response regarding notifying the Commission when the change was made on the Fowley property.
2:10:45 PM	Atty. Rowady to Witness Warner Note: Harward, Sonya	Asking if EKPC has sought to use the Safe Harbour approach for any project since this one.
2:12:21 PM	Barker - Exhibit 13 Note: Harward, Sonya	Letter from Edward Depp of Dinsmore & Shohl LLP to the PSC, dated Jan. 31, 2012, Re: Kentucky Association of Electric Cooperatives Staff Opinion Request Electric Distribution Cooperative Work Plans.
2:15:40 PM	Atty. Rowady to Witness Warner Note: Harward, Sonya	Asking if Witness agrees with previous witnesses about seeking to avoid areas of human habitation for such projects.
2:18:00 PM	Atty. Rowady to Witness Warner Note: Harward, Sonya	Asking if 6 feet of encroachment could have been eliminated.
2:18:39 PM	Atty. Beyer cross exam. of Witness Warner Note: Harward, Sonya	Asking for clarification between 'upgraded replacement' and a 'new line', specifically regarding response to Commission's request, item 1.d.
2:25:11 PM	Atty. Beyer to Witness Warner Note: Harward, Sonya	Asking about the need for the extra 50 feet along the entire line.
2:27:36 PM	Atty. Beyer to Witness Warner Note: Harward, Sonya	Asking if EKPC considers EMF levels when siting a transmission lines.
2:29:20 PM	Atty. Beyer to Witness Warner Note: Harward, Sonya	Asking Witness for an explanation for the need of the 345 kV line.
2:30:45 PM	Atty. Beyer to Witness Warner Note: Harward, Sonya	Asking why 138 kV lines were installed instead of 69 kV lines.
2:32:28 PM	Atty. Beyer to Witness Warner Note: Harward, Sonya	Asking what the cost would be to move the line 250 feet on Barker property.
2:34:08 PM	Atty. Beyer to Witness Warner Note: Harward, Sonya	Referencing EKPC's Staff Opinion Request submitted in 2005.
2:37:00 PM	Vice Chairman Gardner cross exam. of Witness Warner Note: Harward, Sonya	Asking for an explanation of the encroachment agreement.
2:38:36 PM	Vice Chairman Gardner to Witness Warner Note: Harward, Sonya	Asking about the Condemnation suit.
2:39:15 PM	Vice Chairman Gardner to Witness Warner Note: Harward, Sonya	Asking about the purpose of the 69 kV line.
2:42:12 PM	Vice Chairman Gardner to Witness Warner Note: Harward, Sonya	Asking about the need for the lines.

2:48:32 PM	Vice Chairman Gardner to Witness Warner Note: Harward, Sonya	Referencing page 11 of Witness's testimony, regarding definitions of 'replacement' and 'upgrade.'
2:53:11 PM	Vice Chairman Gardner to Witness Warner Note: Harward, Sonya	Asking about the factors that determined if EKPC needed a CPCN or not and if this was an upgrade or a replacement.
2:55:29 PM	Commissioner Breathitt cross exam. to Witness Warner Note: Harward, Sonya	Asking if EKPC is 'splitting hairs' regarding how the route was determined.
2:59:03 PM	Atty. Rowady re-cross exam. of Witness Warner Note: Harward, Sonya	Referencing Barker - Exhibit 11 to this Hearing, regarding how many owners were affected in the Jackson Ferry area.
3:02:48 PM	Atty. Rowady to Witness Warner Note: Harward, Sonya	Asking about encroachment agreement with Barkers.
3:05:16 PM	Atty. Samford Objection Note: Harward, Sonya	Argumentative line of questioning.
3:06:55 PM	Atty. Rowady to Witness Warner Note: Harward, Sonya	Asking about EKPC's Staff Opinion Request and the power lines described therein. (Atty. Rowady provided a copy of the request to the Witness.)
3:09:21 PM	Atty. Beyer re-cross exam. to Witness Warner Note: Harward, Sonya	Asking about when decision was made to upgrade line to 138 kV.
3:12:28 PM	Commissioner Breathitt re-cross exam. of Witness Warner Note: Harward, Sonya	Asking about a statement Witness made regarding an alternative route that incorporated an existing line.
3:14:29 PM	Witness Warner is dismissed from the stand.	
3:14:52 PM	Witness Paul Dolloff takes the stand and is sworn in.	
3:16:46 PM	Atty. Samford direct exam. of Witness Dolloff Note: Harward, Sonya	Accepts prefiled testimony with one clarification and one correction. Clarification on page 28 of testimony, line 18, should be "maximum sag" or "minimum clearance," not "minimum sag". Correction to response to item 33 of Barker request, Table 3, 2nd line, value should be "868.73 amps."
3:19:29 PM	Atty. Rowady cross exam. of Witness Dolloff Note: Harward, Sonya	Referencing Witness's testimony, Exhibit 3, 2nd page, regarding difference between Witness's values and Witness Cott's values of measurements from center line.
3:25:48 PM	Atty. Rowady to Witness Dolloff Note: Harward, Sonya	Referencing Witness's direct testimony concerning his statement about transmission lines never being loaded to maximum capacity and the conductors never reaching maximum operating temperture under normal operating conditions.
3:29:55 PM	Atty. Rowady to Witness Dolloff Note: Harward, Sonya	Asking if Witness is suprised that there are micro shocks at Barker's residence.
3:32:56 PM	Atty. Rowady to Witness Dolloff Note: Harward, Sonya	Asking if Witness suggested the Barker's stay 150 feet or more away from the lines.
3:33:55 PM	Atty. Samford Objection Note: Harward, Sonya	Transcript should be produced if Witness cannot recall the line of questioning.
3:36:38 PM	Atty. Rowady to Witness Dolloff Note: Harward, Sonya	Asking about standards and his conversation regarding this with the Barkers.

3:40:16 PM	Atty. Rowady to Witness Dolloff Note: Harward, Sonya	Referencing response to Barker request, item 35, regarding electrical data Witness provided.
3:44:22 PM	Atty. Beyer cross exam. of Witness Dolloff Note: Harward, Sonya	Asking how often Witness tests EMF levels at a house and how often the meter used should be calibrated.
3:46:47 PM	Atty. Beyer to Witness Dolloff Note: Harward, Sonya	Referencing Witness's direct testimony, page 15, lines 1-9.
3:48:08 PM	Commissioner Breathitt cross exam. of Witness Dolloff Note: Harward, Sonya	Asking about date of meter calibration.
3:49:17 PM	Atty. Samford re-direct exam. of Witness Dolloff Note: Harward, Sonya	Referencing EKPC - Exhibit 7 to this Hearing.
3:51:34 PM	Atty. Samford to Witness Dolloff Note: Harward, Sonya	Asking about his measures on his meter compared to those of the Barkers.
3:51:50 PM	Atty. Rowady re-cross exam. of Witness Dolloff Note: Harward, Sonya	Asking about Witness's location when he took his measures.
3:52:53 PM	Post Hearing Briefs due August 1.	
3:54:38 PM	Discussion about rebuttal testimony.	
3:57:06 PM	Hearing Adjourned.	
3:57:17 PM	Session Paused	
4:00:20 PM	Session Ended	



Exhibit List Report

2013-00291_08-Jul-2014

Barkers vs. East Kentucky Power Cooperative, Inc.

Name:	Description:
Barker - Exhibit 10	Map
Barker - Exhibit 11	Map
Barker - Exhibit 12	Notice of Intent to Construct Proposed Transmission Lines
Barker - Exhibit 13	Letter from Edward Depp of Dinsmore & Shohl LLP to the PSC, dated Jan. 31, 2012, Re: Kentucky Association of Electric Cooperatives Staff Opinion Request Electric Distribution Cooperative Work Plans.
Barker - Exhibit 7	Occupational exposure to extremely low frequency magnetic fields and brain tumor risks in the INTEROCC study, by Turner, et. al.
Barker - Exhibit 8	Page from EKPC's response to item 54 of data requests from Complainant.
Barker - Exhibit 9	East Kentucky Power Cooperative, Transmission Line Siting Data List, Smith - Sideview 345kV, Sheet for Comments.
EKPC - Exhibit 10	Amended Declaration of Dr. David O. Carpenter, M.D., from United States District Court, District of Oregon, Portland Division, AHM and David Mark Morrison vs. Portland Public Schools.
EKPC - Exhibit 11	British Columbia Utilities Commission, Certificate of Public Convenience and Necessity for the Advanced Metering Infrastructure Project, In the Matter of FortisBC Inc., Decision, July 23, 2013.
EKPC - Exhibit 12	Pennsylvania Public Utility Commission, Harrisburg, PA, Public Meeting held January 14, 2010 regarding Case Nos. A-2009-2082652, A-2009-2082832, A-2009-2088297, A-2009-2088337, A-2009-2088327, A-2009-2088340, A-2009-2088312, and A-2009-2088360.
EKPC - Exhibit 13	State of Minnesota, Office of Administrative Hearings for the Public Utilities Commission, In the Matter of the Route Permit Application by Great River Energy and Xcel Energy for a 345 Transmission Line from Brookings County, South Dakota to Hampton
EKPC - Exhibit 14	Opinion of the Supreme Court of the State of Washington, Case No. 87679-7, filed March 7, 2013.
EKPC - Exhibit 15	[In French] Decision, Quebec, Regie De L'Energie, D-2012-127, R-3770-2001, Oct. 5, 2012. (Last page of this exhibit has a translation of paragraph [413] on page numbered 97.)
EKPC - Exhibit 16	Sage EMF Design, Environmental Consultants, from a web page accessed on July 7, 2014.
EKPC - Exhibit 17	Health Council of the Netherlands, The Minister of Housing, Spatial Planning and the Environment (VROM), BioInitiative Report, Sept. 2, 2008.
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EKPC - Exhibit 21	BioInitiative 2012, The Round-Table Proposal - Why It Is Obsolete, dated Feb. 7, 2013.
EKPC - Exhibit 22	Witness's corrected response to Item 22 to data requests by the Complainants.
EKPC - Exhibit 23	Map. Exhibit MJW-4, Alternate Routes. Witness's correction to response to item 58 of data requests by the Complainants.

Ladies and Gentlemen,

My name is Jerry Jessie, I live at 335 Morris Rd. Winchester Ky 40391.

I am here today to voice my concerns and my opinions concerning the way the upgrade of the Smith-Hunt-Sideview Electric Transmission Project was handled. It has come to my attention that what EKPC reported to the (PSC) Public Service Commission was not complete and fully accurate when they applied for permission to complete this project. This allowed them to proceed without obtaining a CPCN. If EKPC's report to the PSC had been accurate and complete, they would have been required to obtain the CPCN order.

This is important because the procedures under the CPCN would have allowed for open forum meetings where the affected people could voice their concerns and EKPC would have had to reconcile all concerns.

There was one meeting. It was not an open forum; they simply told everyone there what they were going to do. They then sent their reps into the crowd to talk to individuals about their concerns, of which my wife and I did. We were concerned about the right of way already being so close to our house with no room for any additional ROW. We also voiced our concerns about the possible health issues involved with the increased size and capacity of the proposed project. They dismissed our comments about health issues. He guaranteed us there would be no health risk from the power lines.

I have a copy of the sheet where EKPC listed the comment and concerns of the people the night of the meeting. For us the list includes: call cell phone, wife works at night and sleeps during the day, house built on edge of easement-no room extend 25'. Told him we would survey to locate. No mention of our comment or concerns about health risk, it was totally omitted.

In August 2009 my wife was diagnosed with nonsmall cell lung cancer, she passed away on October 12, 2009.

While it is true that I cannot prove that the power lines were the cause of or definite factor in her death, neither can EKPC prove that it wasn't.

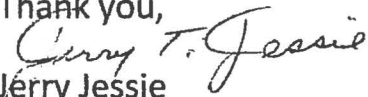
With that I would like to refer you to the work of David O. Carpenter M.D. Titled Human Health Effects of "Nonionizing Electromagnetic Field." Ch. 100 P. 124, final comment and I quote:

"Certainly, more research is needed. However the evidence that excessive exposure to both power line frequency and RF increases the risk of cancer is strong and consistent and society ignores this evidence at its peril." End quote.

This is what EKPC did, ignored our concerns about health risk. Dismissed them out of hand.

Had EKPC been forth right with the PSC, the CPCN obtained, then all the issues including ours, would have been fully explored. EKPC would not have been able to just dismiss and omit whatever wasn't expedient for them.

Ladies and gentlemen, I thank you for this opportunity to speak her today. I thank the Barkers for their persistence in bringing this to this point. I have no idea what will come from this hearing, I do hope that EKPC will at least be held accountable for their misrepresentation of the facts.

Thank you,

Jerry Jessie

E031

15-39

TRANSMISSION LINE RIGHT OF WAY EASEMENT

MICROFILMED

We the undersigned Griggs Lewis and Frances Lewis, Bessie Margaret Quisenberry
and Thomas Quisenberry

(unmarried) (husband and wife) for and in consideration of the sum of One Dollar (\$1.00) cash in hand paid, receipt of which is hereby acknowledged, do hereby grant unto East Kentucky Rural Electric Cooperative Corporation, Winchester, Kentucky, herein called the Cooperative, its successors and assigns, the perpetual right to enter upon the lands of the undersigned, situated in the County of Clark, State of Kentucky, and more particularly described as follows:

A tract of land approximately 50 acres, located on U. S. Highway #60 road, 5 miles from the town of Winchester, being George Lewis the same land conveyed by George Lewis to Griggs Lewis & as his Will dated 1935 to the undersigned by Will dated 15th day of August 1935, recorded in Deed Book 113, pg. 279, Office of the Clark County Clerk.

The specific right of way upon which said transmission and/or distribution line or system shall be located is one hundred (100') feet wide and the center line thereof is described as follows: Beginning at a

point in the line between the lands of the undersigned's above described and the land

land of Herbert Heflin at U. S. Highway 60 at Station No. 519922

and running thence 16° 15' E a distance of 1380 feet

to a point in the line between the lands of the undersigned above described

land and the land of Brooks Barnes at Station No. 533472

and to survey, construct, reconstruct, extend, repair, enlarge, operate, maintain, and inspect on the above described lands and/or in or upon all streets, roads or highways abutting said lands, an electric transmission and/or distribution line or system; together with the right of ingress and egress over the lands of the undersigned to and from said lines in the exercise of the rights and privileges herein granted, provided however, that in exercising such rights of ingress and egress the Cooperative will, whenever practicable to do so, use regularly established highways or farm roads; to cut down and trim any and all trees and shrubbery located within fifty (50') feet of the center line of said line or system; and cut and trim any and all other trees which are of such height that in falling they would come in contact with said line or system; and also the right to remove brush and all other obstructions and obstacles from the right of way which would create a fire hazard to the lines or systems of the Cooperative.

The undersigned, their successors, heirs, or assigns, are fully to use and enjoy the lands crossed by this easement except, however, that such use shall not conflict with any rights and privileges herein granted.

The undersigned agree that all poles, wires and other facilities, installed on the above described lands at the Cooperative's expense, shall remain the property of the Cooperative, removable at the option of the Cooperative.

It is further expressly understood and agreed that the Cooperative will pay to the undersigned any and all damage that may be caused by the Cooperative in going upon said lands and right of way except that the Cooperative will not be liable for any damage for cutting down and trimming trees in the manner and to the extent herein above specified.

All trees cut down shall be cut in such length as the owner may desire, and limbs removed so as to make same into merchantable timber, and brush and unmerchantable trees and limbs should be removed at the Company's expense to place where same

SCANNED
EKPC

EXHIBIT

2

MICROFILMED

shall not interfere with cultivation.

Owner shall have use of right of way strip for all farm purposes and the planting, growing and harvesting of all kinds of crops.

The Company shall not fence any part of said right of way, but owner can put any fences or other structures on same that do not interfere with the maintenance and operation of its lines.

The Company shall pay damages for all injury done to said lands and crops of owner at any time caused by the construction, maintenance or operation of said line.

It is understood that the structures on said land shall be poles placed as indicated on the plat filed with the petition in the condemnation proceedings for this right of way; and if any change causing an increased amount of damage is made in the supporting structures for said electric wires at any time by the Company, additional damage shall be paid for such change. The Company shall be liable for any injury to persons, animals or property occasioned on owner's farm, including right of way, caused by any electric current coming from Company's line occasioned by the negligence of the Cooperative in the construction, operation or maintenance of its said line.

The Company shall pay to the owner any damage or injury done to the Owner's fencing or other structures in the construction, maintenance and operation of said lines and in the exercise of right of ingress and egress over said farm to and from said right of way.

The Company shall restore in as good condition as the same was before the construction of said line the surface of the land, including the removal of all rocks from the surface caused to be there by the construction of said line, and shall cover all guy wires so as to protect stock and persons from injury thereby.

The Company is to restore all roads, bridges and culverts of owner injured by the Company at any time in the construction, maintenance and operation of said line.

The Company shall be responsible for any injury or loss caused by Company, its agents, servants or employees allowing stock to get out of the enclosures.

Wires to be maintained at all times by the Company at a height of not less than eighteen (18) feet above the ground.

The undersigned covenant that they are the owners of the above described lands and that the said lands are free and clear of encumbrances and liens of whatsoever character except those held by the following persons:

In witness thereof the undersigned have set their hands this the 28th day of October, 1952.

Witnesses:

STATE OF KENTUCKY

SGT

COUNTY OF _____

I, _____, Clerk of the county and state aforesaid hereby certify that the foregoing instrument of writing was on this day produced to me in my office, by _____ one of the subscribing witnesses thereto who also proved the signature of _____ the other subscribing witness and on oath testified that _____ did sign the foregoing instrument in their presence and acknowledged the same to be their act and deed. Witness my hand this _____ day of _____, 19____.

Clerk

By _____ D.C.

MICROFILMED

STATE OF KENTUCKY

SGT

COUNTY OF _____

I, _____, a Notary Public in and for the State and County aforesaid do hereby certify that the foregoing instrument of writing to the East Kentucky Rural Electric Cooperative Corporation was this day produced to me in said State and County aforesaid, and was signed and acknowledged by _____ and _____ to be their free act and deed and the same together with this certificate is hereby certified to the proper office for record.

Witness my hand this the _____ day of _____, 19____.

Notary Public

My commission expires _____

STATE OF KENTUCKY

SGT

COUNTY OF _____

I, _____, County Court Clerk of the State and County aforesaid certify that the foregoing instrument of writing from _____ and _____ to the East Kentucky Rural Electric Cooperative Corporation was this day lodged for record in my office whereupon the same, with the foregoing and this my certificate, have been duly recorded in my office.

Witness my hand this _____ day of _____, 19____.

Clerk

By _____ D.C.

B-145-

P. 403

Thurp's Tennis Club
20 Right Way Avenue
East of Round Lake Camp Camp

LODGED for RECORD
FEB 12 1953
CLYDE GRAVETT, Clerk

Ad. before me by Angie
Levin and Thomas Levin
his wife, Bessie Margaret
Levin and Thomas
Levin her husband
this Oct 28, 1952
Clyde Gravett
Clerk

STATE OF KENTUCKY }
COUNTY OF CLARK }

I, Clyde Gravett, Clerk of the Clark County Court, do certify that the foregoing
Transmission of Right of Way to East Kentucky Rural Electric Cooperative Corporation
was on the 28th day of October, 1952, produced to me in said
County, and acknowledged before me by Angie Levin Levin his wife,
Bessie Margaret Levin Levin her husband
parties thereto to be their act and deed and was lodged for record February
12th, 1953. Whereupon the same and this
certificate have been recorded in my office.
Given under my hand this, the 13th day of February, 1953
By Clyde Gravett, Clerk
By Florence Battle

TRANSMISSION LINE RIGHT OF WAY EASEMENT

32
 We the undersigned Brooks Barnes and Elizabeth Barnes, his wife

(~~husband and wife~~) (~~husband and wife~~) for and in consideration of the sum of One Dollar (\$1.00) cash in hand paid, receipt of which is hereby acknowledged, do hereby grant unto East Kentucky Rural Electric Cooperative Corporation, Winchester, Kentucky, herein called the Cooperative, its successors and assigns, the perpetual right to enter upon the lands of the undersigned, situated in the County of Clark, State of Kentucky, and more particularly described as follows:

A tract of land approximately 150 acres, located on Highway 60 road, 6 miles from the town of Winchester, being the same land conveyed by Rodney Haggard to the undersigned by deed dated 13 day of January, 1951, recorded in Deed Book 110, pg. 539, Office of the Clark County Clerk.

The specific right of way upon which said transmission and/or distribution line or system shall be located is one hundred (100') feet wide and the center line thereof is described as follows: Beginning at a

point in the line between the lands of the undersigned's above described and the land of land of R. H. Lewis at Station No. 533+72

and running thence N 18° 41' E for a distance of 1513 feet; thence N 15° 30' E for a distance of 1224 feet.

to a point in the line between the lands of the undersigned above described land and the land of Mrs. Walter Cline at Station No. 561+00

and to survey, construct, reconstruct, extend, repair, enlarge, operate, maintain, and inspect on the above described lands and/or in or upon all streets, roads or highways abutting said lands, an electric transmission and/or distribution line or system; together with the right of ingress and egress over the lands of the undersigned to and from said lines in the exercise of the rights and privileges herein granted, provided however, that in exercising such rights of ingress and egress the Cooperative will, whenever practicable to do so, use regularly established highways or farm roads; to cut down and trim any and all trees and shrubbery located within fifty (50') feet of the center line of said line or system; and cut and trim any and all other trees which are of such height that in falling they would come in contact with said line or system; and also the right to remove brush and all other obstructions and obstacles from the right of way which would create a fire hazard to the lines or systems of the Cooperative.

The undersigned, their successors, heirs, or assigns, are fully to use and enjoy the lands crossed by this easement except, however, that such use shall not conflict with any rights and privileges herein granted.

The undersigned agree that all poles, wires and other facilities, installed on the above described lands at the Cooperative's expense, shall remain the property of the Cooperative, removable at the option of the Cooperative.

It is further expressly understood and agreed that the Cooperative will pay to the undersigned any and all damage that may be caused by the Cooperative in going upon said lands and right of way except that the Cooperative will not be liable for any damage for cutting down and trimming trees in the manner and to the extent herein above specified.

All trees cut down shall be cut in such length as the owner may desire, and limbs removed so as to make same into merchantable timber; and brush and unmerchantable trees and limbs should be removed at the Company's expense to place where same

SCANNED

EKPC

will not interfere with child. and.

Owner shall have use of right of way strip for all farm purposes and the planting, growing and harvesting of all kinds of crops.

The Company shall not fence any part of said right of way, but owner can put any fences or other structures on same that do not interfere with the maintenance and operation of its lines.

The Company shall pay damages for all injury done to said lands and crops of owner at any time caused by the construction, maintenance or operation of said line.

It is understood that the structures on said land shall be poles placed as indicated on the plat filed with the petition in the condemnation proceedings for this right of way; and if any change causing an increased amount of damage is made in the supporting structures for said electric wires at any time by the Company, additional damage shall be paid for such change. The Company shall be liable for any injury to persons, animals or property occasioned on owner's farm, including right of way, caused by any electric current coming from Company's line occasioned by the negligence of the Cooperative in the construction, operation or maintenance of its said line.

The Company shall pay to the owner any damage or injury done to the Owner's fencing or other structures in the construction, maintenance and operation of said lines and in the exercise of right of ingress and egress over said farm to and from said right of way.

The Company shall restore in as good condition as the same was before the construction of said line the surface of the land, including the removal of all rocks from the surface caused to be there by the construction of said line, and shall cover all guy wires so as to protect stock and persons from injury thereby.

The Company is to restore all roads, bridges and culverts of owner injured by the Company at any time in the construction, maintenance and operation of said line.

The Company shall be responsible for any injury or loss caused by Company, its agents, servants or employees allowing stock to get out of the enclosures.

Wires to be maintained at all times by the Company at a height of not less than eighteen (18) feet above the ground.

The undersigned covenant that they are the owners of the above described lands and that the said lands are free and clear of encumbrances and liens of whatsoever character except those held by the following persons:

In witness thereof the undersigned have set their hands this the 13th day of June, 1952.

Brook Barnes
Elizabeth Barnes

Witnesses:

STATE OF KENTUCKY
SGT
COUNTY OF _____

I, _____, Clerk of the county and state aforesaid hereby certify that the foregoing instrument of writing was on this day produced to me in my office, by _____ one of the subscribing witnesses thereto who also proved the signature of _____ the other subscribing witness and on oath testified that _____ did sign the foregoing instrument in their presence and acknowledged the same to be their act and deed.
Witness my hand this _____ day of _____, 19____.

Clerk

D.C.

STATE OF KENTUCKY

COUNTY OF Clark

I, Kathleen Ecton, a Notary Public in and for the State and County aforesaid do hereby certify that the foregoing instrument of writing to the East Kentucky Rural Electric Cooperative Corporation was this day produced to me in said State and County aforesaid, and was signed and acknowledged by Brooks Barnes and Elizabeth Barnes to be their free act and deed and the same together with this certificate is hereby certified to the proper office for record.

Witness my hand this the 13th day of June, 1952

Kathleen Ecton
Notary Public

My commission expires May 22, 1954

STATE OF KENTUCKY

SCT

COUNTY OF Clark

I, Chas. Trant, County Court Clerk of the State and County aforesaid certify that the foregoing instrument of writing from Brooks Barnes and Elizabeth Barnes to the East Kentucky Rural Electric Cooperative Corporation was this day lodged for record in my office whereupon the same, with the foregoing and this my certificate, have been duly recorded in my office.

Witness my hand this 21st day of July, 1952.

Chas. Trant Clerk
By Willard Lindsey D.C.

COMMONWEALTH OF KENTUCKY
BEFORE THE PUBLIC SERVICE COMMISSION

RECEIVED

JUL 29 2013

PUBLIC SERVICE
COMMISSION

IN THE MATTER OF:

HAROLD BARKER; ANN BARKER)	
AND BROOKS BARKER)	
)	
COMPLAINANTS)	
)	
V.)	Case No. 2013-00291
)	
EAST KENTUCKY POWER)	
COOPERATIVE, INC.)	
DEFENDANT)	

OFFER OF SETTLEMENT OF
EAST KENTUCKY POWER COOPERATIVE, INC.

Comes now the Defendant, East Kentucky Power Cooperative, Inc. ("EKPC"), by counsel, pursuant to the Commission's July 18, 2013 Order, and other applicable law, and, as an Offer of Settlement to the Formal Complaint filed on or about July 5, 2013 by the Complainants, Harold Barker, Ann Barker and Brooks Barker (the "Barkers"), does hereby respectfully state as follows:

1. EKPC does not agree with many of the representations set forth in the Complaint and reserves the right to file a more detailed Answer if this Offer of Settlement is not accepted by the Barkers or the Commission. EKPC expressly reserves any and all affirmative defenses or objections to the Complaint to include, without limitation, that: (1) to the extent that the Complaint may relate to issues not related to the "rates" or "service" of EKPC, it is not within the Commission's jurisdiction; (2) the Complaint improperly requests the Commission to award

damages; (3) the Complaint fails to show a prima facie violation of any statute in KRS Chapter 278 or any Commission regulation or Order; (4) the Complainants are not "customers" of EKPC; (5) the Complaint presents issues already subject to the jurisdiction of the Clark Circuit Court; (6) estoppel; (7) assumption of risk; and (8) waiver.

2. On information and belief, the Barkers constructed the structures identified in the Complaint after EKPC's original transmission line was constructed. The transmission line is an overhead line and was therefore plainly visible to the Barkers at the time of the construction of these structures. The Barkers therefore constructed the structures with actual knowledge of the presence of EKPC's transmission line and, at a minimum, with constructive knowledge of the scope and extent of EKPC's easement which was filed as a matter of public record. The Barkers therefore accepted any risk – real or imagined – that such lines would ever be replaced or upgraded.

3. As a result of a need to replace and upgrade the existing transmission line, EKPC commenced a civil action in the Clark Circuit Court on July 7, 2006 to condemn a portion of the Barker's property, which may be described as a parcel located on the north side of U.S. Highway 60 approximately 800 feet north of I-64 in Clark County, Kentucky and consisting of approximately 150 acres. That condemnation proceeding is styled as *East Kentucky Power Cooperative, Inc. v. Harold Barker, et al.* and docketed as Case No. 06-CI-00419 (the "Civil Action"). The Trial Commissioners issued a report in the Civil Action on August 1, 2006 that set the diminution in value of the property condemned by EKPC at \$12,000. EKPC has attempted to engage in pretrial discovery, but no responses have yet been received from the Barkers to support the contention that the Commissioner's award is too low. The parties have engaged in mediation as part of the Civil Action, and extensive settlement negotiations have

been conducted, but no resolution has been reached. EKPC has offered to discuss moving the Barkers' house to another location on their property away from the transmission line and has offered to purchase their house at a mutually agreed upon appraised value. However, the Barkers have not accepted any of EKPC's offers.

4. The Barkers have apparently employed an independent appraiser who verbally indicated to EKPC's counsel in the Civil Action that the diminution in the value of the Barker property caused by EKPC's transmission line was \$179,000.¹ EKPC does not agree that this is the fair market value of the subject property's diminution in value as it is quite out of line with the Trial Commissioners' award. EKPC's counsel in the Civil Action has subsequently been verbally advised by the Barkers' counsel that their appraiser has subsequently raised his estimate of the diminution in value to approximately \$400,000.00. According to the property records of the Clark County Property Valuation Administrator, however, the entire 150 acre property owned by the Barkers is valued at \$317,900.²

5. The transmission line in question is within the area of EKPC's existing easement, or the additional right-of-way condemned by EKPC pursuant to an Agreed Interlocutory Judgment entered in the Civil Action on November 17, 2006 and is therefore lawfully located. The line was also lawfully constructed. EKPC estimates that the cost of moving the transmission line to accommodate the Barker's request to relocate the transmission line is approximately \$1 million. It would be unfair, unjust and unreasonable to require EKPC's members to pay for the relocation of a lawful transmission line if the costs of such relocation exceed the fair market value of the property allegedly affected by the current location of the transmission line.

¹ EKPC has not been provided with a copy of any documentation to support claimed valuations by the Barkers.

² A copy of this valuation is attached hereto and incorporated herein as Exhibit I.

6. EKPC hereby tenders an Offer of Settlement to satisfy the Barker's Complaint and as a Settlement of the Civil Action. EKPC will either: (a) pay the diminution in value of the Barker's property that has occurred as a result of the condemnation of a portion of their property; or (b) purchase the Barkers' house and a mutually agreed upon lot surrounding the house. For either settlement offer, the payment or purchase price shall be established by an independent expert appraiser to be mutually agreed upon by EKPC and the Barkers or to be selected by the Commission. This Offer of Settlement is conditioned upon the Barkers and EKPC entering into suitable settlement documents and the Commission's and Clark Circuit Court's approval of such a settlement as it relates to the Complaint.

This 29th day of July, 2013.

Respectfully submitted,



David S. Samford
GOSS SAMFORD, PLLC
2365 Harrodsburg Road, Suite B235
Lexington, KY 40504
david@gosssamfordlaw.com
(859) 368-7740

and

Sherman Goodpaster
East Kentucky Power Cooperative, Inc.
4775 Lexington Road
P.O. Box 707
Winchester, KY 40392-0707

*Counsel for East Kentucky Power
Cooperative, Inc.*

CERTIFICATE OF SERVICE

This is to certify that a true and correct copy of the foregoing has been served, by delivering same to the custody and care of the U.S. Postal Service, postage pre-paid, this 29th day of July, 2013, addressed to the following:

Harold, Ann & Brooks Barker
5450 Mt. Sterling Road
Winchester, KY 40391

Mr. Alex Rowady, Esq.
212 South Maple Street
Winchester, KY 40391


*Counsel for East Kentucky Power
Cooperative, Inc.*



Clark County Kentucky

Property Valuation Administrator

Karen R. Bushart
karenr.bushart@clarkpva.com

34 S. Main Street
Winchester, KY 40391
Phone: 859-745-0250
Fax: 859-745-0205

Hours: 8:00a.m.-4:00p.m. Tue-Fri
8:00a.m.-5:00p.m. Mondays

Recent Sales in Area	Previous Parcel	Next Parcel	Field Definitions	Return to Main Search Page	Subscription Home	Clark Home
Owner and Parcel Information						
Owner Name	BARKER ANN BROOKS BARNES	Today's Date	July 24, 2013			
Mailing Address	5450 MT STERLING RD WINCHESTER, KY 40391	Map Number/Account Number	088-0000-001-00 / 8090001			
Description	PARCEL 1A & BAL OF LAND	Tax District	County			
Location Address	5450 MT STERLING RD	2012 Rate Per Thousand	0.8820			
Deed Book	212	Parcel Map	Maps available with subscription			
Building Photo	Building Images	Deed Page	133			
		Building Sketch	Building Sketches			

Certified Value Information							
Residential Value	Commercial Value	Mobile Home Value	Farm Tax Value	Farm Fair Cash Value	TC Build Value	TC Land Value	LS Hold Value
NA	NA	NA	\$ 186,000	\$ 317,900	NA	NA	NA
Homestead: Yes							

More detailed information is available via subscription service. Details [here](#)

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COMMONWEALTH OF KENTUCY
BEFORE THE PUBLIC SERVICE COMMISSION

In the Matter of:

HAROLD BARKER;
ANN BARKER; and
BROOKS BARKER

COMPLAINANTS

Case No 2013-00291

V. RESPONSE TO EAST KENTUCKY POWER COOPERATIVE, INC's
OFFER OF SETTLEMENT

EAST KENTUCKY POWER COOPERATIVE, INC.

DEFENDANT

Come the Complainants, Harold Barker, Ann Barker and Brooks Barker ("Complainants"), by counsel, and for their response to the Offer of Settlement submitted by East Kentucky Power Cooperative, Inc. ("EKPC"), state as follows:

Initially, the Complainants wish to clarify certain items of misinformation contained in EKPC's Offer of Settlement. These are:

1. The Complainants and the parents of Complainant Ann Barker, the latter being the Complainants' predecessors in title to the subject property, have been customers of Clark Energy since 1938. Clark Energy is one of the distribution utility companies of EKPC. Accordingly, Complainants are customers of EKPC, contrary to the suggestion made in the Offer of Settlement.

2. The Complainants farm consists of three adjoining tracts totaling 198 acres rather than 150 acres as asserted in the Offer of Settlement.

3. The total assessed value of the Complainants' 198-acre farm is \$927,900.00, rather than \$317,900.00 as stated in the Offer of Settlement. (See attached PVA statement.)

Considered in this light, the loss to the Complainants' real property caused by EKPC's expanded easement as reported by Complainants' appraiser is proportionate to the total value of the land.

4. EKPC has made no written offers of compromise during the course of litigation in Clark Circuit Court. The parties have engaged in some informal settlement discussions but there has been no formal offer which could have been accepted or declined as EKPC's Offer of Settlement implies.

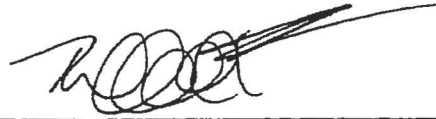
5. Complainants never assumed the risk of a 345 kV/138 kV line running over their residence with the resultant electromagnetic field constantly present in their home.

6. EKPC's Offer of Settlement estimates the cost of moving its transmission line to be approximately \$1 million. Yet EKPC's own figures indicate the cost for the entire 18-mile project of removing the old transmission line and replacing it, along with the necessary land acquisition, was \$20 million. It is beyond cavil to believe that moving less than one-half mile of line would cost as much as EKPC claims.

Complainants decline the proffer contained in paragraph six of EKPC's Offer of Settlement. They believe EKPC should have selected a more suitable route across their land to erect a transmission line carrying much greater capacity than the original 69 kV line. The actual and potential consequences of the new line are of great concern to the Complainants and they believe this is a situation which could have easily been avoided.

Nevertheless, Complainants are willing to engage in meaningful settlement discussions in the presence of a representative of the Commission at a place and time convenient for all parties.

Respectfully submitted,




M. ALEX ROWADY, ESQ.
Blair & Rowady, P.S.C.
212 South Maple Street
Winchester, Kentucky 40391
(859) 744-3251
ATTORNEY FOR COMPLAINANTS

CERTIFICATE OF SERVICE

This is to certify that a true copy of the foregoing Response was sent by first-class mail to Kentucky Public Service Commission, P.O. Box 615, Frankfort, Kentucky 40602-0615, David S. Sanford, Esq., Gross Samford, PLLC, 2365 Harrodsburg Road, Suite B235, Lexington, Kentucky 40504 and Sherman Goodpaster, Esq., Attorney for Plaintiff, P.O. Box 707, Winchester, Kentucky 40392-0707, this 12th day of September, 2013.



M. ALEX ROWADY, ESQ.



Clark County Kentucky Property Valuation Administrator

Karen R. Bushart
karenr.bushart@clarkpva.com

34 S. Main Street
Winchester, KY 40391
Phone: 859-745-0250
Fax: 859-745-0205

Hours: 8:00a.m. - 4:00p.m. Tue-Fri
8:00a.m. - 5:00p.m. Mondays

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Owner and Parcel Information

Owner Name	BARKER ANN BROOKS BARNES	Today's Date	September 12, 2013
Mailing Address	5450 MT STERLING RD WINCHESTER, KY 40391	Map Number/Account Number	088-0000-001-00 / 8090001
Description	PARCEL 1A & BAL OF LAND	Tax District	County
Location Address	5450 MT STERLING RD	2013 Rate Per Thousand	0.9160
Deed Book	212	Parcel Map	Maps available with subscription
Building Photo	Building Images	Deed Page	133
		Building Sketch	Building Sketches

Certified Value Information

Residential Value	Commercial Value	Mobile Home Value	Farm Tax Value	Farm Fair Cash Value	TC Build Value	TC Land Value	LS Hold Value
NA	NA	NA	\$ 186,000	\$ 317,900	NA	NA	NA

Homestead: Yes

More detailed information is available via subscription service. Details [here](#)

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**Clark County Kentucky
Property Valuation Administrator**

Karen R. Bushart
karenr.bushart@clarkpva.com


34 S. Main Street
Winchester, KY 40391
Phone: 859-745-0250
Fax: 859-745-0205

Hours: 8:00a.m.-4:00p.m. Tue-Fri
8:00a.m.-5:00p.m. Mondays

Photograph 1 for Parcel: 088-0000-001-00



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Clark County Kentucky Property Valuation Administrator

Karen R. Bushart
karenr.bushart@clarkpva.com

34 S. Main Street
Winchester, KY 40391
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 [Previous Parcel](#)
 [Next Parcel](#)
 [Field Definitions](#)
 [Return to Main Search Page](#)
 [Subscription Home](#)
 [Clark Home](#)

Owner and Parcel Information

Owner Name	BARKER ANN BROOKS BARNES	Today's Date	September 12, 2013
Mailing Address	5450 MT STERLING RD WINCHESTER, KY 40391	Map Number/Account Number	088-0000-004-01 / 8090004
Description	PARCEL 2	Tax District	County
Location Address	5660 MT STERLING RD	2013 Rate Per Thousand	0.9160
Deed Book		Parcel Map	Maps available with subscription
Deed Page		Deed Page	
Building Photo	Building Images	Building Sketch	NA

Certified Value Information

Residential Value	Commercial Value	Mobile Home Value	Farm Tax Value	Farm Fair Cash Value	TC Build Value	TC Land Value	LS Hold Value
NA	NA	NA	\$ 61,600	\$ 610,000	NA	NA	NA

Homestead: No

More detailed information is available via subscription service. Details [here](#)

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**Clark County Kentucky
Property Valuation Administrator**

Karen R. Bushart
karenr.bushart@clarkpva.com

34 S. Main Street
Winchester, KY 40391
Phone: 859-745-0250
Fax: 859-745-0205

Hours: 8:00a.m.-4:00p.m. Tue-Fri
8:00a.m.-5:00p.m. Mondays

Photograph 1 for Parcel: 088-0000-004-01



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PUBLIC SERVICE
COMMISSION

* * * * *

Handwritten signature

ATTORNEY FOR COMPLAINANTS

HAROLD BARKER;)
ANN BARKER; and)
BROOKS BARKER,)
COMPLAINANTS)
V.) TESTIMONY OF JOHN C. PFEIFFER
EAST KENTUCKY POWER)
COOPERATIVE, INC.,)
DEFENDANT)

* * * * *

1. He is a registered professional engineer, electrical, in the states of Kentucky, Indiana, Tennessee and Ohio.
2. His report rendered in connection with the above matter, and his curriculum vitae, are attached hereto and he adopts same as his testimony herein.
3. The authority cited in his report are those commonly consulted and referenced in the field of electrical engineering design.

JOHN C. PFEIFFER

Subscribed and sworn before me by **JOHN C. PFEIFFER**, on this 27th day of April, 2014.

My commission expires: 12/31/2011

NOTARY PUBLIC
STATE OF KENTUCKY AT LARGE



Pfeiffer Engineering Co., Inc.

...the art of engineering

INVESTIGATION REPORT

FOR

Mr. & Mrs. Barker

5450 Mount Sterling Road

Winchester, Kentucky

PREPARED BY:

PFEIFFER ENGINEERING CO., INC.

BY: JOHN C. PFEIFFER, P.E.

PRESIDENT

PROJECT NO. 212001

DATE: April 24, 2014

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SECTION 1

I. INTRODUCTION:

At the request of Ann Barker, John C. Pfeiffer, P.E., investigated the installation of new overhead electrical transmission lines belonging to the East Kentucky Power Cooperative (EKPC). The purpose of the investigation was to determine if hazards are now present on her property as a result of the new transmission line.

II. QUALIFICATIONS:

John C. Pfeiffer, P.E. is a registered electrical engineer in the states of Kentucky, Ohio, Tennessee and Indiana and is employed by Pfeiffer Engineering Co., Inc. as principal engineer/owner. He has worked in the practice of electrical engineering for more than forty years. Primary experience is in the design of electrical systems for industry.

III. COMPLIANCE:

All work is performed in compliance with the National Fire Protection Association No. 921 "Guide for Fire and Explosion Investigation".

IV. SUMMARY OF ISSUES:

This report is a review of the issues concerning the location of the new 345,000 Volt (345kV) Smith-Hunt-Sideview transmission line that EKPC installed across the farm belonging to Mr. & Mrs. Barker. The issues concern the safety or perceived safety of the transmission lines that were installed very close to their house. Due to the procedures followed by EKPC the Barkers' were denied the time to explore the health and safety issues associated with such a high voltage transmission line afforded by the Certificate of Public Convenience and Necessity process required by the Public Service Commission.

The EKPC report¹ states that there are only three (3) houses that are within 0 to 100 feet of the new transmission line. One of these houses is the Barker house/garage, which is within 48 feet of the nearest 345 kV conductor. This report will layout two options for relocation of the transmission line to a safer distance from the Barker house and the estimated total cost of this relocation (at the time of initial construction) is only \$2000.00 or 0.01% of the cost of the overall transmission line project. Thus, if EKPC had followed the design guidelines of the Rural Utility Service branch of the U.S. Department of Agriculture, the cost to EKPC would have been absolutely minimal particularly considering that there were only three houses so close to the transmission lines. If EKPC would have considered the Barkers' safety and the general public's safety this additional cost would have been well worth reducing the potential health risk that the Barkers' now face.

The cost to move the line now that they are installed will be many times the cost if the line was installed correctly from the beginning.

This report may appear to express a legal opinion which the author is not qualified to opine but rather the intent is to define many facts that which are primarily scientific in nature.

¹ EKPC Environmental Report for the Proposed Smith to Sideview electric Transmission Project, May 2006, page 40 (Gilpin Report)

A. Initial Problem:

An H-Frame transmission line pole was to be placed near the front yard of the Barkers' house. See Figure 1 below.

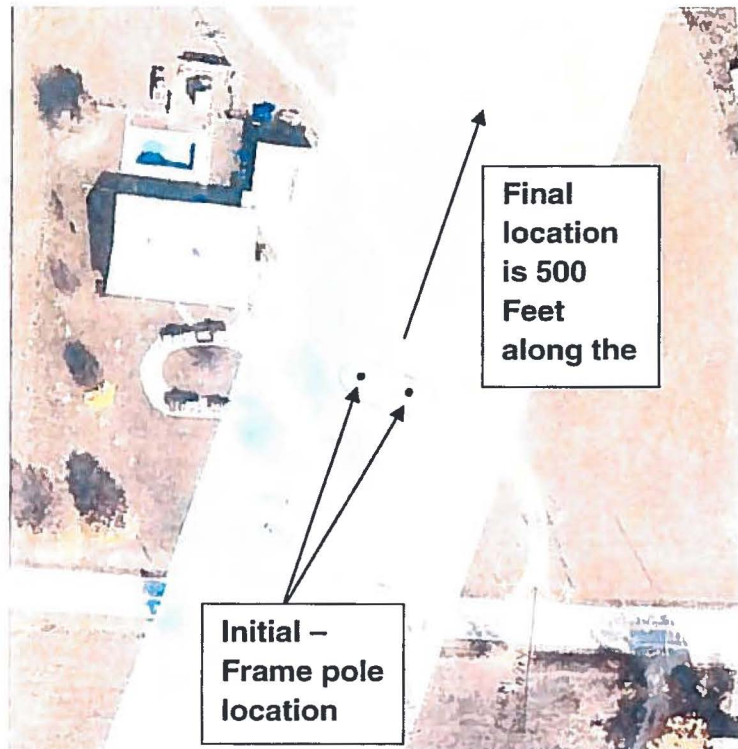


Figure 1 - Preliminary EKPC Right Of Way Document²

B. Second Problem:

The poles were relocated 500 feet to the rear of the house but the Right-of-Way (ROW) did not move. The ROW still encroaches upon the Barkers' house.

² EKPC presented this photograph at the public meeting on Meeting of 11/10/2005



Figure 2 - New Transmission Lines at the Barker House

V. Overall Concerns:

There are a number of key issues with respect to this transmission line, which will be addressed here and then detailed later on in this report.

- A. East Kentucky Power Cooperative Inc. (EKPC) was required by KRS 278 to obtain a Certificate of Public Convenience and Necessity (CPCN). EKPC misrepresented critical distances where new right-of-way for the transmission line is required in addition to the existing right-of-way being used for the majority of the project. This mis-statement of facts occurred on October 7, 2005 in EKPC's letter to the Public Service Commission requesting a waiver for the need to apply for a CPCN. As a result of this mis-statement of facts the Barkers' were denied the right to express their concerns for any health risk associated with such a high voltage transmission line in close proximity to their house. The house and garage is partly in the existing right-of-way.
- B. The Barkers' have concerns associated with health risks to themselves as well as visitors to their house, particularly for children, pregnant women and older people with implanted medical devices that visit their candy shop.
- C. EKPC recognized the Barkers' health concerns as well as the close proximity of their house to the right-of-way at EKPC's open house as documented by Mr. Thad A. Mumm, P.E. This request by the Barkers' was made well before the design of the transmission line was complete. Design was performed between 8/05 and 4/06, and the Open House

on 11/10/05. Mr. Mumm noted³ that the Barkers' concerns for EMF and requested that the transmission line be moved away from their house. Mr. Mumm is an electrical engineer and was employed by EKPC between January 2005 and October 2007 as an engineer responsible for the design, routing and construction of 69kV to 345kV transmission lines⁴.

- D. EKPC met with the Barkers' on 4/27/06 concerning the placement of H-frame utility poles near their front yard as was planned. On 5/8/06, EKPC met again with Barkers' to inform them that the pole could be moved about 40 feet back from its planned location. The pole was in fact moved about 500 feet back to where the pole is today.
- E. At this point in the design of the transmission line, while they were relocating the poles and line, they could have easily designed the changes in line location so that the right-of-way did not encroach on the Barkers' house and garage. Thad Mumm, one of EKPC's electrical engineers, recorded the Barkers' concerns about EMF and line location on November 10, 2005.
- F. EKPC mis-represented the health concerns associated with Electro Magnetic Fields (EMF) when Dr. Paul A. Dolloff, met with the Barkers' on 12/05/08. He stated that he knew of no regulations in the United States concerning power line EMF. Dr. Dolloff is a Senior Engineer, Research & Development Group of EKPC and a member of the Electric Power Research Institute (EPRI) which is one of the premier engineering organizations dealing with electrical energy transmission. The EPRI has performed and/or collected a large amount of technical reports concerning the health effects of power line EMF. See Section 9 which lists 370 of the many EMF health reports available on the EPRI website.
- G. The health and safety issues of EMF have existed for many years and after thousands of tests and research projects, there is no consensus as to the existence or severity of these effects. One of the biggest problems with the EMF health issue is the lack of consensus on how research is performed. Some of the following questions still have to be agreed to.
 - What is Proof? Is an unreasonably high and overly-restrictive definition of proof keeping organizations from accepting the issues?
 - What is sufficient proof? How much proof is needed?
 - Are we researching all EMF frequencies during a research project or do we limit the research to just power line frequencies?
 - Do we have to determine the exact mechanisms that cause a disease to take precautions? We still don't know how a lot of cancers work yet we believe that cancer is a serious issue.

³ EKPC Transmission Line Siting Data List, from 11/10/05

⁴ LinkedIn - <http://www.linkedin.com/pub/thad-a-mumm-p-a/3a/7b2/a26>

- Do we have to be able to reproduce in the laboratory using mice before we accept that there is a serious concern?
- Some of these issues have existed for many years. As research continues with 1800 such projects over the last few years some of the last issues have started to be proven, such as a potential mechanism as to how EMF cause disease has been found and as well as some EMF effects have been replicated in laboratory mice.
- As of today, no one has proven that EMF does not affect health.

H. Perceived Health Risk:

Transmission lines that are of a voltage level of 138kV and 345kV are perceived by many in the general public and also by many learned professionals, to pose a significant health risk. These health risks are associated with the electromagnetic fields (EMF) that are produced by these transmission lines.

These perceived health risk are also affecting the candy business that Mrs. Ann Barker runs out of her garage, as people are afraid to come to her business because of the close proximity to these lines.

SECTION 2 – OPINION

The purpose of this investigation was to determine if there is a potential of danger to people being in the vicinity of the Barkers' house due to the close proximity of the new electric transmission lines as well as the Barkers themselves.

The analysis and conclusions are based upon the information reviewed to date plus general engineering knowledge and experience. Information reviewed at a later date may warrant modifying or clarifying the conclusions.

It is my opinion, based on a reasonable degree of engineering certainty, that the electric utility should have known of these potential health risks and could have easily reduced these hazards.

- A. That EKPC set the new right of way too close to the Barkers' house, garage/office and driveway.

Evidence:

EKPC photograph presented at a public meeting on November 10, 2005, which shows the existing right of way crossing the garage and driveway.

At EKPC's Open House on November 5, 2005, Mr. Mumm is an electrical engineer and was employed by EKPC between January 2005 and October 2007 as an engineer responsible for the design, routing and construction of 69kV to 345kV transmission lines⁵, noted the close proximity of the Barker house to the power lines and the potential for EMF problems⁶.

- B. That EKPC did review the Barkers' close proximity to the transmission lines at a time when corrective action could have been taken at minimal cost.

Evidence:

This section of the transmission line was redesigned as it encroached upon the Barkers' house. The H-frame pole system was relocated approximately 500 feet to the north.

- C. The cost of relocating the power lines before construction started would have been in the range of \$2,000.00 to \$4,000.00.

Evidence:

A calculation of the additional cost is provided below.

- D. That there is a real danger for people with implanted medical heart devices when they are in the close proximity of the Barker house, such as on the driveway. The danger comes from the electric fields at the house, which can rise to a level that will interfere with implanted medical devices.

Evidence:

⁵ LinkedIn - <http://www.linkedin.com/pub/thad-a-mumm-p-e/3a/7b2/a26>

⁶ EKPC Transmission Line Siting Data List, from 11/10/05

EKPC had concerns about electric fields that could product micro-shocks at the time of construction of the power line. They sent workers to the farm to install grounding connections to the fences around the house.

Even after fence grounding was installed, the potential of micro-shocks still exists and vehicles become charged as they sit in the driveway. The truck belonging to Brooks Barker had measured charges that were recorded at 265.7 volts. Other measurements have read as high as 330.0 volts.

Electric Power Research Institute (EPRI) is in the process of developing a small hand held electric field meter, which is intended to be used by electrical lineman and electricians to use to check for dangerous electric fields.

Medical Institute Opinions:

Yale Medical Group, Yale School of Medicine "Living With a Pacemaker or Implantable Cardioverter Defibrillator (ICD).

"Avoid certain high-voltage or radar machinery, such as radio or television transmitters, arc welders, high-tension wires, radar installations, or smelting furnaces."

Rochester Medical Center, Permanent Pacemakers, "Avoid being near areas with high voltage, magnetic force fields, or radiation because these can cause pacemaker malfunction. These areas may include high-tension wires, power plants, large industrial magnets and arc welding machines. Symptoms of pacemaker malfunction are dizziness, lightheadness or changes in heart rhythm. If symptoms occur, back up 10 feet and check your pulse."

Mercy Health Organizations, "You should avoid all strong magnetic fields, such as welding, large transformers, or large motors."

Electric Power Research Institute (EPRI), They are in the process of developing a device which will be a simple method to test for potential problems.

E. That there is a potential health risks due to the magnetic and electric fields.

There are an overwhelming number of research projects and papers that have been written on the effects of electric and magnetic fields caused by low frequency power sources on the health of people, animals, etc. Organizations, such as Electric Power Research Institute (EPRI) has documented 398 or more such reports over 30 years. From 2007 to 2012 an additional 1800 research projects were performed. The following is a list of just a few of the world wide organizations who are studying the effects of EMF:

- World Health Organization (WHO)
- Electric Power Research Institute (EPRI)
- Institute of Electrical and electronic Engineers (IEEE)
- Department of energy (DOE)\
- National Institute of environmental Health (NIEHS)
- International Agency for Research on Cancer (IARC)
- BioInitiative Working Group
- European Health Risk Assessment Network (EFHRAN)

American Conference of governmental Industrial Hygienists (ACGIH)

Evidence:

The World Health Organization has reviewed over 1800 new studies between 2007 and 2012 on EMF health effects.

EPRI has performed research on EMF effects for over 30 years.

"The World Health Organization (WHO) has weighed the full body of evidence from all these studies and classified EMF as **"possible carcinogenic,"** primarily because of observations made in human populations that show an association between magnetic field exposures and childhood leukemia." (EPRI publication: EMF and Your Health, January 2012).

EPRI EMF Research News: American Journal of Epidemiology on November 5, 2008, reported an increased risk in mortality from Alzheimer's disease and senile dementia among people who live less than 50 meters (164 feet) from power lines, compared with those who lived at least 600 meters (1968 feet) from power lines.

Xiaoming Shen and his colleagues of Jiao Tong University School of Medicine in Shanghai announced the results of research that may finally explain just how EMF radiation causes childhood leukemia. They finally determined that the distribution of leukemia among children living near high voltage power lines or transformers is not random; rather, it affects children carrying a certain genetic variant that is, the ability to repair DNA breaks vastly more often^{7 8 9}

Acute exposure to a 60 Hz increases DNA strand breaks in rat brain cells.¹⁰ And these are repeatable tests.

High frequency EMF has been known for many years that it will KILL human cells. This high frequency EMF known as X-Rays have been used for years to kill cancer cells in the human body.

Seven states have standards dealing with exposure to electric and magnetic fields. Other states have taken steps to limit exposure to EMF. In addition, a number of countries have established standards and limits to EMF exposure.¹¹

- Six states have limits on magnetic fields^{12 13}
 - Florida
 - New York
- Two states have limits on electric fields^{14 15}
 - Florida

7 Faulty DNA Repair May Explain EMF Role in Childhood Leukemia, Microwave News, December 15, 2008

8 Power-line radiation and childhood leukemia, IEEE spectrum, December 16, 2008

9 Leukemia & Lymphoma, Dec. 2008

10 Bioelectromagnetics vol 18, issue 2, pages 156-165, H. Lai & N.P. Singh

11 Environmental Law Centre, Regulating Power Line EMF Exposure: International Precedents, 4/15/05

12 International Commission Non-Ionizing Radiation Protection (ICNIRP)

13 NEIHS 2002

14 International Commission Non-Ionizing Radiation Protection (ICNIRP)

15 NEIHS 2002

- Minnesota
- Montana
- New Jersey
- New York
- Oregon
- States with state and local power line restrictions
 - Connecticut
 - California
 - Washington
 - Rhode Island
 - Colorado
 - Kentucky – Sitings of Electrical Transmissions Lines, research Report No. 348, 11/2/07, Health concerns related to electromagnetic Fields.
- Countries
 - European Union – European Council issued Council recommendation 1999/519/EC setting a limit on the exposure of EMF to the public
 - United Kingdom – adopted ICNIRP standards
 - Austria
 - Finland
 - France
 - Italy
 - Latvia
 - Republic of Lithuania
 - Romania
 - Switzerland

With all of this existing research, research continues and a definitive cause-effect connection has only been basically defined and a cause-effect connection has NOT been eliminated. This is partly due to the lack of consensus as to the research protocols.

F. The full effects of EMF on the Barker house has yet be felt.

The power lines are being operated at far less than full capacity today. As the loading increases, the power lines will sag causing them to come closer to the house. This

sagging of the power lines is due to the heat buildup because of resistive losses in the power line conductors.

As the power lines come closer to the Barker house, the EMF levels will increase.

Evidence:

Calculations of conductor sag and their effect on EMF have been developed for this location and is defined below.

I have estimated that the magnetic fields will be varying from 10 mG and to a high of 191 mG over time. Also the electric fields will vary from 0.997 kV/m to a high of 1.438kV/m over time.

"The background levels of power line magnetic fields in the typical U.S. home are between 0.5 mG and 4 mG with an average of 0.9 mG."¹⁶ The Barkers' house has measurements at the kitchen window as shown below.

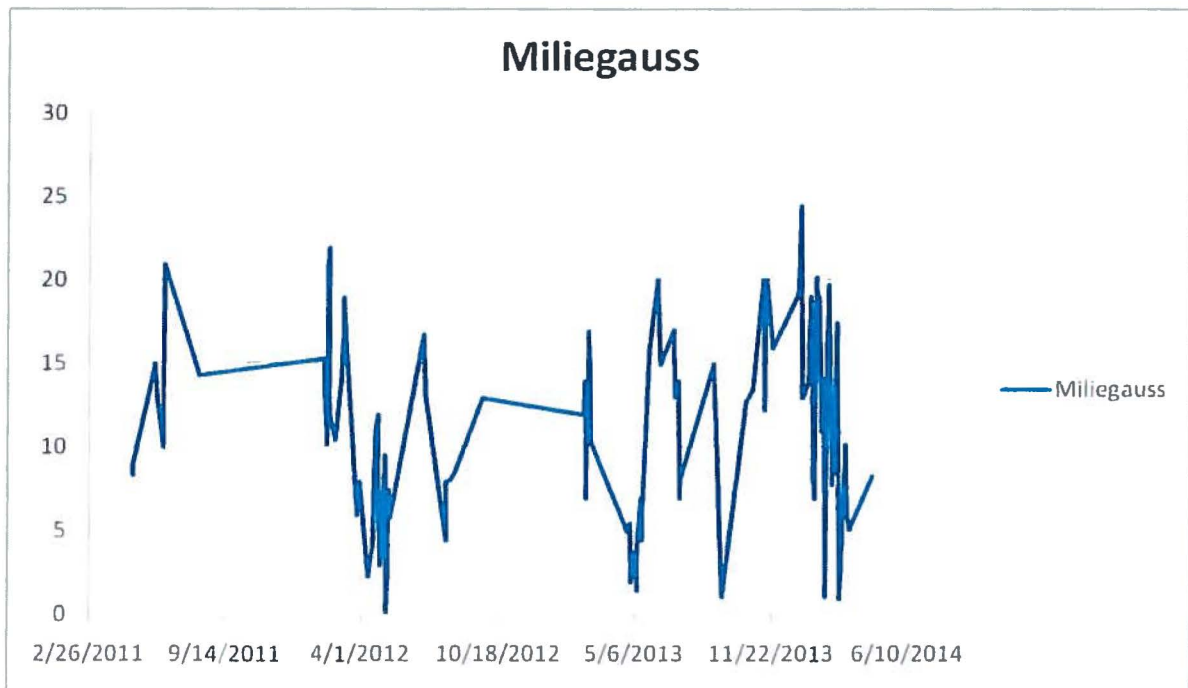


Figure 3 - Barker Magnetic Field Measurements

- G. EKPC personnel knowingly mislead the Barkers with respect to the known health risks associated with EMF.

Evidence:

Recording of the conversation between Dr. Paul A. Dolloff, EKPC Senior Engineer, Research & Development Group of EKPC where he stated that he does not know of any standards dealing with EMF in the US. Dr. Dolloff being in a senior position of EKPC and a member of EPRI where he has access to all of their literature on EMF he surely knew or should have known of what other utilities are doing with respect to EMF. Dr. Dolloff had access to the needed test equipment at EKPC.

¹⁶ CapX2020 "Electric and Magnetic Fields (EMF): the Basics, www.capx2020.com

H. EKPC Environmental Report produced by the Gilpin Group, May 2006, stated that "no structures would be located close enough to the proposed transmission line to experience increased EMF levels."¹⁷ This is clearly an inaccurate statement as will be shown at trial.

Further, it is my opinion that the electric utility should have known of these potential health risks and could have easily reduced these hazards.

¹⁷ EKPC Environmental Report, May 2006, Page 54

SECTION 3 – BASIC INFORMATION

VI. BASIC FACTS

- Barker property – 5450 Mt. Sterling Road, Winchester, Kentucky 40391
- Original transmission line was 69 kV.
- EKPC checked the location of the Barker house before the house was built (according to Ann Barker) and did not object to its location.
- The Right Of Way was increased from 100 feet to 150 feet for this new line.
- Initial design placed one H-frame pole system next to the house. This design was shown to the Barkers at a public meeting on November 10, 2005.
- The Right of Way for the new line was shown to be Barkers as being right next to their house.
- EKPC reviewed the location of the Barker house when the new transmission line was designed.
- This section of the transmission line was redesigned as it encroached upon the Barkers' house. The H-frame pole system was relocated approximately 400 feet to the north.
- Micro-shocks are being felt by persons on the Barker property since the new lines were energized.
- Electrostatic charge buildup has been measured on cars/trucks in the driveway as high as 330 volts.
- The cost for moving the line 221 feet to the east at the time of construction would have only added approximately between \$2,000.00 and \$4,000.00 to the overall cost of the project.
- Only three (3) houses on the proposed transmission line were within 100' of the right-of way.
- RUS requires that every reasonable effort should be made by the engineer to accommodate the landowner.
- RUS requires that it may be necessary to consider routing small segments of the line due to the inability of the right-of-way agent to satisfy the demands of property owners.
- Dr. Paul A. Dolloff, EKPC Research & Development, stated that **he knew of no standards anywhere¹⁸ within the United States.**

¹⁸ Meeting at the Barker house on 12/2008, meeting was video recorded.

- EKPC stated that there are "no structures would be located close enough to the proposed transmission line to experience increased EMF levels."¹⁹

VII. TIMELINE OF EVENTS

11/9/51	Original easement issued, 50 acres where the house is located
6/13/52	Easement issued for the 150 acres for the remaining part of the farm
1974	House built
8/05 – 4/06	Survey
8/05 – 4/06	Design
8/05 – 8/06	Negotiate ROW
10/7/05	EKPC requested a waiver of the CPCN
10/26/05	PSC granted the waiver of the CPCN
10/28/05	EKPC mailed notices to 250 property owners
10/29/05	Janet Smallwood & Timothy Smallwood accepted an option on their ROW
10/31/05	The Barkers' received letter inviting her to meeting
10/31/05	The Barkers' received booklet on EMF
11/3/05	Notices of meeting published in the Winchester newspaper
11/5/05	Notices of meeting published in the Winchester newspaper
11/7/05	Notices of meeting published in the Winchester newspaper
11/10/05	Public meeting @ Clark County Cooperative Office The Barkers' first meeting with EKPC EKPC stated that they did not know the exact route of the line
12/20/05	Letter to U.S. fish and Wildlife Service provided the proposed route
1/1/06	Established the centerline of the transmission line
4/06 – 7/06	Structure staking
4/06 – 4/07	Line construction
4/27/06	EKPC met with the Barkers' to discuss the H-frame pole near their front yard.
5/8/06	EKPC decided to relocate the H-Frame pole
5/06	Gilpin Group Environmental Report
5/27/06	Legal Notice on rebuilding the transmission line
6/25/07	Final Report
7/16/07	Public Service Commission – applicant's response
12/5/08	EKU electric field measurements
2010	Voltage reading – car lug nut to earth 253.5 v
2010	Voltage reading – car lug nut to earth 265.9 v
1/8/12	6.5 mG @9:45 pm inside house
1/9/12	6.9 mG @6.45 am inside house
1/19/12	PECI mG measurements

SECTION 4 – CERTIFICATE OF PUBLIC CONVENIENCE AND NECESSITY

VIII. BASIC REQUIREMENTS:

The requirements that govern how the public can comment on the acceptability of new transmission line projects is partly contained within KRS 278, which requires a Certificate of Public Convenience and Necessity. The requirement that defines when a CPCN is required is stated in paragraph 278.020 (1) and (2). Following this definition is an exception, which will allow the PSC to waive the CPCN requirement. The use of this exception by EKPC is one of the reasons for this report. This exception requires the determination of the length on the transmission line from engineering maps and the determination as to where the transmission line deviates from existing Right-of-Ways.

"278.020 Certificate of Convenience and Necessity required for construction provision of utility service or of utility -- Exceptions -- Approval required for acquisition or transfer of ownership -- Public hearing on proposed transmission line -- Severability of provisions."

"(2) For the purposes of this section, construction of any electric transmission line of one hundred thirty-eight (138) kilovolts or more and of more than five thousand two hundred eighty (5,280) feet in length shall not be considered an ordinary extension of an existing system in the usual course of business and shall require a certificate of public convenience and necessity. However, ordinary extensions of existing systems in the usual course of business not requiring such a certificate shall include:

- (a) The replacement or upgrading of any existing electric transmission line; or
- (b) The relocation of any existing electric transmission line to accommodate construction or expansion of a roadway or other transportation infrastructure; or
- (c) An electric transmission line that is constructed solely to serve a single customer and that will pass over no property other than that owned by the customer to be served."

The above statute requires that all new transmission lines of a voltage of 138kV or greater be considered for the certificate process. The new Smith-Hunt-Sideview transmission line is a 345kV transmission line that is replacing an existing 69kV transmission line. The 69kV transmission line was completely removed.

What is contested here is the length of new right-of-way that is required where no previous right-of way existed. EKPC has made various claims as to the lengths of additional right-of-way required in this project. The following is an engineering evaluation of the lengths of each section of this new transmission line and defines where each deviation takes place. There are three areas where deviations take place.

1. North Clark New Substation/Switchyard
2. Clark (Hunt) Substation
3. J.K. Smith Generating Station Substation/Switchyard

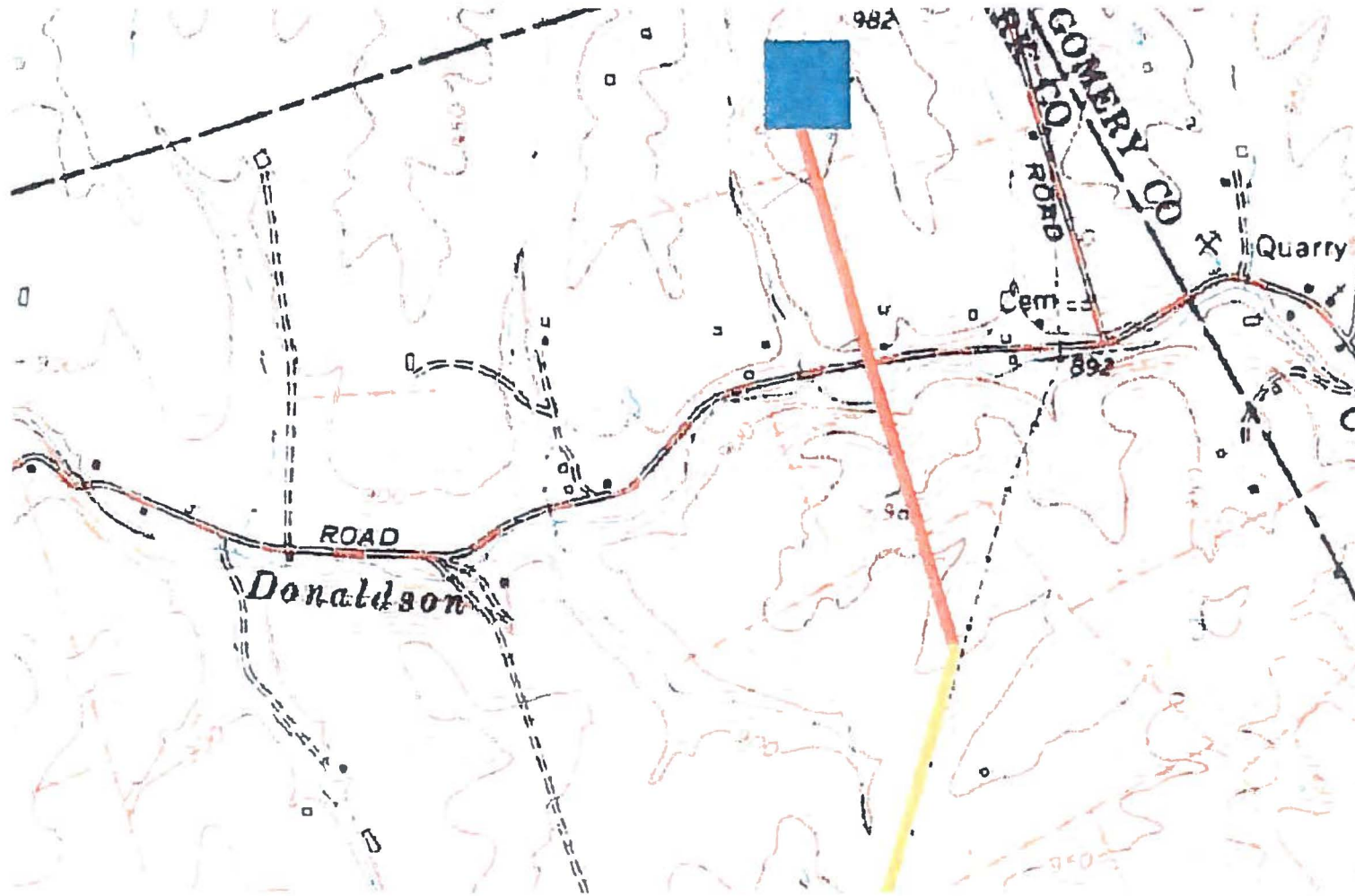
Based upon EKPC documentation²⁰ the transmission line is approximately 18.68 miles long and consists of a 345 kV circuit and a 138 kV circuit. This transmission line's estimated cost was reported to be \$20,000,000.00.

IX. ENGINEERING EVALUATION of KRS 278:

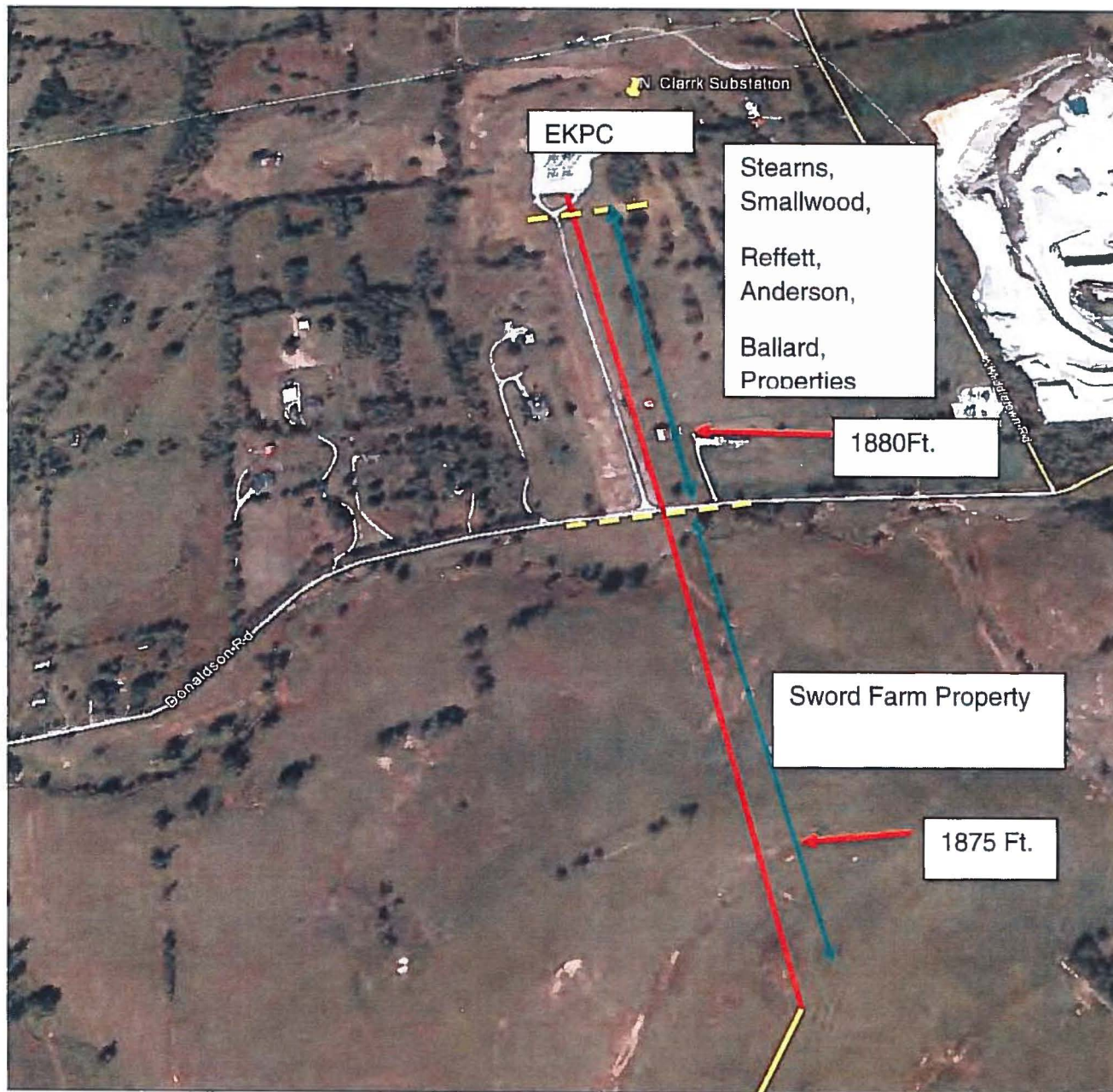
In Kentucky as well as all states there are various standards that have to be interpreted on a daily basis by engineers in their performance of engineering work as defined by the State of Kentucky. Standards such as the National Electrical Code – NFPA 70 are adopted by the State Legislature every three years in order to make these standards a requirement. Engineering interpretation of portions of KSR 278 fall into the class where Engineering interpretation is a valid duty of an engineer and does not require the interpretation of a legal staff.

²⁰ EKPC Environmental Report for the Proposed Smith to Sideview electric Transmission Project, May 2006

X. NORTH CLARK GENERATING STATION – NEW SUBSTATION



The above map from the Gilpin report defined the new right-of-way requirements in orange the existing right-of-way which is to be reused in yellow.



EKPC answer to PSC Request 1, Response 1d. page 3 of 3, states "that 1880 feet of this derivation ...is located on EKPC's substation property."

This property did not belong to EKPC until:

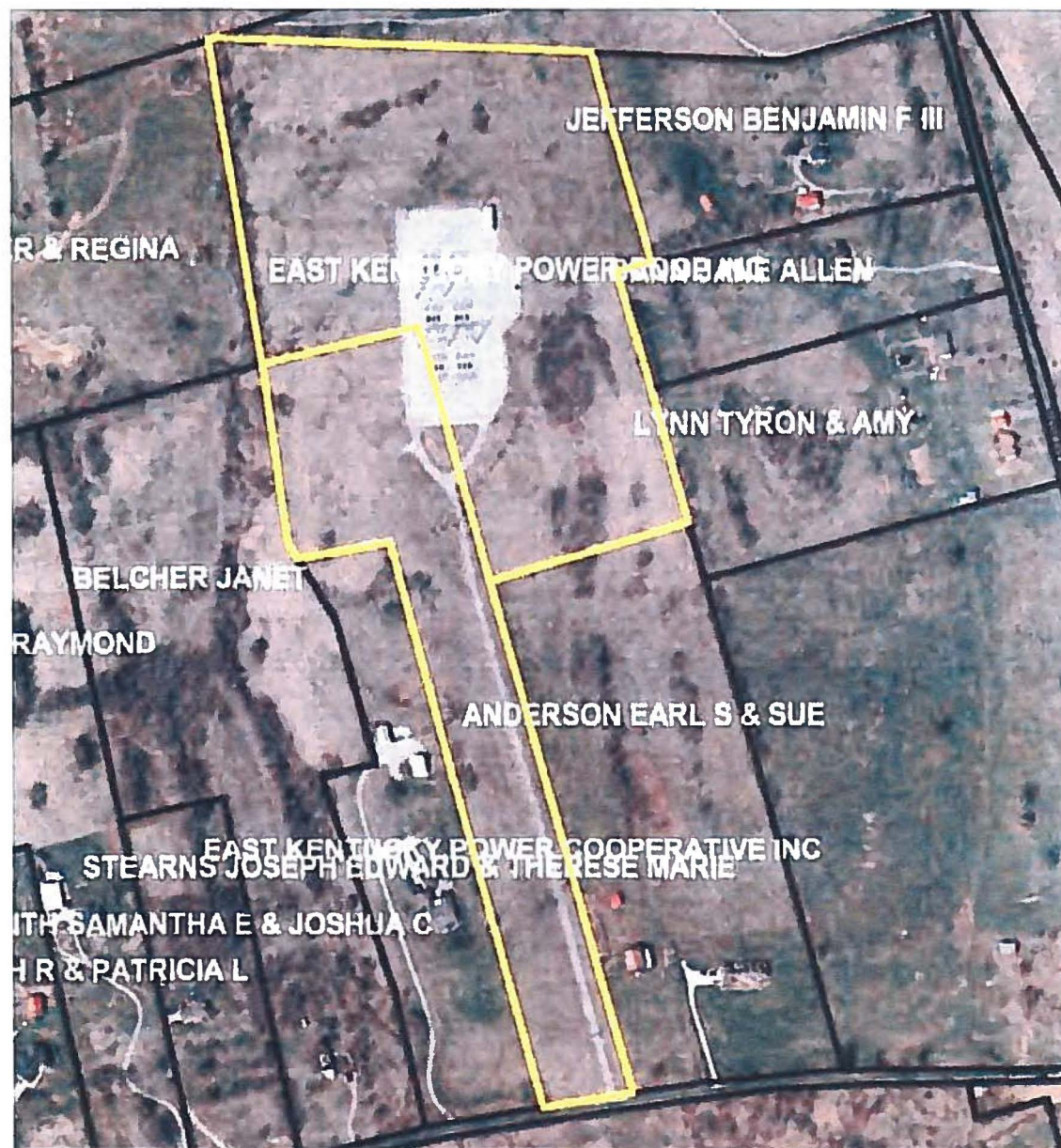
- a. Joseph & Therese Stearns – June 6, 2006 & June 16, 2006
- b. Roby & Dawn Ballard – May 8, 2006
- c. Janet & Timothy Smallwood June 6, 2006
- d. Joey & Gulena Reffett June 6, 2005
- e. Earl & Sue Anderson – October 3, 2006

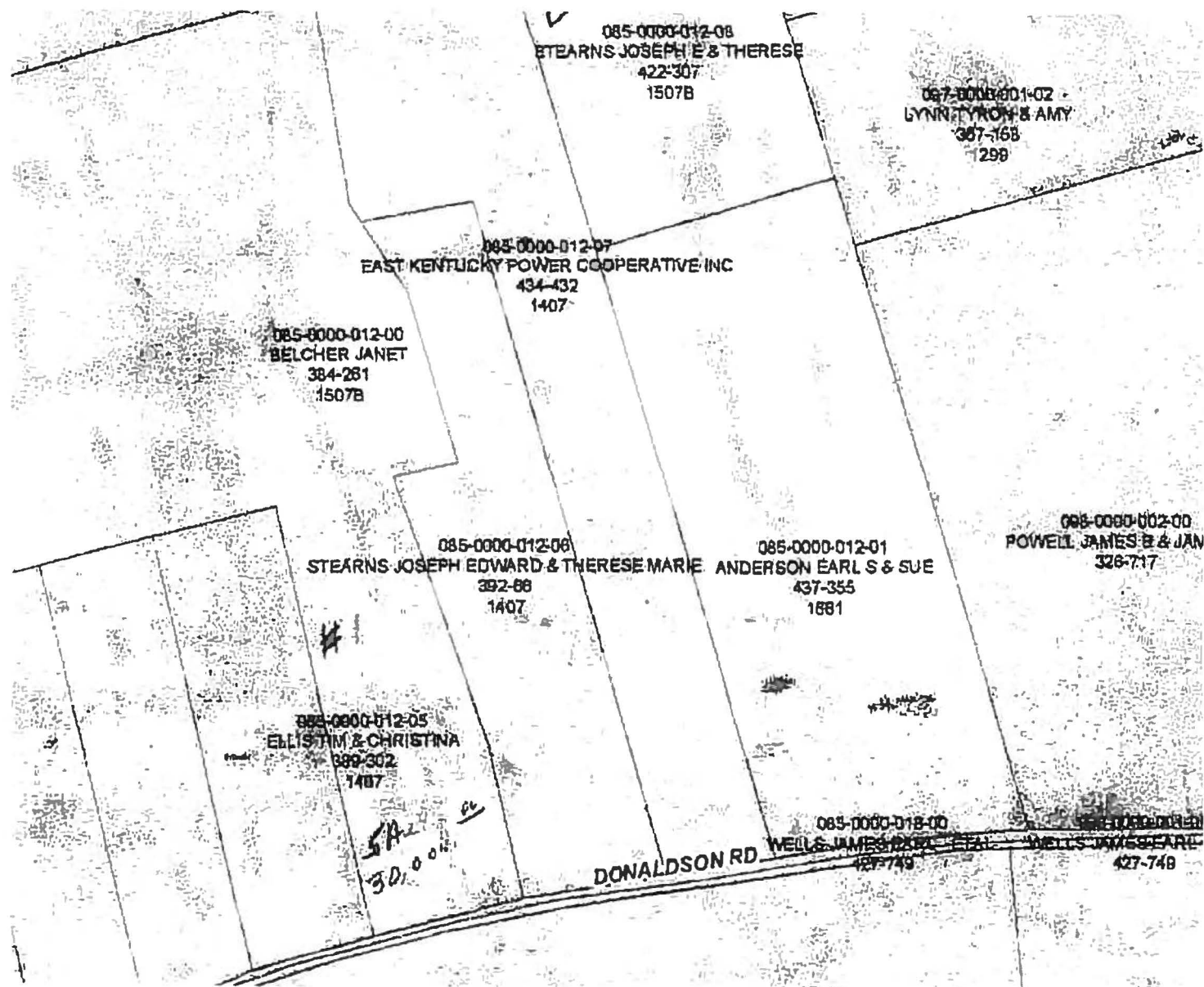
EKPC signed option to purchase the Reffett property on 11/24/2005

The above aerial view from Google Earth shows the existing and new transmission lines as they existed in 2013. The colors differentiate the new transmission line right-of-way from what was existed before this project. Also listed is the measured length of the new right-of-way. These measurements are not of the accuracy that could be provided by a Registered Land Surveyor but have the accuracy obtained using manual methods with topographical maps.

One of EKPC's claims is that the 1880 feet section of this deviation from existing right-of-way is on existing EKPC property. That is incorrect since the property leading up to the substation/switching site was purchased for this project. The chart on the right of the diagram shows the dates the property segments were purchased.

Also, nowhere in KSR 278.020 states that utility owned property is exempted for the CPCN requirements.





Kentucky property map

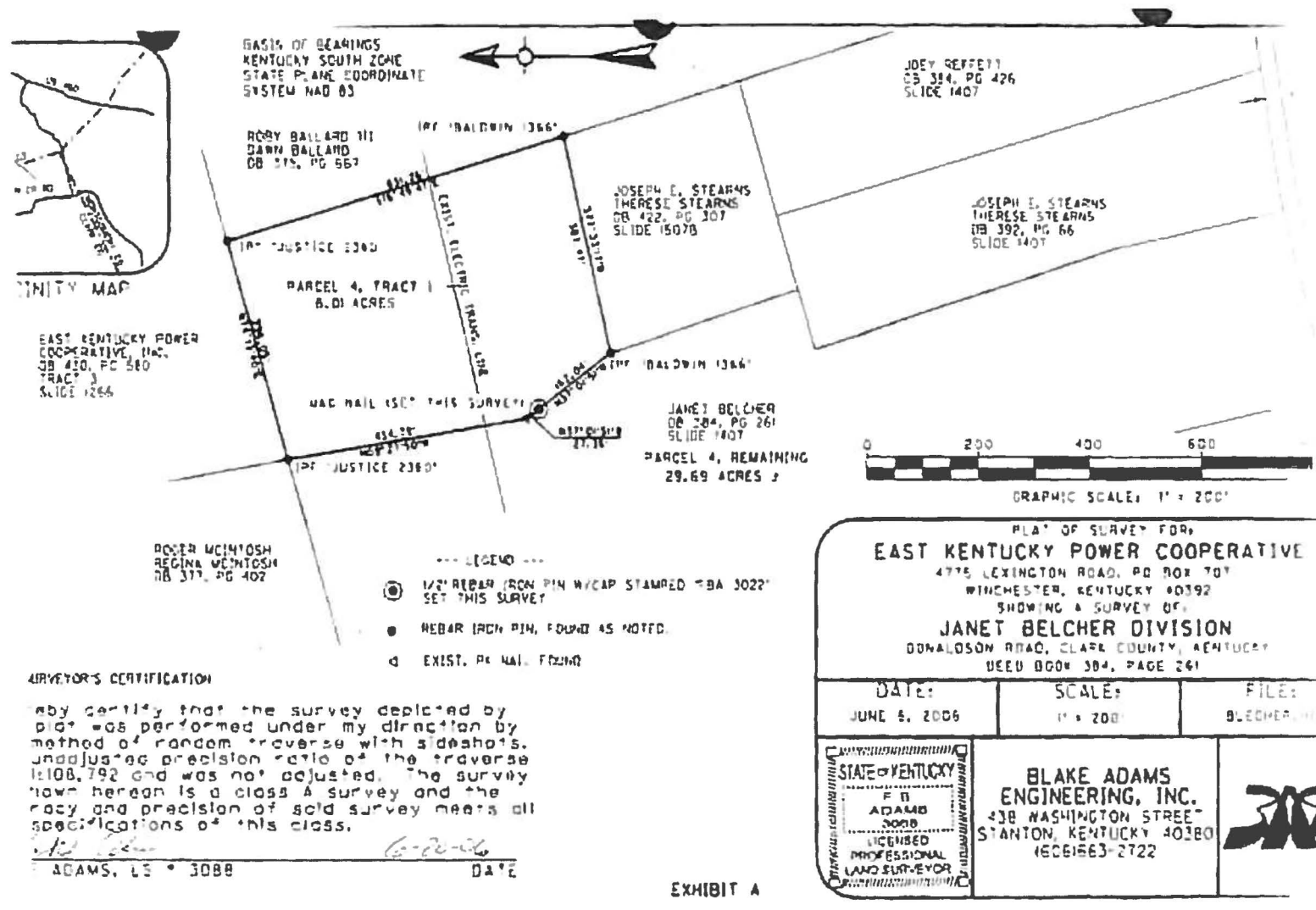
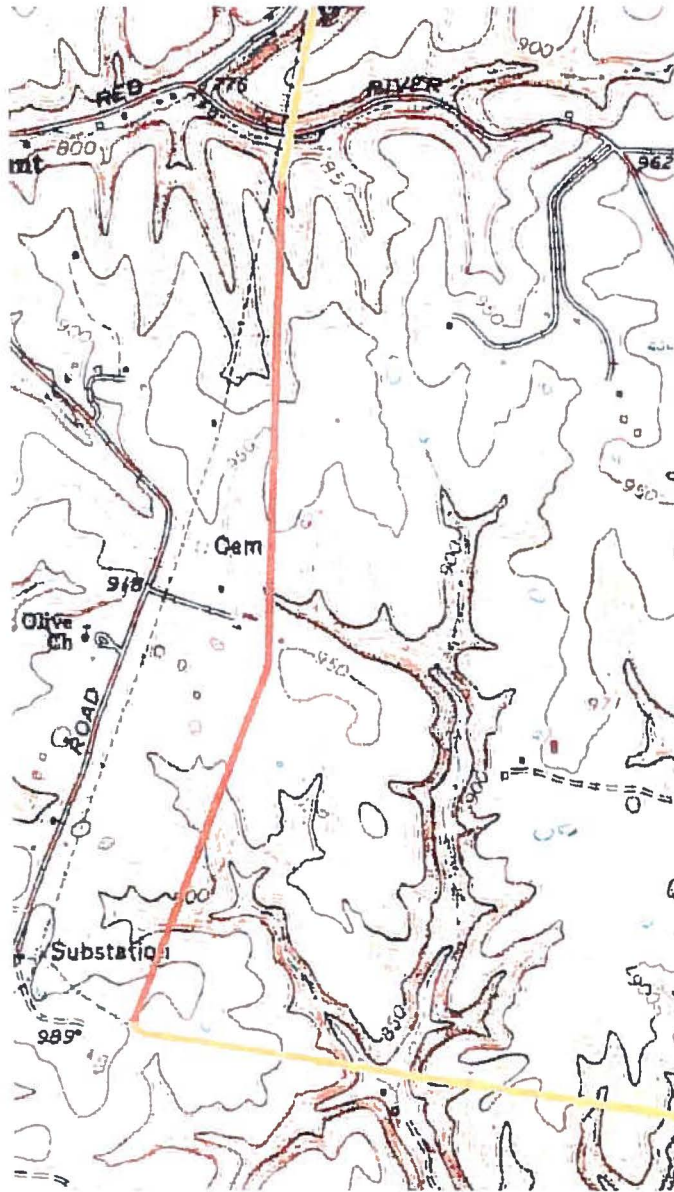


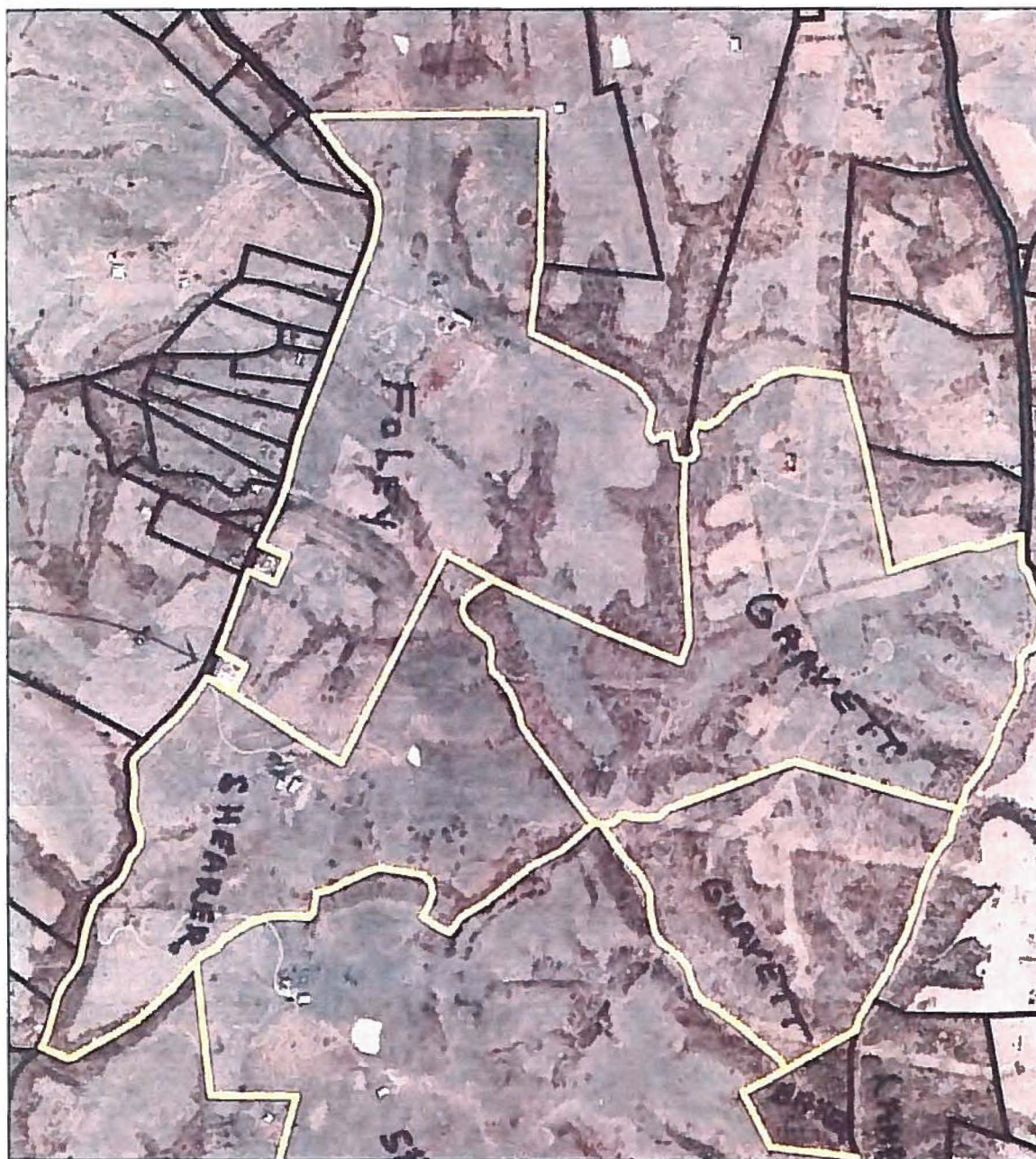
EXHIBIT A

Survey map of EKPC purchase of the Smallwood property. Property was optioned by EKPC on October 29, 2005. Sherman Goodpaster's letter to the PSC for waiver of CPCN was on October 7, 2005.

XI. CLARK SUBSTATION



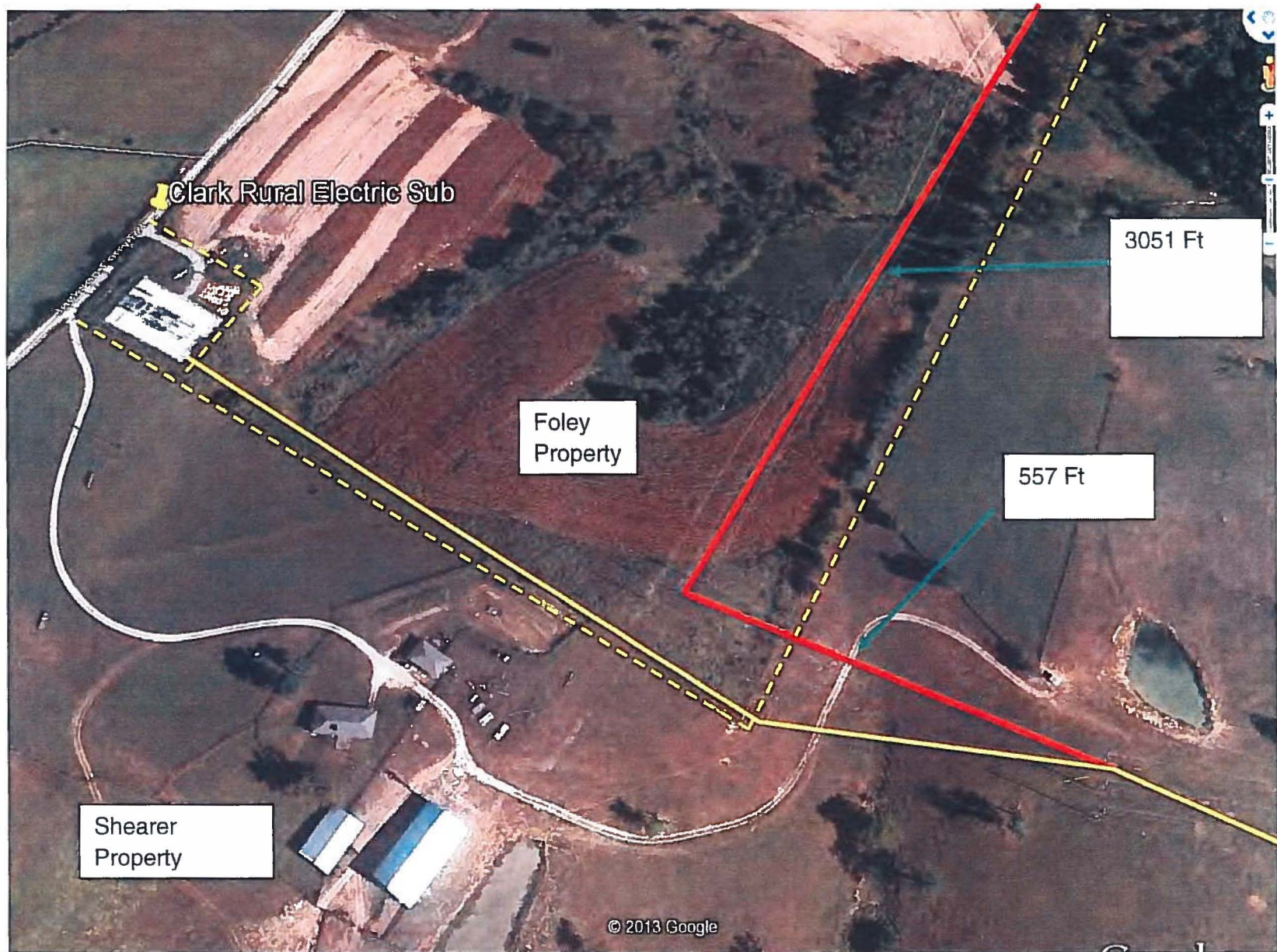
The above map from the Gilpin report defined the new right-of-way requirements in orange the existing right-of-way which is to be reused in yellow



Map from the state of Kentucky
defines the property owners
around the Clark Substation

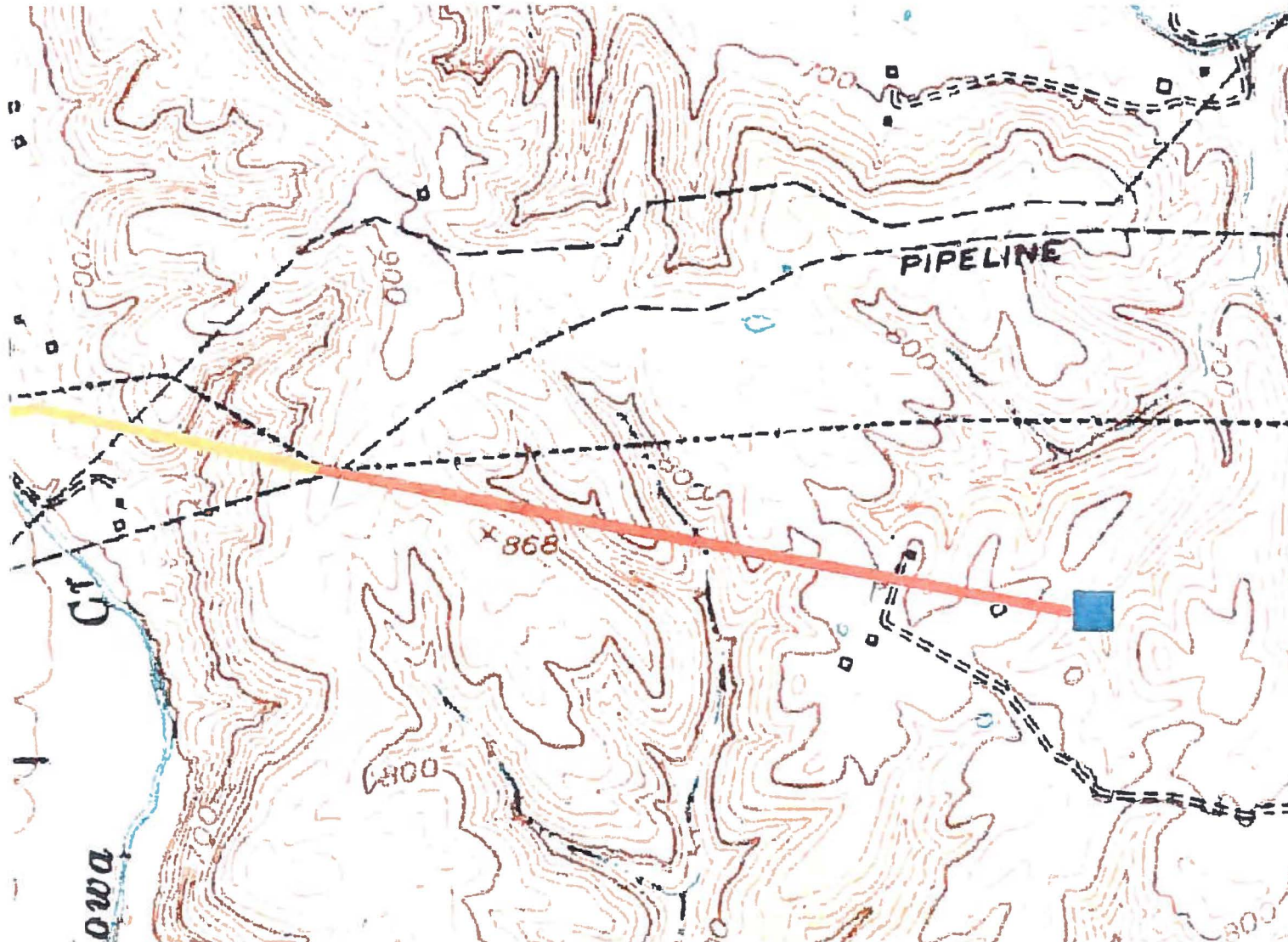


Map from the state of Kentucky defines the existing transmission lines before this project was installed along with the new transmission lines

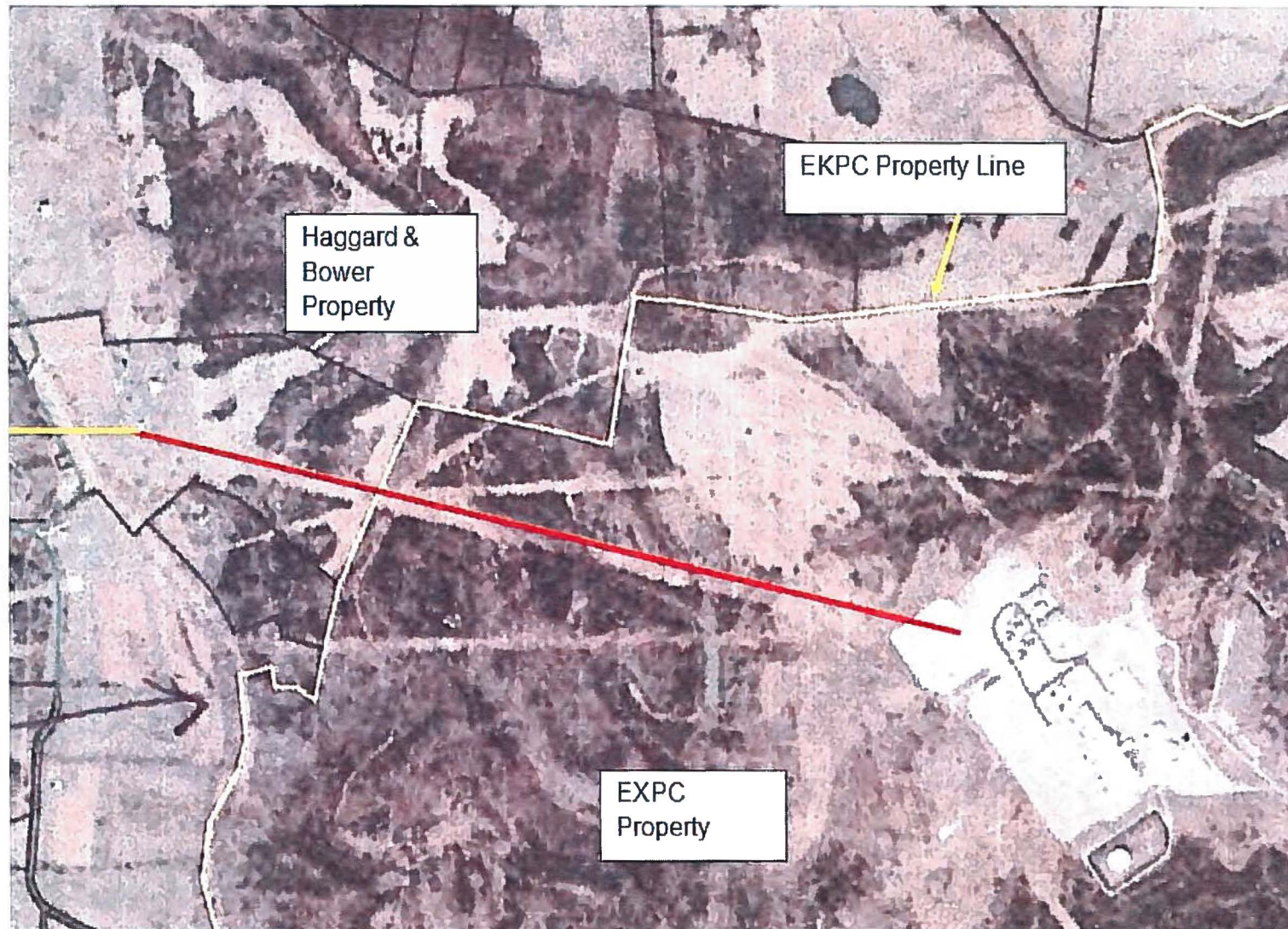


The above aerial view from Google Earth shows the existing and new transmission lines as they existed in 2013. The colors differentiate the new transmission line right-of-way from what existed before this project. Also listed is the measured length of the new right-of-way. These measurements are not of the accuracy that could be provided by a Registered Land Surveyor but have the accuracy obtained using manual methods with topographical maps.

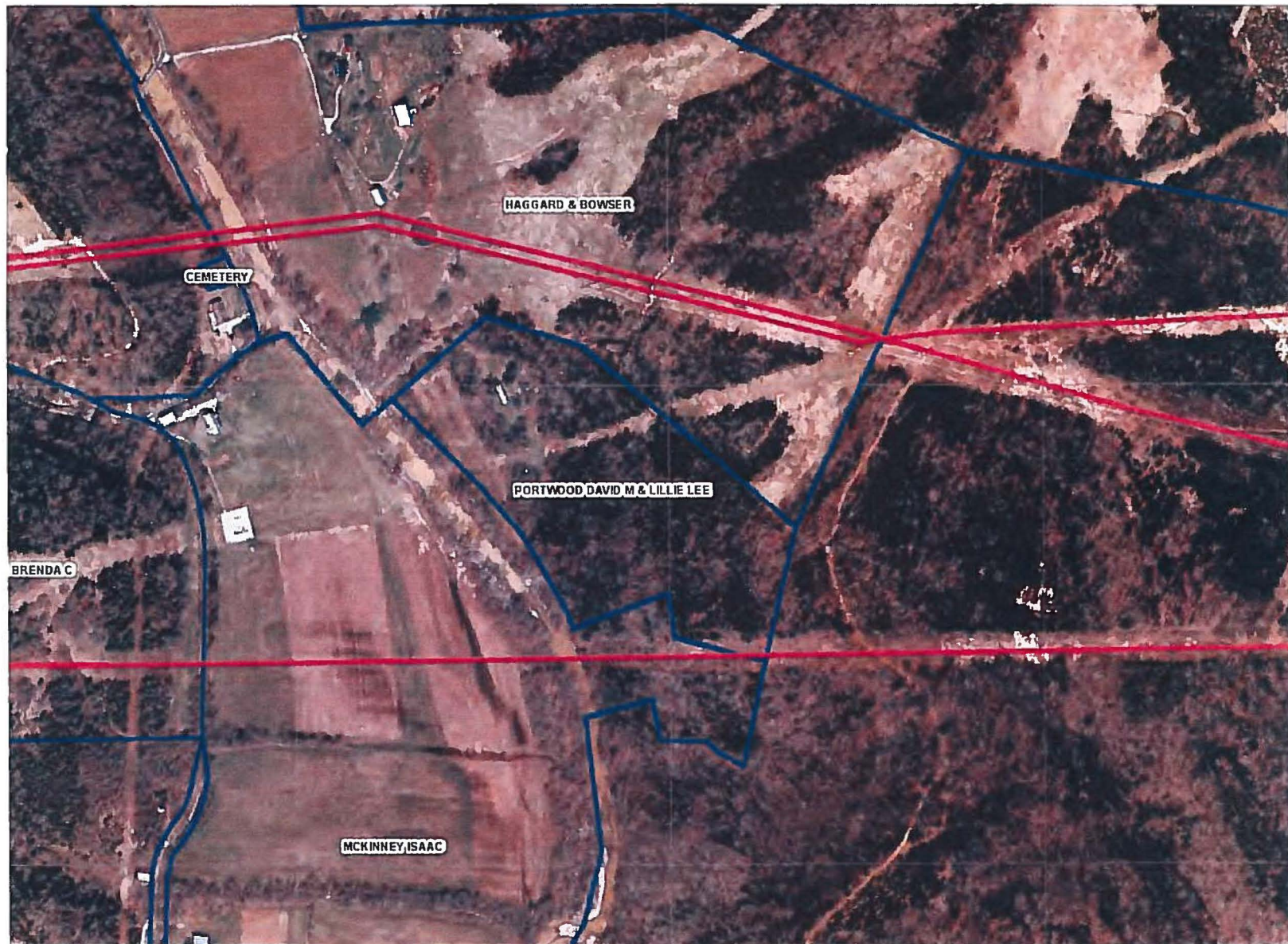
XII. J.K. SMITH GENERATING STATION:

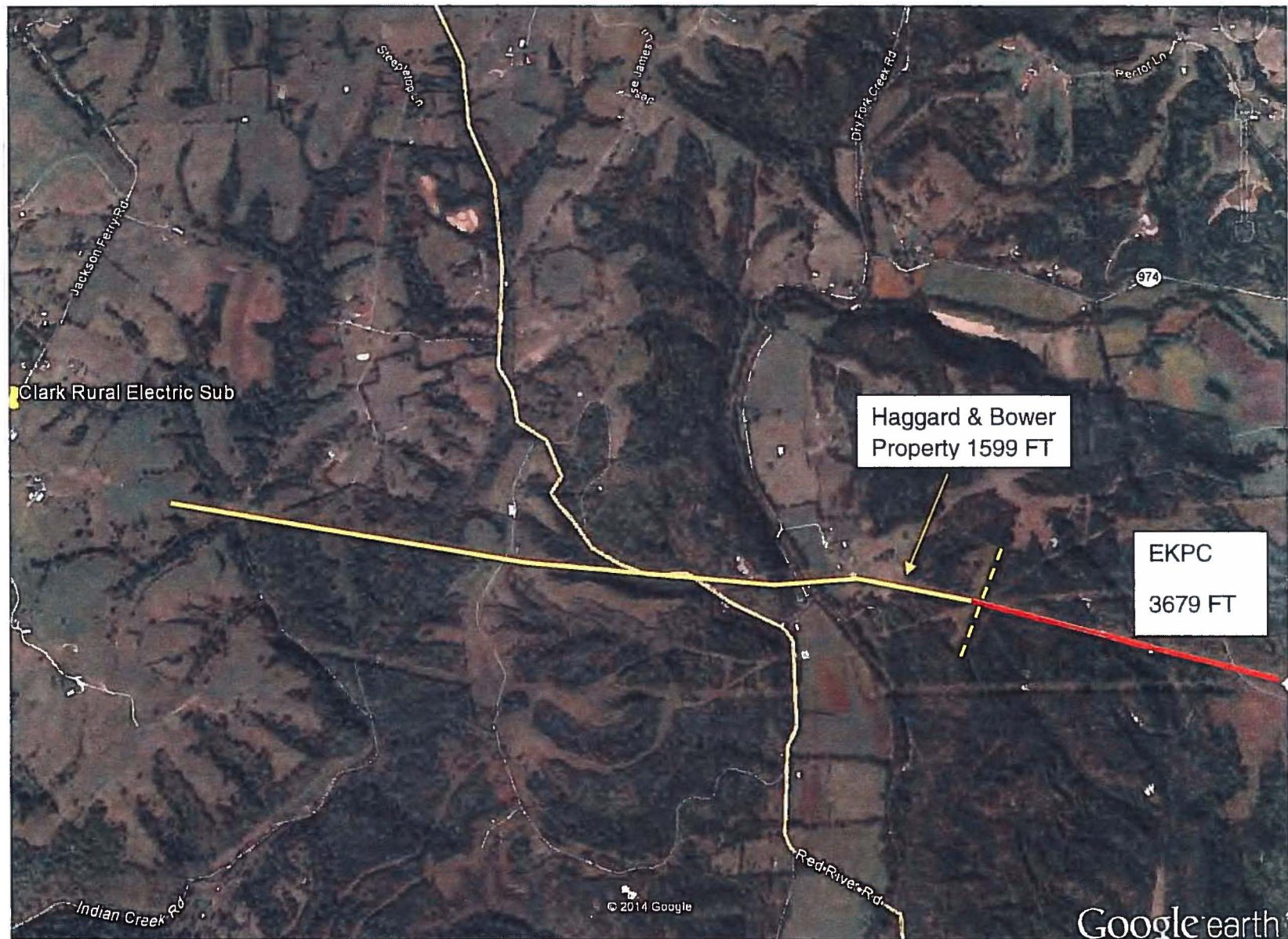


The above map from the Gilpin report defined the new right-of-way requirements in orange the existing right-of-way which is to be reused in yellow.



Map from the state of Kentucky defines the property owners around the J.K. Smith Generating Station.





The above aerial view from Google Earth shows the existing and new transmission lines as they existed in 2013. The colors differentiate the new transmission line right-of-way from what existed before this project. Also listed is the measured length of the new right-of-way. These measurements are not of the accuracy that could be provided by a Registered Land Surveyor but have the accuracy obtained using manual methods with topographical maps.

XIII. SUMMERIZATION of LINE DEVIATION SEGMENTS:

	Line Segment Distance in Feet	Total Line Segment Distance in Feet	Property Owners	Total Line Segment Distance in Feet	Total Line Segment Distance in Feet	Data Source
North Clark	1880		Stearns, Reffett, etc.	1693		Gilpin pg 18
	1875		Sword			
Segment Total Clark Substation		3755			3755	PSC Request 1
	557		Foley & Shearer			
	3051		Foley Property 1			
	3435		Foley Property 2			
Segment Total JK Smith Gen Station		7043		6969		Gilpin pg 18 PSC Request 1
	0		Haggard & Bower		6975	
	3679		EKPC			
Segment Total		3679		3977	3977	Gilpin pg 18
Total Deviation from Existing ROW		14477		10946	14707	

On May 27, 2006 in a legal public notice in the local newspaper listed that the rebuilt portion of the line is 15.9 miles and the total line length is 19 miles. Other documents show the total line length more accurately as 18.68. Using the 15.9 miles and 18.86 miles the calculated deviation from the established ROW is 2.78 miles or **14678.4 feet** not 5280 feet as EKPC claims.

SECTION 5 – Right-of-Way

XIV. Right Of Way

A. Requirements²¹

3. TRANSMISSION LINE LOCATION, ENGINEERING SURVEY AND RIGHT-OF WAY ACTIVITIES

Final route selection, whether for a large or small project, is a matter of judgment and requires sound evaluation of divergent requirements, including costs of easements, cost of clearing, and ease of maintenance as well as the effect a line may have on the environment. Public relations and public input are necessary in the corridor selection and preliminary survey stages.

3.3 Right-of-Way: A right-of-way agent (or borrower's representative) should precede the preliminary survey party in order to acquaint property owners with the purpose of the project, the survey, and to secure permission to run the survey line. The agent or surveyor should also be responsible for determining property boundaries crossed and for maintaining good public relations. The agent should avoid making any commitments for individual pole locations before structures are spotted on the plan and profile sheets. However, if the landowner feels particularly sensitive about placing a pole in a particular location along the alignment, then the agent should deliver that information to the engineer, and every reasonable effort should be made by the engineer to accommodate the landowner.

3.6 Rerouting: During the final survey, it may be necessary to consider routing small segments of the line due to the inability of the right-of-way agent to satisfy the demands of property owners. In such instances, the engineer should ascertain the costs and public attitudes towards all reasonable alternatives. The engineer should then decide to either satisfy the property owner's demands, relocate the line, initiate condemnation proceedings, or take other action as appropriate. Additional environmental review may also be required.

B. RIGHT-OF-WAY WIDTH²²

5.1 General: The preliminary comments and assumptions in Chapter 4 of this bulletin also apply to this chapter.

5.2 Minimum Horizontal Clearance of Conductor to Objects: Recommended design horizontal clearances of conductors to various objects are provided in Table 5-1 and minimum radial operating clearances of conductors to vegetation in Table 5-2. The clearances apply only for lines that are capable of automatically clearing line-to-ground faults.

²¹ Bulletin 1724e-200 Design Manual For High Voltage Transmission Lines, U.S. Department Of Agriculture, Rural Utilities Service Electric Staff Division

²² Bulletin 1724e-200 Design Manual For High Voltage Transmission Lines, U.S. Department Of Agriculture, Rural Utilities Service Electric Staff Division

Clearance values provided in Table 5-1 are recommended design values. In order to provide an additional margin of safety, the recommended design values exceed the minimum clearances in the 2007 NESC. Clearance values provided in Table 5-2 are minimum operating clearances to be used by the designer to determine appropriate design clearances for vegetation maintenance management.

5.2.1 Conditions Under Which Horizontal Clearances to Other Supporting Structures, Buildings and Other Installations Apply:

Conductors at Rest (No Wind Displacement): When conductors are at rest the clearances apply for the following conditions: (a) 167°F but not less than 120°F, final sag, (b) the maximum operating temperature the line is designed to operate, final sag, (c) 32°F, final sag with radial thickness of ice for the loading district (0 in., ¼ in., or ½ in.).

Conductors Displaced by 6 psf Wind: The clearances apply when the conductor is displaced by 6 lbs. per sq. ft. at final sag at 60°F. See Figure 5-1.

TABLE 5-1
RECOMMENDED DESIGN HORIZONTAL CLEARANCES (in feet) FROM CONDUCTORS
AT REST AND DISPLACED BY 6 PSF WIND TO OTHER SUPPORTING STRUCTURES,
BUILDINGS AND OTHER INSTALLATIONS
(NESC Rules 234B, 234C, 234D, 234E, 234F, 234I, Tables 234-1, 234-2, 234-3)

Conditions under which clearances apply

No wind: When the conductor is at rest the clearances apply at the following conditions: (a) 120°F, final sag, (b) the maximum operating temperature the line is designed to operate, final sag, (c) 32°F, final sag with radial thickness of ice for the loading district (1/4 in. for Medium or 1/2 in. Heavy).

Displaced by Wind: Horizontal clearances are to be applied with the conductor displaced from rest by a 6 psf wind at final sag at 60°F. The displacement of the conductor is to include deflection of suspension insulators and deflection of flexible structures.

The clearances shown are for the displaced conductors and do not provide for the horizontal distance required to account for blowout of the conductor and the insulator string. This distance is to be added to the required clearance. See Equation 5-1.

Clearances are based on the Maximum Operating Voltage

Nominal voltage, Phase to Phase, kV _{L-L}	34.5 & 46	69	115	138	161	230
Max. Operating Voltage, Phase to Phase, kV _{L-L}	---	72.5	120.8	144.9	169.1	241.5
Max. Operating Voltage, Phase to Ground, kV _{L-G}	---	41.8	69.7	83.7	97.6	139.4

Horizontal Clearances - (Notes 1,2,3)	NESC		Clearances in feet				
	Basic	Clear					
1.0 From a lighting support, traffic signal support or supporting structure of another line							
At rest (NESC Rule 234B1a)	5.0	6.5	6.5	7.2	7.6	8.1	9.5
Displaced by wind (NESC Rule 234B1b)	4.5	6.2	6.7	7.6	8.1	8.5	9.9
<hr style="border-top: 1px dashed red;"/>							
2.0 From buildings, walls, projections, guarded windows, windows not designed to open, balconies, and areas accessible to pedestrians							
At rest (NESC Rule 234C1a)	7.5	9.2	9.7	10.6	11.1	11.5	12.9
Displaced by wind (NESC Rule 234C1b)	4.5	6.2	6.7	7.6	8.1	8.5	9.9
<hr style="border-top: 1px dashed red;"/>							
3.0 From signs, chimneys, billboards, radio, & TV antennas, tanks & other installations not classified as buildings							
At rest (NESC Rule 234C1a)	7.5	9.2	9.7	10.6	11.1	11.5	12.9
Displaced by wind (NESC Rule 234C1b)	4.5	6.2	6.7	7.6	8.1	8.5	9.9
<hr style="border-top: 1px dashed red;"/>							
4.0 From portions of bridges which are readily accessible and supporting structures are not attached							
At rest (NESC Rule 234D1a)	7.5	9.2	9.7	10.6	11.1	11.5	12.9
Displaced by wind (NESC Rule 234D1b)	4.5	6.2	6.7	7.6	8.1	8.5	9.9
<hr style="border-top: 1px dashed red;"/>							
5.0 From portions of bridges which are ordinarily inaccessible and supporting structures are not attached							
At rest (NESC Rule 234D1a)	6.5	8.2	8.7	9.6	10.1	10.5	11.9
Displaced by wind (NESC Rule 234D1b)	4.5	6.2	6.7	7.6	8.1	8.5	9.9

TABLE 5-1 (continued)
 RECOMMENDED DESIGN HORIZONTAL CLEARANCES (in feet) FROM CONDUCTORS
 AT REST AND DISPLACED BY 6 PSF WIND TO OTHER SUPPORTING STRUCTURES,
 BUILDINGS AND OTHER INSTALLATIONS
 (NESC Rules 234B, 234C, 234D, 234E, 234F, 234I, Tables 234-1, 234-2, 234-3)

Conditions under which clearances apply:							
No wind: When the conductor is at rest the clearances apply at the following conditions: (a) 120°F, final sag, (b) the maximum operating temperature the line is designed to operate, final sag, (c) 32°F, final sag with radial thickness of ice for the loading district (1/4 in. for Medium or 1/2 in. Heavy).							
Displaced by Wind: Horizontal clearances are to be applied with the conductor displaced from rest by a 6 psf wind at final sag at 60°F under extreme wind conditions (such as the 50 or 100-year mean wind) at final sag at 60°F. The displacement of the conductor is to include deflection of suspension insulators and deflection of flexible structures.							
The clearances shown are for the displaced conductors and do not provide for the horizontal distance required to account for blowout of the conductor and the insulator string. This distance is to be added to the required clearance. See Equation 5-1.							
Clearances are based on the Maximum Operating Voltage							
Nominal voltage, Phase to Phase, kV _{L-L}	34.5 & 46	69	115	138	161	230	
Max. Operating Voltage, Phase to Phase, kV _{L-L}	---	72.5	120.8	144.9	169.1	241.5	
Max. Operating Voltage, Phase to Ground, kV _{L-G}	---	41.8	69.7	83.7	97.6	139.4	
Horizontal Clearances - (Notes 1,2,3)	NESC Basic Clear	Clearances in feet					
6.0 Swimming pools - see section 4.4.3 of Chapter 4 and item 9 of Table 4-2. (NESC Rule 234E)							
Clearance in any direction from swimming pool edge (Clearance A, Figure 4-2 of this bulletin)	25.0	27.2	27.7	28.6	29.1	29.5	30.9
Clearance in any direction from diving structures (Clearance B, Figure 4-2 of this bulletin)	17.0	19.2	19.7	20.6	21.1	21.5	22.9
7.0 From grain bins loaded with permanently attached conveyor							
At rest (NESC Rule 234F1b)	15.0	17.2	17.7	18.6	19.1	19.5	20.9
Displaced by wind (NESC Rule 234C1b)	4.5	6.7	7.2	8.1	8.6	9.0	10.4
8.0 From grain bins loaded with a portable conveyor. Height 'V' of highest filling or probing port on bin must be added to clearance shown. Clearances for 'at rest' and not displaced by the wind. See NESC Figure 234-4 for other requirements. Horizontal clearance envelope (includes area of sloped clearance per NESC Figure 234-4b)							(24+V) + 1.5V (Note 3)
9.0 From rail cars (Applies only to lines parallel to tracks) See Figure 234-5 and section 234I (Eye) of the NESC							
Clearance measured to the nearest rail	14.1	14.1	15.1	15.6	16.0	17.5	
ALTITUDE CORRECTION TO BE ADDED TO VALUES ABOVE							
Additional feet of clearance per 1000 feet of altitude above 3300 feet	.02	.02	.05	.07	.08	.12	
Notes:							
1. Clearances for categories 1-5 in the table are approximately 1.5 feet greater than NESC clearances.							
2. Clearances for categories 6 to 9 in the table are approximately 2.0 feet greater than NESC clearances.							
3. "V" is the height of the highest filling or probing port on a grain bin. Clearance is for the highest voltage of 230 kV.							

4.4.4 Lines Over Swimming Pools: Clearances over swimming pools are for reference purposes only. Lines should not pass over or within clearance 'A' of the edge of a swimming pool or the base of the diving platform. Clearance 'B' should be maintained in any direction to the diving platform or tower.

FIGURE 4-4 SWIMMING POOL CLEARANCES (See TABLE 4-2)
From IEEE/ANSI C2-2007, National Electrical Safety Code, Copyright 2006. All rights reserved.

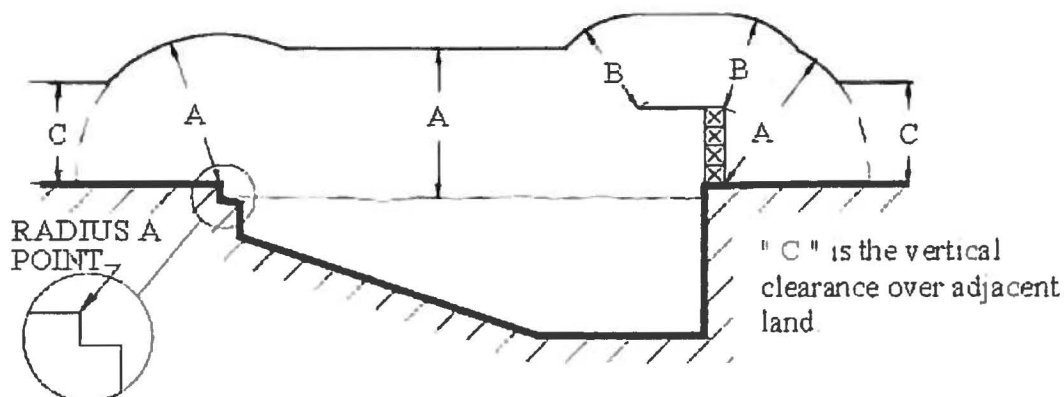


TABLE 5-3
TYPICAL RIGHT-OF-WAY WIDTHS

	Nominal Line-to-Line Voltage in kV				
	69	115	138	161	230
ROW Width, ft	75-100	100	100-150	100-150	125-200

Right-of-way widths can be calculated using the method described below. The calculated values for right-of-way widths are directly related to the particular parameters of the line design. This method provides sufficient width to meet clearance requirements to buildings of undetermined height or vegetation located directly on the edge of the right-of-way. See Figures 5-8 and 5-9

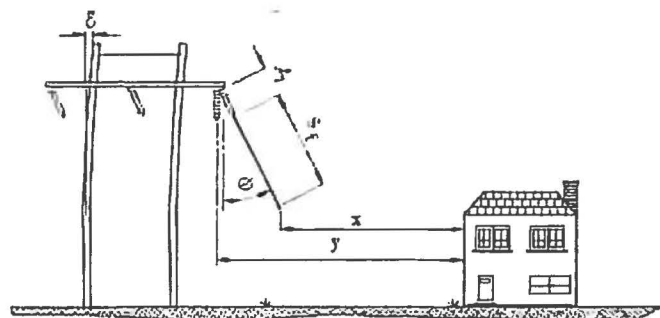


FIGURE 5-1 HORIZONTAL CLEARANCE REQUIREMENT TO BUILDINGS

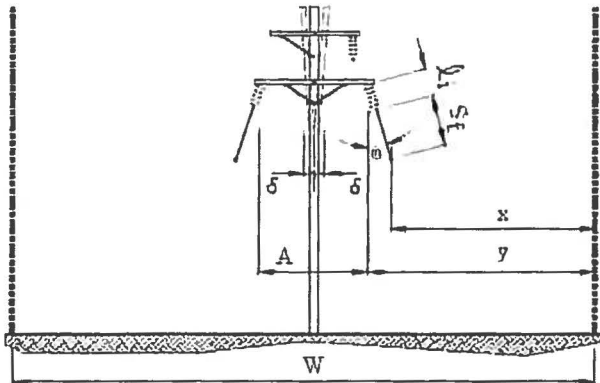


FIGURE 5-9: ROW WIDTH FOR SINGLE LINE OF STRUCTURES

$$W = A + 2(l_i + S_f) \sin \phi + 2\delta + 2x \quad \text{Eq. 5-3}$$

where:

W = total right-of-way width required

A = separation between points of suspension of insulator strings for outer two phases

X = clearance required per Table 5-1 and appropriate clearance derived from Table 5-2 of this bulletin (include altitude correction if necessary)

Y = clearance required per Section 5.2.1 and Table 5-1 and appropriate clearance derived from Section 5.2.2. and Table 5-2 of this bulletin (include altitude correction if necessary)

ϕ = conductor swing out angle in degrees under all rated operating conditions

S_f = conductor final sag at all rated operating conditions

l_i = insulator string length ($l_i = 0$ for post insulators or restrained suspension insulators).

δ = structure deflection at all rated operating conditions

For those spans that exceed this base span, additional width is added as appropriate.

$A = 54$ FT. (Pole diagram)

$X = 12.9$ ft. for 230kV (More for 345 kV)

δ = unknown

$\Phi = 20$ Degrees (estimated)

$$S_f = 32.3$$

$$l_i = 10 \text{ Ft.}$$

$$W = A + 2(l_i + S_f) \sin \phi + 2\delta + 2x$$

$$X = 7.5 + .4(V_{L-G} - 22)/12 = 13.4$$

$$\text{WOR} = W = 54 + 2(10 + 32.3) \cdot 9129 + 2 \times 13.4$$

$$\text{WOR} = W = 166 \text{ feet}$$

EKPC set the WOR at 150 feet but it should have been 166 feet or more.

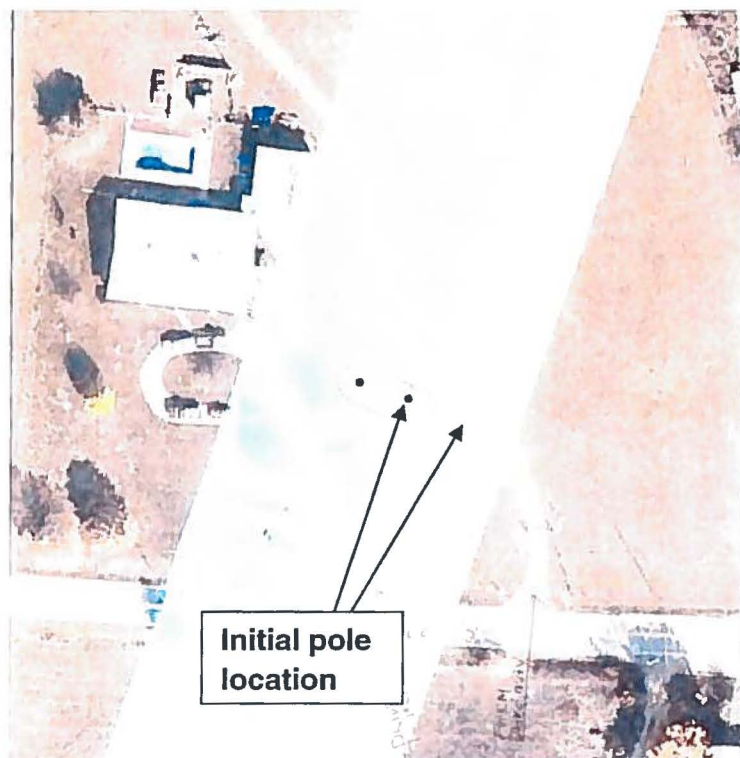


Figure 4 - Preliminary EKPC Right Of Way Document²³

The above photograph was presented to the Barkers by EKPC at a public meeting on November 10, 2005. The photograph shows the original 100 foot right of way and the additional 50 feet of right of way that EKPC was requesting as well as the location of the utility pole.

The above photograph clearly shows that the transmission line ROW crosses the Barkers garage/business and the carport attached to the house.

²³ EKPC presented this photograph at the public meeting on Meeting of 11/10/2005

[illegible]

The above figure shows the design drawing of the pole structure that was installed. This drawing was provided to the Barkers as part of the informational handout at the public meeting.

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Figure 6 - Google Earth Measurement of House to Transmission Line – 33.77 Ft.



Figure 7 - Google Earth Measurement of House to Transmission Line – 30.69 Ft.



Figure 8 - Google Earth Measurement of House to Transmission Line – 47.36 Ft.

Based on Google Earth measurements of the distance of the house to the transmission line the transmission line comes within 30 feet of the garage or well inside the Right of Way. The right of way is 75 feet on either side of the center conductor or 48 feet from the outer conductor.

When you consider that the right of way should have been 166 ft or more rather than 150 ft, this places the right of way over the more of the house and garage.

As a means of verifying the accuracy of Google Earth we measured the distance between the two outer conductors. Google Earth measured 54 feet, the same as the design drawing.

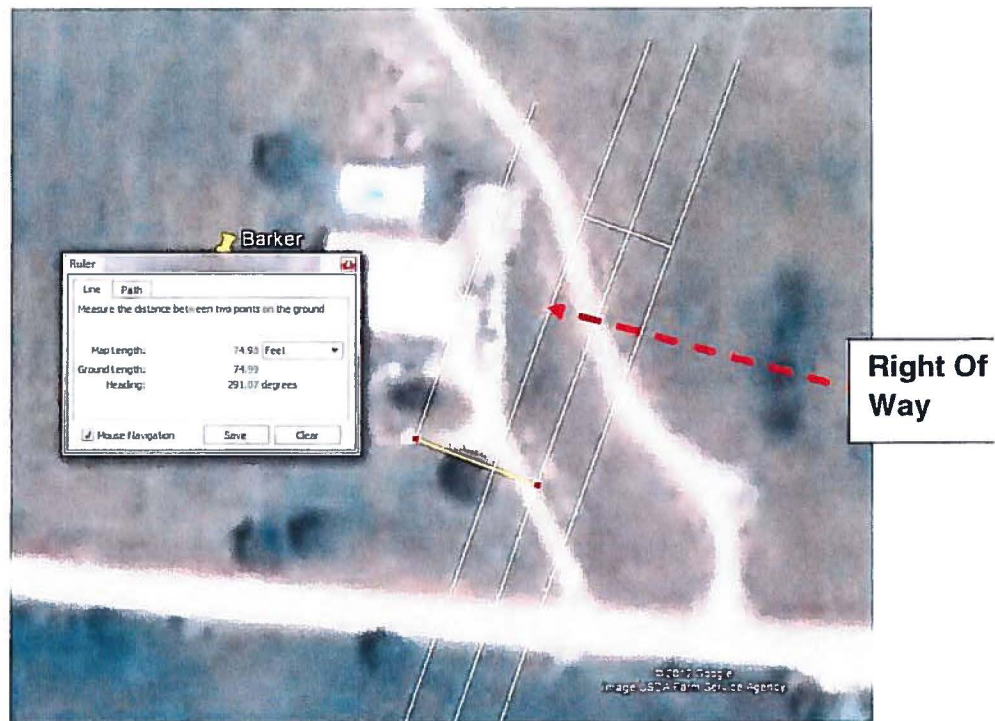


Figure 9 - ROW Line Measurement – 75 Feet



Figure 10 – ROW Line Measurement – 75 Feet



Figure 11 - Google Earth Measurement of Width of Transmission Line – 54 Ft.

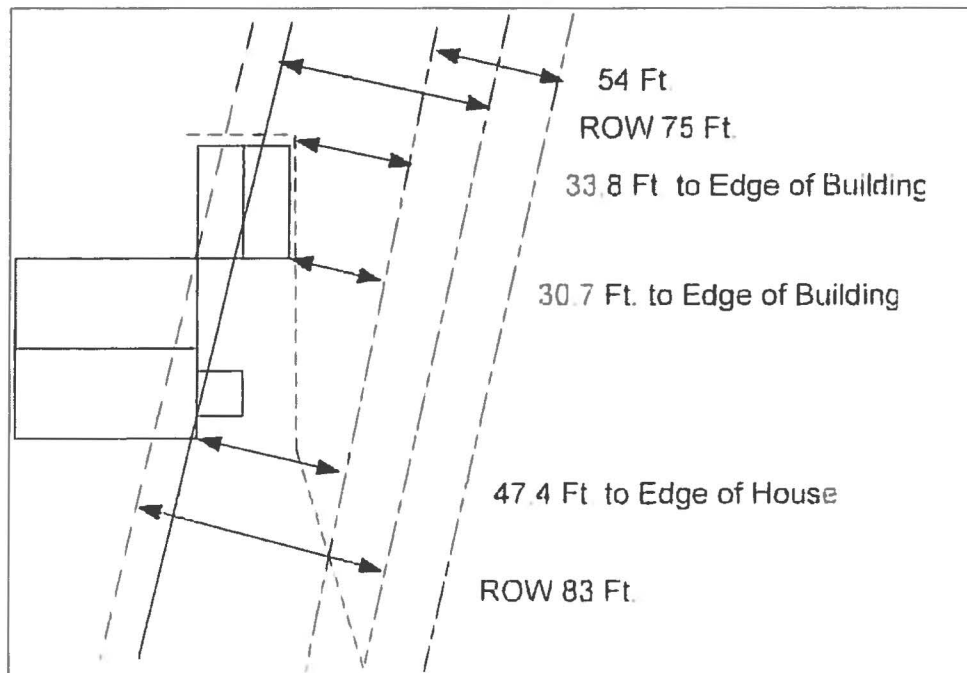


Figure 12 - Sketch of the Close Proximity of the Bakers' House to the Transmission Lines ROW

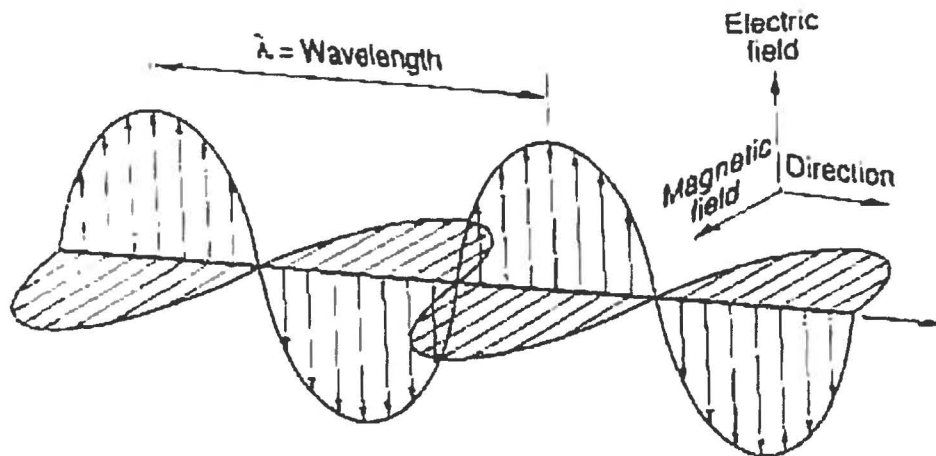
The above sketches confirm that the right of way does go through the Barkers' house and violates the intent of the RUS standards since this transmission was completely rebuilt. The existing transmission line and poles were removed before the new transmission line was constructed. Thus, the new line was required to comply with the right of way requirements.

SECTION 6 - Medical Concerns

The purpose of this section is first to explain what EMF is about, then providing information on the health issues. Next, how the health issues effect the Barkers'

XV. EMF

Electromagnetic fields consist of electric (E) and magnetic (H) waves travelling together, as shown in the diagram below. They travel at the speed of light and are characterized by a frequency and a wavelength.



Electric fields arise from electric charges. They govern the motion of other charges situated in them. Their strength is measured in units of volt per meter, (V/m), or kilovolt per meter (kV/m). When charges accumulate on an object they create a tendency for like or opposite charges to be repelled or attracted, respectively. The strength of that tendency is characterized by the **voltage** and is measured in units of volt, (V). Any device connected to an electrical outlet, even if the device is not switched on, will have an associated electric field that is proportional to the voltage of the source to which it is connected. Electric fields are strongest close the device and diminish with distance. Common materials, such as wood and metal, shield against them.

- Electric field strength is proportional to the voltage.
- The strength of electric fields decrease with distance.
- Electric fields may tend to add together or cancel each other out when there are two sets of cables involved
- Electric fields will induce a charge on ungrounded metallic objects within the field.
- An electric field is stopped by grounded objects and can be shielded
- People are able to detect the presence of some electric fields

Magnetic fields arise from the motion of electric charges, i.e. a current. They govern the motion of moving charges. Their strength is measured in units of ampere per meter, (A/m) but is usually expressed in terms of the corresponding magnetic induction measured in units of Tesla, (T), millitesla (mT) or microtesla (μ T). In some countries another unit called the gauss, (G), is commonly used for measuring magnetic induction ($10,000 \text{ G} = 1 \text{ T}$, $1 \text{ G} = 100 \mu\text{T}$, $1 \text{ mT} = 10 \text{ G}$, $1 \mu\text{T} = 10 \text{ mG}$). Any device connected to an electrical outlet, when the device is switched on and a current is flowing, will have an associated magnetic field that is proportional to the current drawn from the source to which it is connected. Magnetic fields are strongest close to the device and diminish with distance. They are not shielded by most common materials, and pass easily through them.

- Magnetic field strength is proportional to the current.
- The strength of magnetic fields decrease with distance.
- Magnetic fields may tend to add together or cancel each other out when there are two sets of cables involved.
- Magnetic fields will induce a current in a conducting metal loop.
- A magnetic field cannot be stopped by grounded objects and other objects
- People are not able to detect the presence of magnetic fields.

A. EMF Scientific Units

- Electric field Strength (E) – units in V/m or kV/m
- Magnetic Field Strength (H) – units in A/m
- Magnetic Flux Density (B) – units in Gauss (G) or Tesla (T)
- $1\text{mG} = 0.1\mu\text{T} = 0.001 \text{ mT}$
- $1\text{A/m} = 1.25 \mu\text{T}$

B. EMF Standards and Concerns

The electrical utility and health organizations have had concerns about the effects of EMF on the human body for many years and there have been many studies to try to quantify these effects. To date, no conclusions have been reached as additional scientific data needs to be obtained. However, the data collected does show a causal relationship. As a result the international community continues to develop a large amount of data and has established standards and guidelines to reduce the potential health effects.

C. Induced currents²⁵

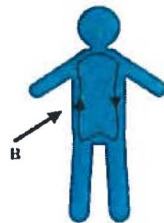
The quantum energy of 50 Hz electromagnetic fields is too small to break chemical bonds. It is clear that power-frequency EMFs or radiation does not cause ionization in

²⁵ <http://www.emfs.info/The+Science/highfields/Inducedcurrents/>

the same way that x-rays or alpha particles do. Instead, the main known way 50 Hz fields interact with people is by inducing currents.

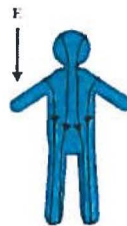
What currents do magnetic fields produce?

Any alternating magnetic field will induce an electric field, which in turn produces a current in a conducting medium. The human body is conducting and will therefore have a current induced in it – albeit, usually, a very small one. As shown on the figure below the current circulates round the body.



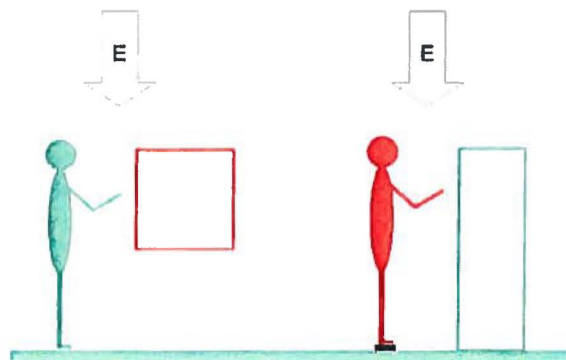
What currents do electric fields produce?

Alternating electric fields also induce currents in the body. As shown below, for a vertical field, they run up and down the body. The calculation has to take account of the perturbation to the field caused by the body itself. For a typical person standing in a vertical field, a current of 1 mA through the body is induced by 70 kV/m.



Effects of induced currents on the body

Within the body, currents induced by fields have the same range of effects as currents injected via electrodes, e.g. in an electric shock. However, these effects depend entirely on the size of the current. Thus current densities of about 0.1 A/m^2 can stimulate excitable tissue and current densities above about 1 A/m^2 can cause ventricular fibrillation, as well as producing heating. However these current densities correspond to fields far larger than are ever encountered at 50 Hz.



At lower fields a range of possible effects have been reported. The established effect observed in humans at the lowest magnetic field is the magnetophosphene effect, where a flickering sensation is produced in peripheral vision by 50 Hz magnetic fields above about 10 mT (i.e. 10,000 μ T). Magnetophosphenes are probably caused by induced current densities in the retina; the threshold at 20 Hz (the most sensitive frequency) is about 20 mA/m².

Micro-shocks are a related but separate phenomenon, caused not by a continuous current but by a one-off discharge.

D. Sources of EMF

Electromagnetic fields come from many sources as will be defined below. However, what we are concerned with are the fields produced by electrical transmission lines.

Magnetic Fields

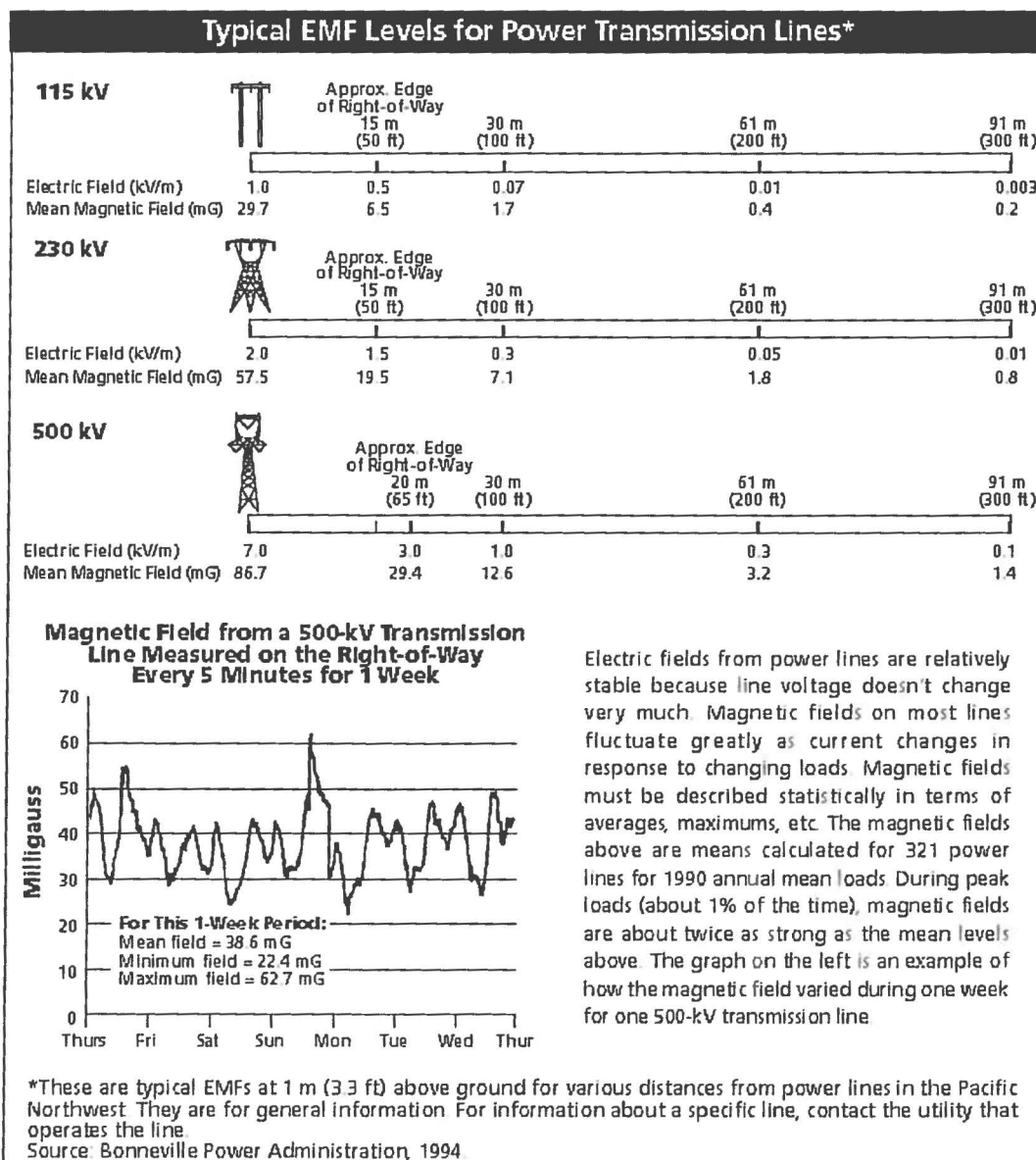


Figure 13 –Typical EMF Levels for Transmission Lines²⁶
 The following are typical magnetic field strengths measured with a gauss meter.

26 EMF Electric and Magnetic Fields Associated with the Use of Electric Power, June 2002, National Institute of Health

Sources of Magnetic Fields (mG)*									
Distance from source					Distance from source				
	6"	1'	2'	4'		6"	1'	2'	4'
Office Sources					Workshop Sources				
AIR CLEANERS					BATTERY CHARGERS				
Lowest	110	20	3	—	Lowest	3	2	—	—
Median	180	35	5	1	Median	30	3	—	—
Highest	250	50	8	2	Highest	50	4	—	—
COPY MACHINES					DRILLS				
Lowest	4	2	1	—	Lowest	100	20	3	—
Median	90	20	7	1	Median	150	30	4	—
Highest	200	40	13	4	Highest	200	40	6	—
FAX MACHINES					POWER SAWS				
Lowest	4	—	—	—	Lowest	50	9	1	—
Median	6	—	—	—	Median	200	40	5	—
Highest	9	2	—	—	Highest	1000	300	40	4
FLUORESCENT LIGHTS					ELECTRIC SCREWDRIVERS (while charging)				
Lowest	20	—	—	—	Lowest	—	—	—	—
Median	40	6	2	—	Median	—	—	—	—
Highest	100	30	8	4	Highest	—	—	—	—
ELECTRIC PENCIL SHARPENERS									
Lowest	20	8	5	—	Distance from source				
Median	200	70	20	2	1' 2' 4'				
Highest	300	90	30	30					
VIDEO DISPLAY TERMINALS (see page 48)					Living/Family Room Sources				
(PCs with color monitors)**					CEILING FANS				
Lowest	7	2	1	—	Lowest	—	—	—	
Median	14	5	2	—	Median	3	—	—	
Highest	20	6	3	—	Highest	50	6	1	
					WINDOW AIR CONDITIONERS				
Bathroom Sources					Lowest	—	—	—	
HAIR DRYERS					Median	3	1	—	
Lowest	1	—	—	—	Highest	20	6	4	
Median	300	1	—	—	COLOR TELEVISIONS**				
Highest	700	70	10	1	Lowest	—	—	—	
ELECTRIC SHAVERS					Median	7	2	—	
Lowest	4	—	—	—	Highest	20	8	4	
Median	100	20	—	—					
Highest	600	100	10	1					

Sources of Magnetic Fields (mG)*									
Distance from source					Distance from source				
	6"	1'	2'	4'		6"	1'	2'	4'
Kitchen Sources					Kitchen Sources				
BLENDERS					ELECTRIC OVENS				
Lowest	30	5	—	—	Lowest	4	1	—	—
Median	70	10	2	—	Median	9	4	—	—
Highest	100	20	3	—	Highest	20	5	1	—
CAN OPENERS					ELECTRIC RANGES				
Lowest	500	40	3	—	Lowest	20	—	—	—
Median	600	150	20	2	Median	30	8	2	—
Highest	1500	300	30	4	Highest	200	30	9	6
COFFEE MAKERS					REFRIGERATORS				
Lowest	4	—	—	—	Lowest	—	—	—	—
Median	7	—	—	—	Median	2	2	1	—
Highest	10	1	—	—	Highest	40	20	10	10
DISHWASHERS					TOASTERS				
Lowest	10	6	2	—	Lowest	5	—	—	—
Median	20	10	4	—	Median	10	3	—	—
Highest	100	30	7	1	Highest	20	7	—	—
FOOD PROCESSORS					Bedroom Sources				
Lowest	20	5	—	—	DIGITAL CLOCK****				
Median	30	6	2	—	Lowest	—	—	—	—
Highest	130	20	3	—	Median	1	—	—	—
GARBAGE DISPOSALS					High	8	2	1	—
Lowest	60	8	1	—	ANALOG CLOCKS				
Median	80	10	2	—	(conventional clockface)****				
Highest	100	20	3	—	Lowest	1	—	—	—
MICROWAVE OVENS***					Median	15	2	—	—
Lowest	100	1	1	—	Highest	30	5	3	—
Median	200	4	10	2	BABY MONITOR (unit nearest child)				
Highest	300	200	30	20	Lowest	4	—	—	—
MIXERS					Median	6	1	—	—
Lowest	30	5	—	—	Highest	15	2	—	—
Median	100	10	1	—					
Highest	600	100	10	—					

Sources of Magnetic Fields (mG)*									
Distance from source					Distance from source				
	6"	1'	2'	4'		6"	1'	2'	4'
Laundry/Utility Sources					Laundry/Utility Sources				
ELECTRIC CLOTHES DRYERS					PORTABLE HEATERS				
Lowest	2	—	—	—	Lowest	5	1	—	—
Median	3	2	—	—	Median	100	20	4	—
Highest	10	3	—	—	Highest	150	40	8	1
WASHING MACHINES					VACUUM CLEANERS				
Lowest	4	1	—	—	Lowest	100	20	4	—
Median	20	7	1	—	Median	300	60	10	1
Highest	100	30	6	—	Highest	700	200	50	10
IRONS					SEWING MACHINES				
Lowest	6	1	—	—	Home sewing machines can produce magnetic fields of 12 mG at chest level and 5 mG at head level. Magnetic fields as high as 35 mG at chest level and 215 mG at knee level have been measured from industrial sewing machine models (Sobel, 1994).				
Median	8	1	—	—					
Highest	20	3	—	—					

Source: EMF In Your Environment, U. S. Environmental Protection Agency, 1992.

* Dash (—) means that the magnetic field at this distance from the operating appliance could not be distinguished from background measurements taken before the appliance had been turned on.

** Some appliances produce both 60-Hz and higher frequency fields. For example, televisions and computer screens produce fields at 10,000-30,000 Hz (10-30 kHz) as well as 60-Hz fields.

*** Microwave ovens produce 60-Hz fields of several hundred milligauss, but they also create microwave energy inside the appliance that is at a much higher frequency (about 2.45 billion hertz). We are shielded from the higher frequency fields but not from the 60-Hz fields.

**** Most digital clocks have low magnetic fields. In some analog clocks, however, higher magnetic fields are produced by the motor that drives the hands. In the above table, the clocks are electrically powered using alternating current, as are all the appliances described in these tables.

E. Electric Fields

In the United States, there are no federal standards limiting occupational or residential exposure to 60-Hz EMF. However, at least seven states have set standards for transmission line electric fields; two of these also have standards for magnetic fields (see table below). In most cases, the maximum fields permitted by each state are the maximum fields that existing lines produce at maximum load-carrying conditions. Some states further limit electric field strength at road crossings to ensure that electric current induced into large metal objects such as trucks and buses does not represent an electric shock hazard.

State Transmission Line Standards and Guidelines				
State	Electric Field		Magnetic Field	
	On R.O.W.*	Edge R.O.W.	On R.O.W.	Edge R.O.W.
Florida	8 kV/m ^a 10 kV/m ^b	2 kV/m	—	150 mG ^a (max. load) 200 mG ^b (max. load) 250 mG ^c (max. load)
Minnesota	8 kV/m	—	—	—
Montana	7 kV/m ^d	1 kV/m ^e	—	—
New Jersey	—	3 kV/m	—	—
New York	11.8 kV/m 11.0 kV/m ^f 7.0 kV/m ^d	1.6 kV/m	—	200 mG (max. load)
Oregon	9 kV/m	—	—	—

*R.O.W. = right-of-way (or in the Florida standard, certain additional areas adjoining the right-of-way). kV/m = kilovolt per meter. One kilovolt = 1,000 volts. ^aFor lines of 69-230 kV. ^bFor 500 kV lines. ^cFor 500 kV lines on certain existing R.O.W. ^dMaximum for highway crossings. ^eMay be waived by the landowner. ^fMaximum for private road crossings.

Figure 15 - State Transmission Line Standards and Guidelines²⁸

Add North Dakota to the above list.

Two organizations have developed voluntary occupational exposure guidelines for EMF exposure. These guidelines are intended to prevent effects, such as induced currents in cells or nerve stimulation, which are known to occur at high magnitudes, much higher (more than 1,000 times higher) than EMF levels found typically in occupational and residential environments. These guidelines are summarized in the tables below.

The International Commission Non-Ionizing Radiation Protection (ICNIRP) concluded that available data regarding potential long-term effects, such as increased risk of cancer, are insufficient to provide a basis for setting exposure restrictions.

The American Conference of Governmental Industrial Hygienists (ACGIH) publishes "Threshold Limit Values" (TLVs) for various physical agents. The TLVs for 60-Hz EMF shown in the table are identified as guides to control exposure; they are not intended to demarcate safe and dangerous levels.

The following are several other standards found:

- California Safety Limits for Public Schools 1.2 mG²⁹
- Swiss Standard 2.5 mG ELF³⁰
- Swedish standard 1.0 mG³¹

28 EMF Electric and Magnetic Fields Associated with the Use of Electric Power, June 2002, National Institute of Health

29 EMF Levels & Safety, ScanTech Consultants, www.scantech7.com

30 EMF Levels & Safety, ScanTech Consultants, www.scantech7.com

31 EMF Levels & Safety, ScanTech Consultants, www.scantech7.com

ICNIRP Guidelines for EMF Exposure		
Exposure (60 Hz)	Electric field	Magnetic field
Occupational	8.3 kV/m	4.2 G (4,200 mG)
General Public	4.2 kV/m	0.833 G (833 mG)
International Commission on Non-Ionizing Radiation Protection (ICNIRP) is an organization of 15,000 scientists from 40 nations who specialize in radiation protection. Source: ICNIRP, 1998.		
ACGIH Occupational Threshold Limit Values for 60-Hz EMF		
	Electric field	Magnetic field
Occupational exposure should not exceed	25 kV/m	10 G (10,000 mG)
Prudence dictates the use of protective clothing above	15 kV/m	—
Exposure of workers with cardiac pacemakers should not exceed	1 kV/m	1 G (1,000 mG)
American Conference of Governmental Industrial Hygienists (ACGIH) is a professional organization that facilitates the exchange of technical information about worker health protection. It is not a government regulatory agency. Source: ACGIH, 2001.		

Figure 16 - Guidelines³²

F. Does EMF affect people with pacemakers or other medical devices?

According to the U.S. Food and Drug Administration (FDA), interference from EMF can affect various medical devices including cardiac pacemakers and implantable defibrillators. Most current research in this area focuses on higher frequency sources such as cellular phones, citizens band radios, wireless computer links, microwave signals, radio and television transmitters, and paging transmitters.

Sources such as welding equipment, power lines at electric generating plants, and rail transportation equipment can produce lower frequency EMF strong enough to interfere with some models of pacemakers and defibrillators. The occupational exposure guidelines developed by ACGIH state that workers with cardiac pacemakers should not be exposed to a 60-Hz magnetic field greater than 1 gauss (1,000 mG) or a 60-Hz electric field greater than 1 kilovolt per meter (1,000 V/m) (see ACGIH guidelines above). Workers who are concerned about EMF exposure effects on pacemakers, implantable defibrillators, or other implanted electronic medical devices should consult their doctors or industrial hygienists.

³² EMF Electric and Magnetic Fields Associated with the Use of Electric Power, June 2002, National Institute of Health

Non-electronic metallic medical implants (such as artificial joints, pins, nails, screws, and plates) can be affected by high magnetic fields such as those from magnetic resonance imaging (MRI) devices and aluminum refining equipment, but are generally unaffected by the lower fields from most other sources.

The FDA MedWatch program is collecting information about medical device problems thought to be associated with exposure to or interference from EMF.

What is a safe level of induced current?

Exposure guidelines are usually designed to prevent all effects of induced currents, on the basis that any effect in the brain or nervous system is potentially harmful. For example, the ICNIRP exposure guidelines currently recommend that people at work should not be exposed to current densities in the head, neck and trunk of greater than 10 mA/m^2 (the "basic restriction") with a lower limit of 2 mA/m^2 for the general population, which may include people who are more sensitive because of medical conditions.

G. Effects on equipment

There are several types of equipment that can be affected by fields. However, the fields required are usually rather higher than those commonly encountered in the environment.

- Credit cards, railway tickets etc. have information encoded on a magnetic strip. This can be corrupted by magnetic fields above about $10,000 \mu\text{T}$. Such fields almost never occur at 50 Hz, but a problem can arise with static fields such as those from magnetic catches on handbags.
- Some cars with electronic control systems have been found to be susceptible to interference from power-frequency magnetic fields above about $2,000 \mu\text{T}$. Again, such fields are rare at 50 Hz. This tends to be more of a problem at higher frequencies.
- There is no direct effect of EMFs on bicycles but riding a bicycle under a high-voltage power line can produce a micro-shock.
- Quartz watches with analogue dials use a small stepper motor to drive the hands. This stepper motor can be driven by a suitably oriented external power-frequency magnetic field of about $1000 \mu\text{T}$ or greater, causing the hands to rotate 100 or more times faster than normal. The effect is spectacular but has not been found to cause any damage to the watch.
- Power-frequency electric and magnetic fields constitute a possible source of interference with the operation of some types of implanted cardiac pacemakers or other active implants. Interference has been reported in certain models of implanted cardiac pacemaker with electric fields above about 1.5 kV/m and with magnetic fields above about $100 \mu\text{T}$ at 50 Hz, though interference would not usually occur at fields as low as these. Most pacemakers are designed to 'fail safe' by reverting to fixed-rate operation when they sense the presence of interference above a certain level. The field strengths necessary to induce such behavior vary from one pacemaker model to another but are generally higher than the fields encountered in the environment. There has been no recorded case in Britain of a patient coming to any harm as a result of fields produced

by the power system. The UK Department of Health, Medicines and Healthcare products Regulatory Agency (MHRA), does not consider that transmission-line electric or magnetic fields constitute a significant hazard. More detail on EMFs and implanted medical devices.

- Magnetic fields may, in some circumstances, affect the steadiness of the image on visual display units (VDUs) which use cathode-ray tubes. This can occur if the frame frequency of the VDU is close to but different from the power frequency (50 Hz). The effect is to cause the image to wobble at a frequency, which depends on the difference between the frame frequency and the power frequency. Some VDU models may typically be sensitive to fields of 0.5 microtesla, although liquid-crystal, plasma and other modern display technologies are virtually immune from such problems. Limited amelioration can be achieved by careful orientation of the VDU and by screening. Screening magnetic fields is, however, difficult; even using high-permeability alloys such as "mumetal", worthwhile screening factors still require large amounts of the screening material.
- A fluorescent tube works by an electric field inside the tube causing a discharge, and this electric field can come either, as normally, from applying a mains voltage across the tube, or from the electric field produced by a power line. So fluorescent tubes will produce a visible glow under a power line, though usually it is only visible after dark as it is much weaker than the light they normally produce. The current through a fluorescent tube under a power line would probably be 20 – 200 micro-amps (μA) depending on the field. This is much less than a person can normally perceive, so you can hold the tube yourself under the power line without it hurting. (For comparison, a 10 W tube at 230 V draws 40 mA – 200 times greater). You can sometimes also make a fluorescent tube produce visible flickers by holding one end and rubbing your foot on a carpet to generate static electricity, though again, this needs to be done in a dark room.

H. Micro-shocks³³

In certain circumstances, a person exposed to a high electric field could experience small spark discharges on touching other objects.

This can happen two different ways. In both cases the common feature is the person touching an object, where one is at earth potential and the other, which is not earthed, has been raised to a higher potential by the electric field. When the person touches the object, charge flows so as to equalize the potentials, and this charge, concentrated on the small area of skin where contact is first made, creates the micro-shock.

The size of micro-shocks

The size of a micro-shock depends on the size of the objects concerned and how well grounded or insulated they are, as well as the field, so it is not possible to set a simple field limit to prevent them. Generally speaking, below 5 kV/m they are not a problem. Above 5 kV/m they may start being painful, depending on the individual situation.

How sensitive people are to micro-shocks

³³ <http://www.emfs.info/The+Science/highfields/Microshocks/Microshocks.htm>

There is data from America showing that in a field of 5 kV/m, for example, around 80% of people will perceive a micro-shock when touching a grounded object, but only about a quarter will describe it as annoying.

Micro-shocks and bicycles

One particular way a micro-shock can be experienced is by riding a bicycle under a high-voltage power line.

Micro-shocks are the phenomenon when a person gets charged in an electric field. When they touch a conducting object they discharge, and although the amount of charge involved is small, because that is concentrated on the small area of the skin where the contact is first made, it produces a sensation very much like the discharge you can sometimes get after walking across a carpet. See more on micro-shocks in general.

One specific way this can happen is by riding a bicycle underneath a high-voltage power line. If you are in electrical contact with a metal part of the bicycle all the times, then no charge can build up between you and the bicycle, and you should not experience any micro-shocks. However, if you are electrically isolated from the bicycle - e.g. you are holding rubber handlebar grips, or are wearing insulating gloves - then a charge can build up. This can then discharge as a micro-shock. The most common place for this to happen is either on the fingers if they brush against the brake lever, or in the inside of the upper thigh, as it comes close to the top of the seat pillar just below the saddle or to the saddle rails once each pedal revolution.

These micro-shocks do not cause any harm to the body or have any lasting effects that we know of. However, in the highest fields - that is, under spans of 400 kV power lines with the lowest clearance - they can be mildly painful, and they are certainly disconcerting because they are usually unexpected. (more on electric field levels under high-voltage power lines and on the sizes of the voltages and charges involved in micro-shocks)

How exposure limits change from 50 to 60 Hz

Exposure limits can vary a lot over the full range of frequencies from extremely low to radio frequencies. But even within the extremely low frequency range - where power systems operate - there can be differences between 50 Hz and 60 Hz. 50 Hz is used in parts of the world more influenced by British and European practice, 60 Hz is used in parts of the world more influenced by American practice.

In this page we summarize how the values of the exposure limits change from 50 to 60 Hz.

I. The 1998 ICNIRP Guidelines

These are the values used in the 1998 ICNIRP guidelines themselves and also the EU Recommendation for public exposure and Directive for occupational exposure which are based on them

	50 Hz	60 Hz	Units
Occupational			
basic restriction	10	10	mA/ m^2
magnetic field reference levels	500	417	μT
electric field reference level	10	8.333	kV m
General public			
basic restriction	2	2	mA/ m^2
magnetic field reference levels	100	83	μT
electric field reference level	5	4.167	kV/m

J. The 2010 ICNIRP Guidelines

	50 Hz	60 Hz	Units
Occupational			
basic restriction: Head	100	120	mA/ m^2
basic restriction: Whole Body	800	800	mA/ m^2
magnetic field reference levels	1000	1000	μT
electric field reference level	10	8.333	kV/ m
General public			
basic restriction: Head	20	24	mA/ m^2
basic restriction: Whole Body	400	400	mA/m^2
magnetic field reference levels	200	200	μT (2000mG)
electric field reference level	5	4.167	kV/m

K. CONSIDERATIONS REGARDING POSSIBLE LONG-TERM EFFECTS³⁴

As noted above, epidemiological studies have consistently found that everyday chronic low-intensity (above 0.3– 0.4 μT) (3 – 4mG) power frequency magnetic field exposure is associated with an increased risk of childhood leukemia. IARC³⁵ has classified such fields as possibly carcinogenic. However, a causal relationship between magnetic fields

³⁴ ICNIP Guidelines, 2010

³⁵ International Agency for Research on Cancer

and childhood leukemia has not been established nor have any other long term effects been established. The absence of established causality means that this effect cannot be addressed in the basic restrictions. However, risk management advice, including considerations on precautionary measures, has been given by WHO (2007a and b) and other entities.

L. Cardiac Pacemakers and Similar Devices

American Conference of Governmental Industrial Hygienist (ACGIH) issued standards for workers in 2001.³⁶

The American Conference of Governmental Industrial Hygienists (ACGIH) issued guidelines for EMF exposure for workers with pacemakers or implantable defibrillators. Maximum safe exposure for workers with these medical devices at 60 Hz (the frequency of most transmission lines) is **1 G (1,000 mG)** for magnetic fields and **1 kV/m** for electric fields.

Workers with Cardiac Pacemakers	1kV/m	1000mG
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M. Controversy Over EMF

The health and safety issues of EMF have existed for many years and after thousands of tests and research projects, there is no consensus as to the existence or severity of these effects. One of the biggest problems with the EMF health issue is the lack of consensus on how research is performed. Some of the following questions still have to be agreed to.

- What is Proof? Is an unreasonably high and overly-restrictive definition of proof keeping organizations from accepting the issues?
- What is sufficient proof? How much proof is needed?
- Are we researching all EMF frequencies during a research project or do we limit the research to just power line frequencies?
- Do we have to determine the exact mechanisms that cause a disease to take precautions? We still don't know how a lot of cancers work yet we believe that cancer is a serious issue.
- Do we have to be able to reproduce in the laboratory using mice before we accept that there is a serious concern?
- Some of these issues have existed for many years. As research continues with 1800 such projects over the last few year some of the last to issues have started to be proven, such as a potential mechanism as to how EMF cause disease has been found and as well as some EMF effects have been replicated in laboratory mice.
- As of today, no one has proven that EMF does not affect health.

36 www.capx2020.com/Images/EMF_factsheet.pdf

The World Health Organization has reviewed over 1800 new studies between 2007 and 2012 on EMF health effects.

EPRI has performed research on EMF effects for over 30 years.

"The World Health Organization (WHO) has weighed the full body of evidence from all these studies and classified EMF as **"possible carcinogenic,"** primarily because of observations made in human populations that show an association between magnetic field exposures and childhood leukemia." (EPRI publication: EMF and Your Health, January 2012).

EPRI EMF Research News: American Journal of Epidemiology on November 5, 2008, reported an increased risk in mortality from Alzheimer's disease and senile dementia among people who live less than 50 meters (164 feet) from power lines, compared with those who lived at least 600 meters (1968 feet) from power lines.

Xiaoming Shen and his colleagues of Jiao Tong University School of Medicine in Shanghai announced the results of research that may **finally explain just how EMF radiation causes childhood leukemia**. They finally determined that the distribution of leukemia among children living near high voltage power lines or transformers is not random; rather, it affects children carrying a certain genetic variant that is, the ability to repair DNA breaks vastly more often^{37 38 39}

Acute exposure to a 60 Hz increases DNA strand breaks in rat brain cells.⁴⁰ And these are repeatable tests.

XVI. TRANSMISSION LINE SAG:

All cables that are stretched between two poles will have some amount of sag in the center of the span. The amount of sag is a function of:

- Cable Weight
- Cable Tension
- Cable Temperature
- External Temperature
- Wind
- Ice

Electrical cables also are affected by the electrical current passing through the cable. Due to the internal resistance of the cable heat builds up in the cable and this heat causes cable elongation and additional sag. From the time when the cable is first installed the cable will also

37 Faulty DNA Repair May Explain EMF Role In Childhood Leukemia, Microwave News, December 15, 2008

38 Power-line radiation and childhood leukemia, IEEE spectrum, December 16, 2008

39 Leukemia & Lymphoma, Dec. 2008

40 Bioelectromagnetics vol 18, issue 2, pages 156-165, H. Lai & N.P. Singh

stretch which will cause additional sag. The following two diagrams show the affects of cable sag.

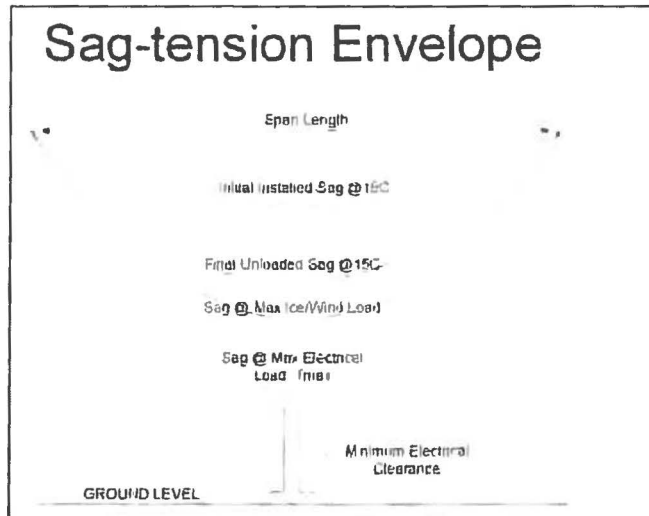


Figure 17 – Transmission Line Sag-Tension ⁴¹

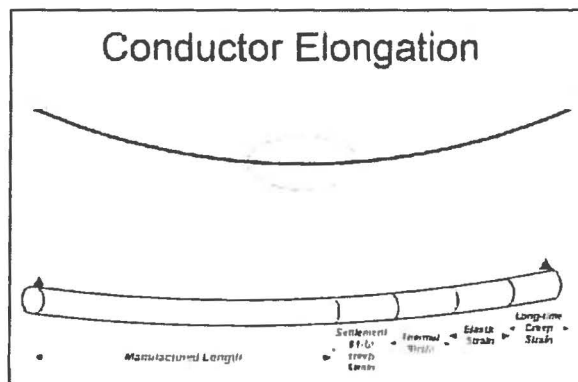


Figure 18 - Transmission Line Elongation ⁴²

A. Cables: ⁴³

The following data is based upon the cables used in the transmission line crossing the Barker property.

Upper cable (Dual Cables):

Measured diameter: 1.182 inches

Measured strand diameter: 0.132 inches

⁴¹ IEEE TP&C Tutorial June 2005

⁴² IEEE TP&C Tutorial June 2005

⁴³ Data estimated from samples left behind on Barker property

Estimated cable type: Alcan
 ACSR 954kcmil 1.196 in dia 54/7 Al/St 0.1329 AL cond. Dia.
 Code Name Cardinal Alcan base cost \$3.0725 per foot⁴⁴

Lower cable:

Measured diameter: 1.1120 inches
 Measured strand diameter: 0.18 inches
 Estimated cable type: Alcan
 ACSR 795kcmil 1.108 in dia 26/7 Al/St 0.1749 AL cond. Dia.
 Code Name Drake Alcan base cost \$2.3849 per foot

B. Cable Sag Calculations:⁴⁵

The two cables being considered are separated by 1070 feet and the pole height is approximately 118 FT (top of upper cross arm).

	Upper Cable	Lower Cable Tension	
Estimated Initial Sag:	20.79	19.87	25%
Estimated Final Sag:	26.85	26.61	19.4%/18.7%
Estimated Sag @ 167 Degrees F	29.5	28.8	17.6%/17.2%
Estimated Sag @ 212 Degrees F	32.3	31.58	16.1%/15.7%

Definitions:

Thermal Rating - The maximum electrical current, which can be safely carried in overhead transmission line (same meaning as ampacity).

RBS - Rated Breaking Strength of conductor. A calculated value of composite tensile strength, which indicates the minimum test value for stranded bare conductor. Similar terms include Ultimate Tensile Strength (UTS) and Calculated Breaking Load (CBL).

⁴⁴ Alcan 1/3/12 base price from the internet

⁴⁵ Sag and Tension of Conductors by D.A. Douglas & Ridley Thrash, 2006

SECTION 7- MEASUREMENTS

XVII. FIELD MEASUREMENTS:

Various EMF measurements were made at the Barker home since the new line was energized.

A. Magnetic Field Measurements in the House:

The following is a partial list of magnetic field measurements taken at the Barker house.

	Kitchen sink	12 Ft. from sink	30 Ft. from Sink	
5/1/11	8.3 mG	6.4 mG	5.0 mG	12:00 Noon
6/3/11	14.9 mG	9.1 mG	7.4 mG	9:52 PM
6/16/11	20.9 mG	15.8 mG	12.4 mG	1:00 PM
2/6/12	10.5 mG	8.3 mG	6.4 mG	3:50 PM
2/13/12	21.9 mG	17.0 mG	13.8 mG	4:45 AM
4/11/12	2.3 mG	1.6 mG	1.1 mG	6:30 AM

B. Voltage Measurements by the Barker Family

5/23/11	256 VAC	5:15PM	Truck
6/16/11	288 VAC	1:00 PM	Truck
2010	265.7		
2010	253.5		
?	330.0		

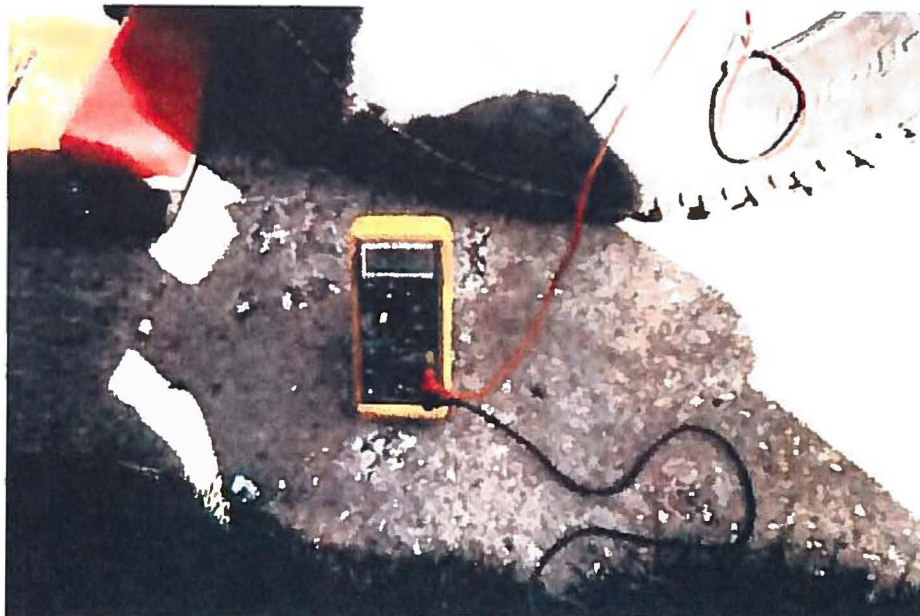


Figure 19 – Measurement by Brooks Barker

265.7 V was measured by Brooks Barker in 2010. The measurement was from the wheel lug nut to the earth. A similar measurement was also made in 2010 and the reading was 253.5 V. Readings have been made as high as 330v.

C. Measurements by EKPC⁴⁶

On December 5, 2008, 12:20 to 1:10 P.M. EKPC made measurements of the electric field strength on the property of the Barkers. They began at the corner of the house under the carport. They made a measurement every 5 feet from the house to a point 100 feet from the house. The temperature that day was 27 degrees F and both the 345kV and the 69kV lines were energized.

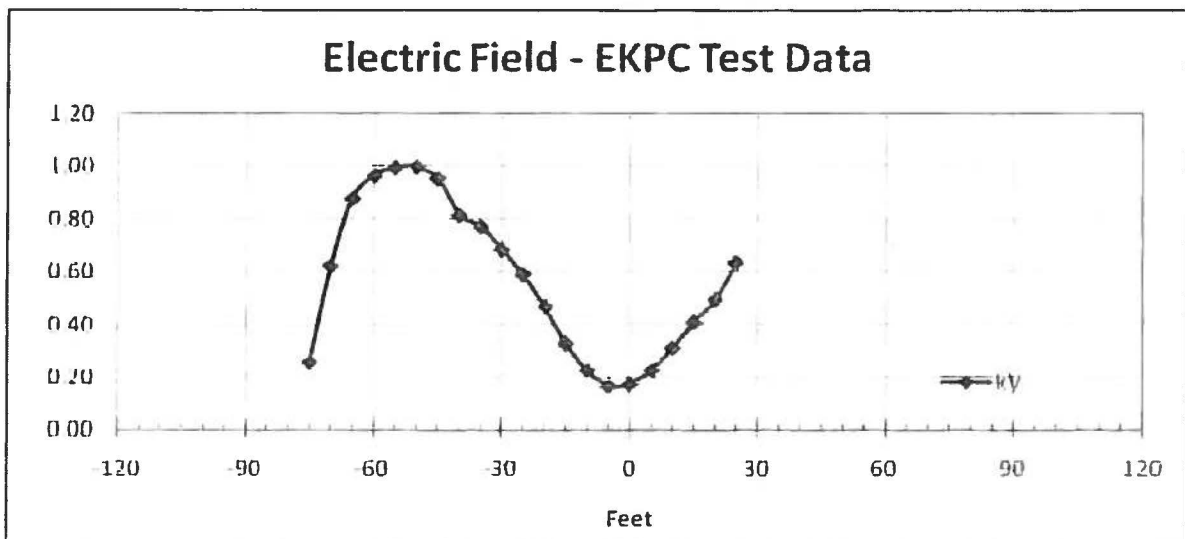


Figure 20 - Plot of EKPC Electric Field Measurements

⁴⁶ Report to Sherman Goodpaster from Paul Dolloff on December 8, 2008

D. Measurements By PEI

Measurements made by Pfeiffer Engineering Co., Inc. (PECI) were made on January 19, 2012 with the temperature at approximately 35 Degrees F. Pfeiffer Engineering used an Alpha Lab Model UHS ac milligauss meter.

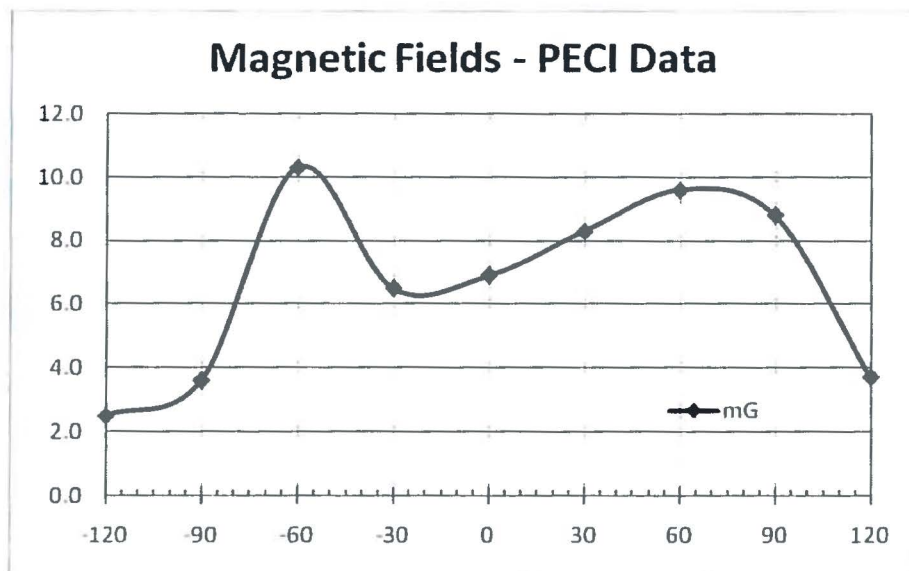


Figure 21 - Plot of PEI Magnetic Field Data



Figure 22 – Magnetic Fields Measurement Methods – Shows the line, measuring wheel and Flags

The method we used was to attach a line to the rear corner of the garage (North West) and run the line out into the field to a point past the transmission line. The line was moved until it was approximately parallel with the back side of the garage. It was also approximately perpendicular to the transmission line. Next, the center transmission line cable was located and marked with a flag. From that point measurement points were marked at 30 foot intervals and measurements were taken.

E. Effects of the Land

Both sets of field measurements resulted in unusual looking plots. This is because, as we move from the house toward the center of the transmission line, the land falls off to the east. This causes the distance from the measuring point to the transmission line to be inconsistent. Also as we go past the first cable of the transmission line the measurements are distorted by the fields from all the cables interacting. Thus, the data becomes complex and some of it has to be discarded.



Figure 23 – Magnetic Field Measurements – Note the Drop Off of the Land



Figure 24 – Magnetic Fields Measurements – Showing Where Measuring Line was Run

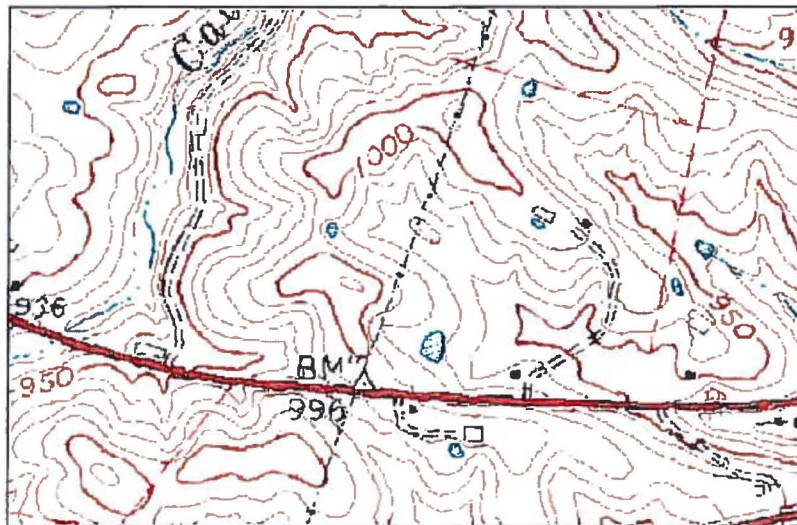


Figure 25 – Topographical Map of the Barkers' Farm

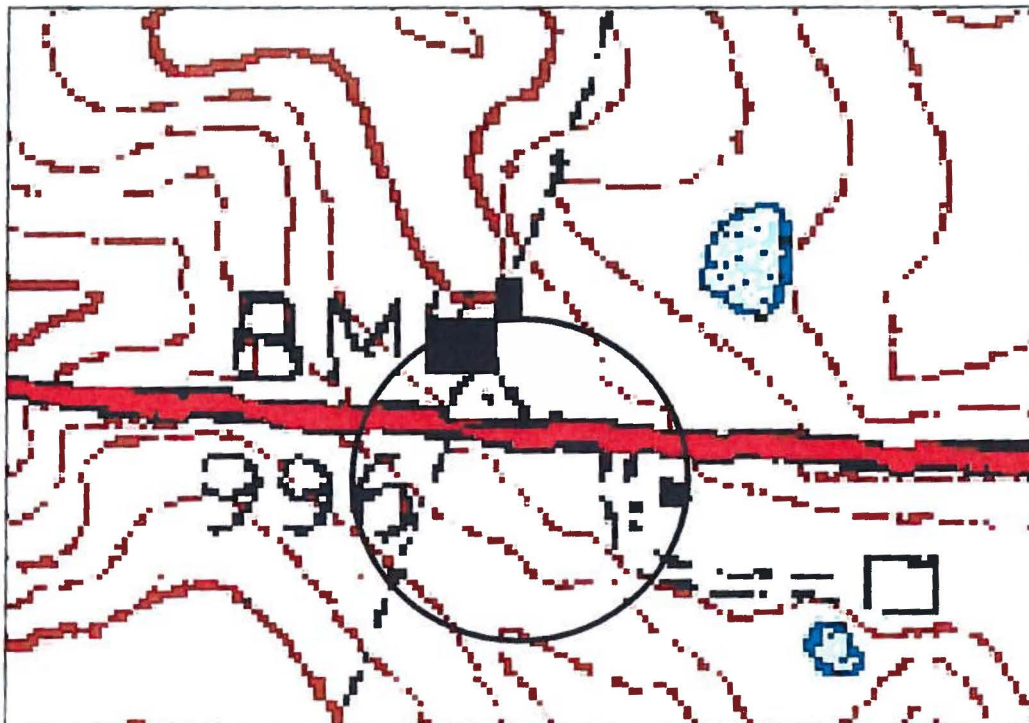


Figure 26 - Circle is ~200 Ft. in Diameter

The above figure shows roughly how much the land drops off under the transmission lines.

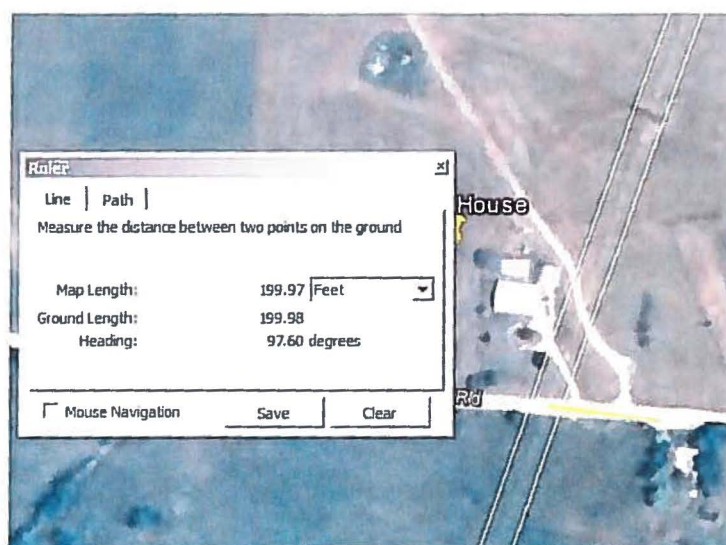


Figure 27 - Establishing a Reference

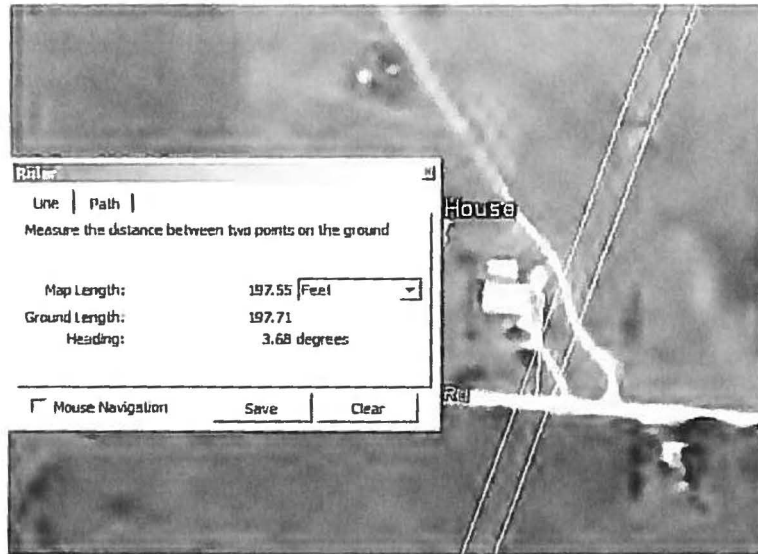


Figure 28 - Establishing a Reference

The above aerial photographs allow us to establish a scale on the topographical map and thus show the approximate location of the Barkers' house. From this we can estimate how much the ground drops off during the measurements of the electric and magnetic fields.

The following charts have been lined up so we can compare the values with respect to the house.

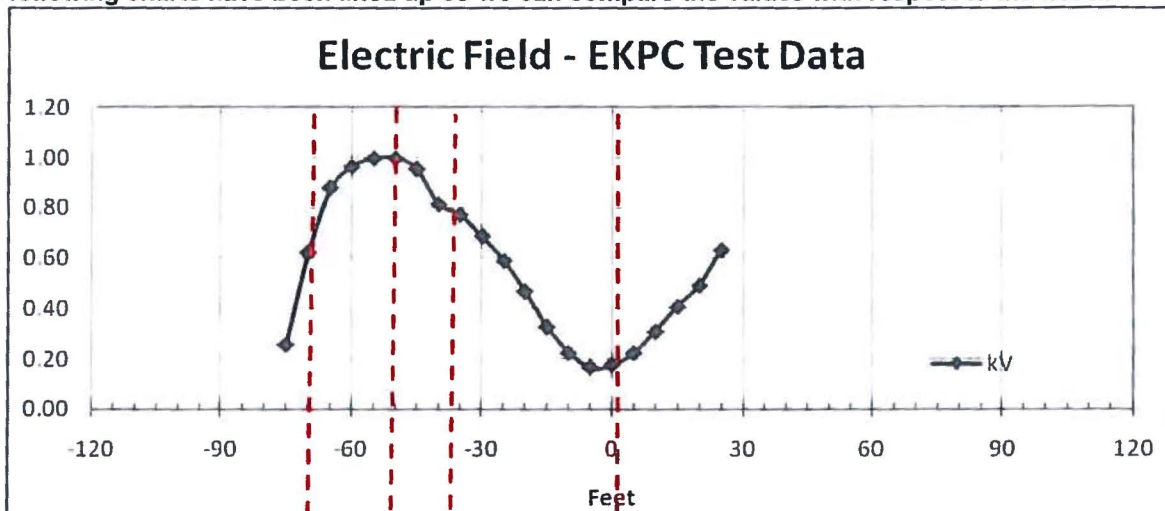


Figure 29 –Electric Field Measurements

Center of Power Line

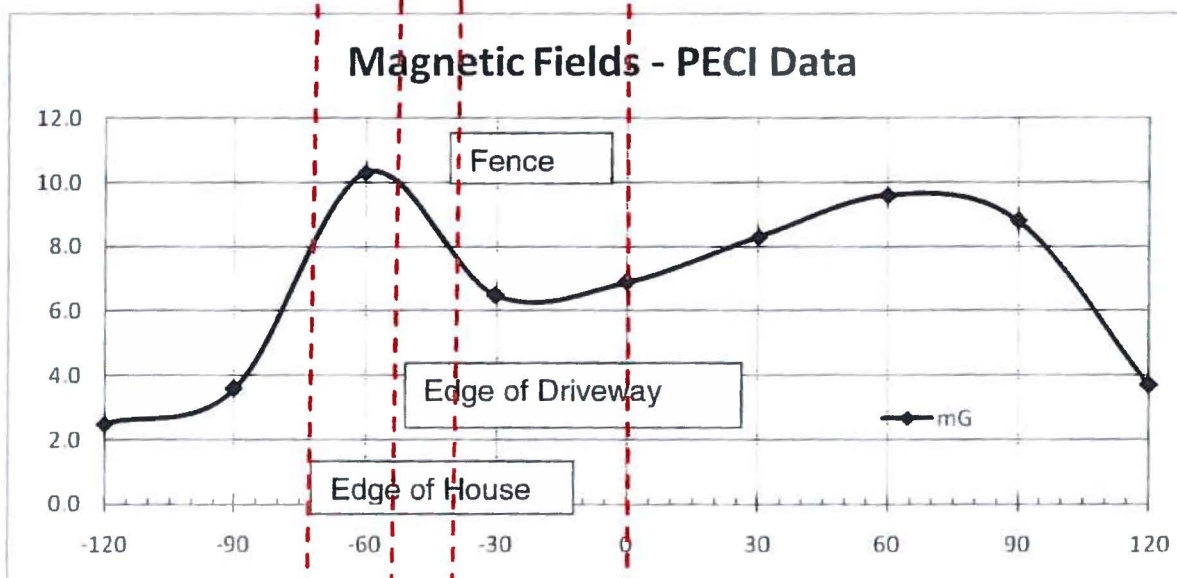


Figure 30 – Magnetic Field Measurements

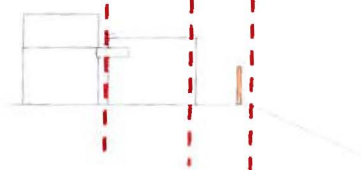


Figure 31 - Rough Sketch Showing Approximately Where the Measurements Were Made

Note that the ground drops off past the fence. This drop off causes the above data to be distorted as we approach the center of the power line.

The above show the following measurements as displayed in the above chart.

	Electric	Magnetic Fields
At the edge of the house	0.257 kV/m	8.0 mG
Just off the outer edge of the driveway	0.996 kV/m	10.0 mG
At the fence	0.793 kV/m	8.0 mG
Center of the power line	0.176 kV/m	7.0 mG

The primary area of concern is the area between the house and the fence where people are likely to walk. Below is an aerial view of the Barker property with the above measurements.

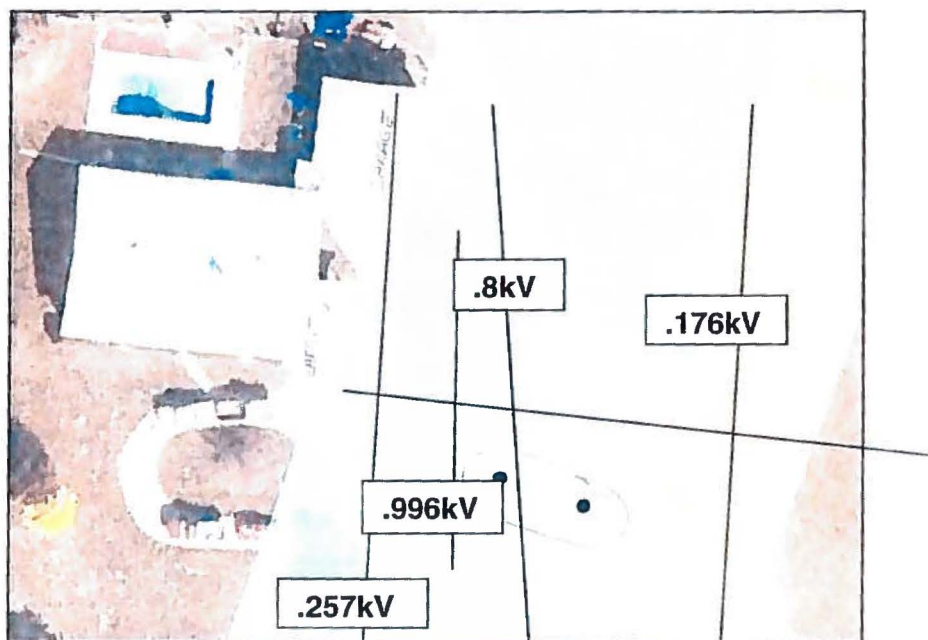


Figure 32 - EKPC Electric Field Measurements

F. Reality of Measurements:

The measurements shown above, while accurate do not represent the worse-case conditions. There are a number of variables that affect the intensity of the electric and magnetic fields.

4. 138 kV Line

This line, at the time of the measurements, was operated at 69kV. Thus, the resultant EMF is lower than what can be expected in the future.

5. Electrical Energy

The EKPC electric field measurements were made with the power line operating under the following conditions:

Actual Conditions			Maximum ⁴⁷ Winter/Summer	Load vs. Capacity (W)
345kV Line	351.9kV	255.2 MVA	1948/1554	13.1%
69kV Line	71.0kV	17.1 MVA	351/280	4.9%

Temperature: ²⁷ Degrees F with a constant breeze

Pfeiffer Engineering magnetic field measurements were made with the power line operating under the following conditions:

Actual Conditions			Maximum Winter/Summer	Load vs. Capacity (W)
345kV Line	67.8 MVA avg	(28 to 110MVA)	1948/1554	3.5%
69kV Line	28.4 MVA avg	(27 to 29 MVA)	351/280	8.1%

6. Maximum Line Conditions:

Thermal Capacity (MVA)

Normal/Contingency Conditions⁴⁸

176/212 Degree F Operation

	<u>Winter</u>		<u>Summer</u>	
2-345kV Line	1746 MVA	1947 MVA	1257 MVA	1554 MVA
69kV Line	315 MVA	351 MVA	227 MVA	280 MVA

7. Full Load Effects:

From the above data it is easy to see that the measurements were made in the winter where the temperature was low and the transmission lines were being operated at well below their capacity. Also the lower line was operated at 69kV where it is planned for the line to be operated at twice that voltage or at 138kV.

As the lower line's voltage is raised it will cause the electric fields to rise. As the energy is increased the magnetic fields will also increase. Also, as the energy levels (MVA) increase the transmission lines will begin to sag.

⁴⁷ Table 2 EKPC typical Line Ratings - Commonwealth of KY Before the Public Service Commission, Case 2006-00463, 7/16/07

⁴⁸ Table 2 EKPC typical Line Ratings - Commonwealth of KY Before the Public Service Commission, Case 2006-00463, 7/16/07

The measurements made by EKPC and PECL were made when the energy transmission was low and the temperature was low so the sag would be near the design final sag values of 26.85 & 26.61 feet. As the weather heats up and the electricity demand increases due to the use of air conditioning. The lines will sag more.

For the first few years after the transmission lines are installed the electric load on the lines is expected to be low as is shown in the data. However, all such lines are designed for future load increases and thus, it is reasonable to expect the loading on these lines will increase and will approach their design capacity sometime in the future. Thus, we need to look at the effects of further line sag.

Transmission lines are designed for normal operation at line capacity, which is the point where the cables will heat up to a point where their temperature will reach between 167 and 176 degrees F and under emergency conditions for the temperature to reach up to 212 degrees F for extended periods of time. Transmission lines can also be expected to exceed 212 degrees F for short periods of time.

As the sag in the transmission lines increase the electric fields and magnetic fields at the edge of the house will increase because the sag will lower the lines and thus bring them closer to the house.

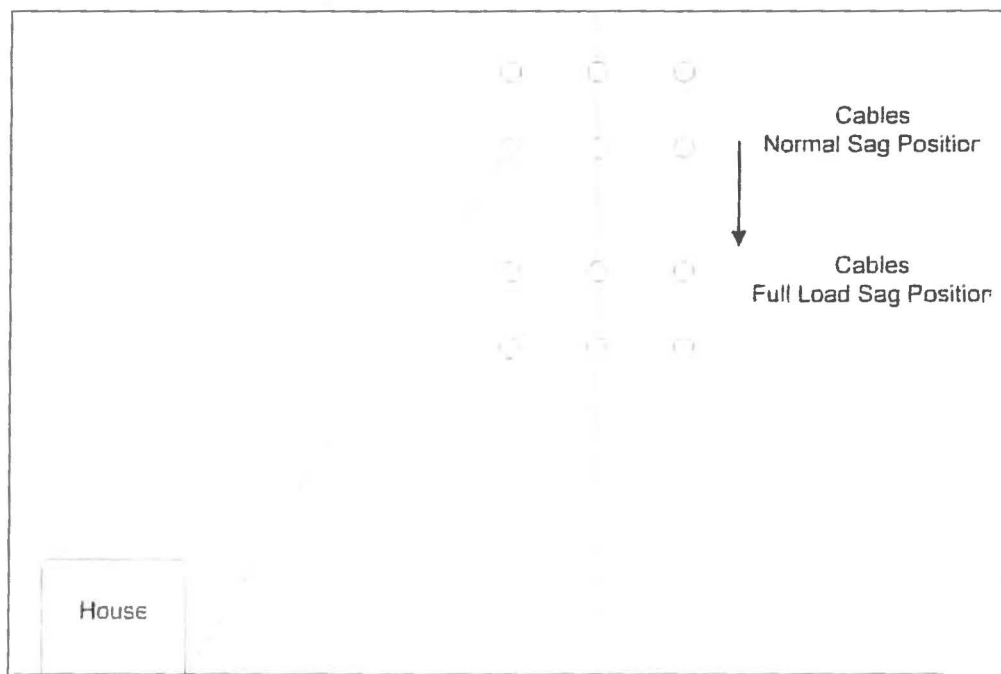


Figure 33 - Transmission Line Sag Effects

The above sketch shows the effects of increasing the sag on the power lines. The lines become closer to the house and the drive way.

From the above the electric and magnetic field measurements, under winter conditions, with minimal levels of energy flow are as follows:

	Electric Fields	Magnetic Fields
At edge of driveway	0.996 kV/m	8mG
Standards	1.0 kV/m	1000mG

From the above it can be seen that the electric fields are the main concern. At the time of the tests the electric fields were at the limit of the recognized standards. Further, it is known that:

- Increasing the voltage of the 69kV line to 138kV will increase the electric fields.
- Increasing the energy transmission levels will increase the sag, which will increase the electric fields.
- Increasing the energy transmission levels will increase the magnetic fields.

G. Electric Fields Data

We next need to compare the measured data against typical data for transmission lines. The following chart shows the typical electric field under a 345kV line. This chart is for a transmission line with only one circuit where as the new transmission line has two circuits.

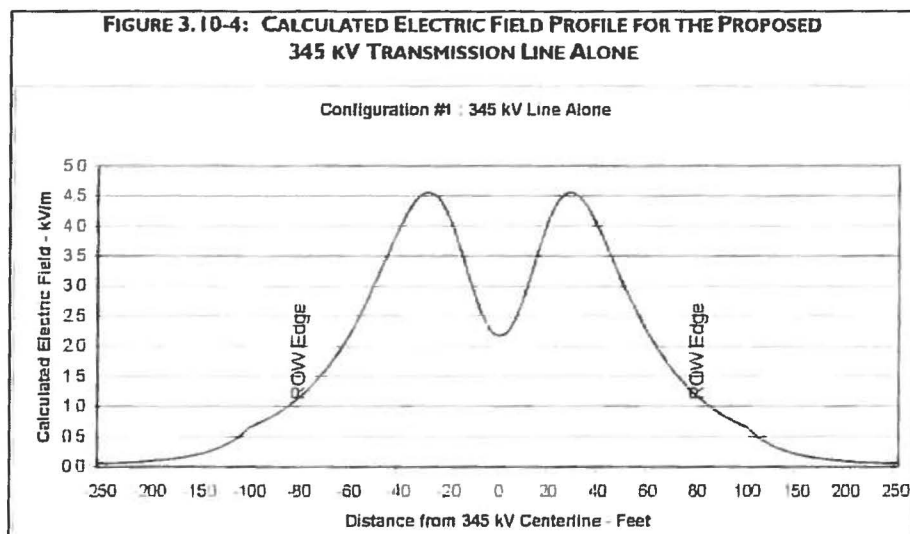


Figure 34 – Typical Electrical Fields for a 345kV Transmission Line – Single Circuit

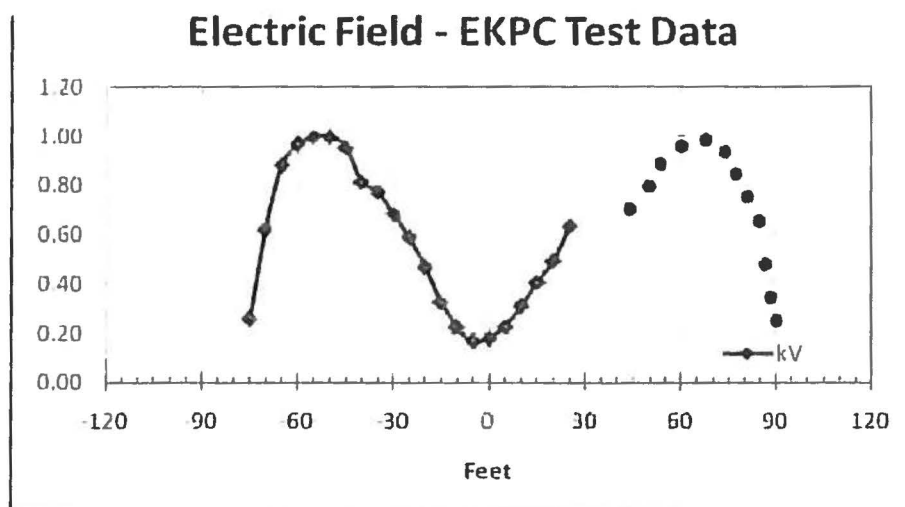


Figure 35 – EKPC Electric Fields Measured Data

In comparing the two charts, they look nothing alike. By adding a few dots as shown above the curve starts to compare to the above. The distorted data is partly due to the land dropping off rather than being flat. The fact that the transmission line has two circuits, one at 345kV and the other at 69kV complicates this issue and further distorts the data. Also the last point measured (toward the house) was measured under the carport. The carport blocked a part of the electric fields.

In order to analyze the data only a small part of the data could be used. The analysis process began with the development of standardized models for electric and magnetic fields. Next, the models were adjusted for actual site conditions and then compared against field data.

Electromagnetic fields decrease (decay) as you move away from the transmission lines. The following chart shows the typical decay of electric and magnetic fields. In general the decay is in the order of $1/R$ where the R is the distance from the transmission line.

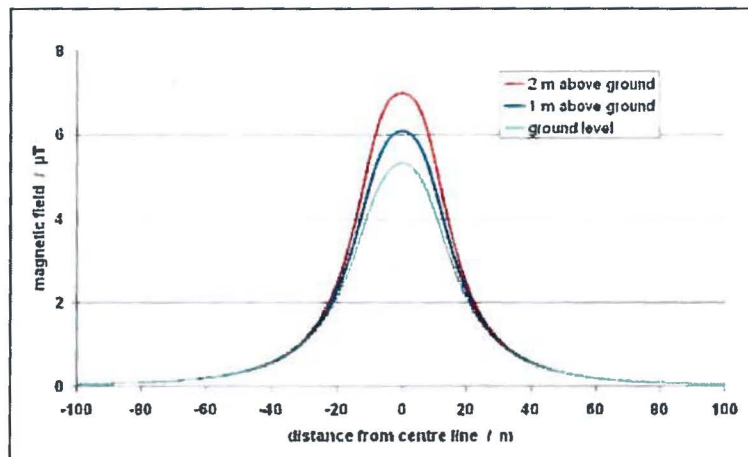


Figure 36 - Typical Magnetic Fields

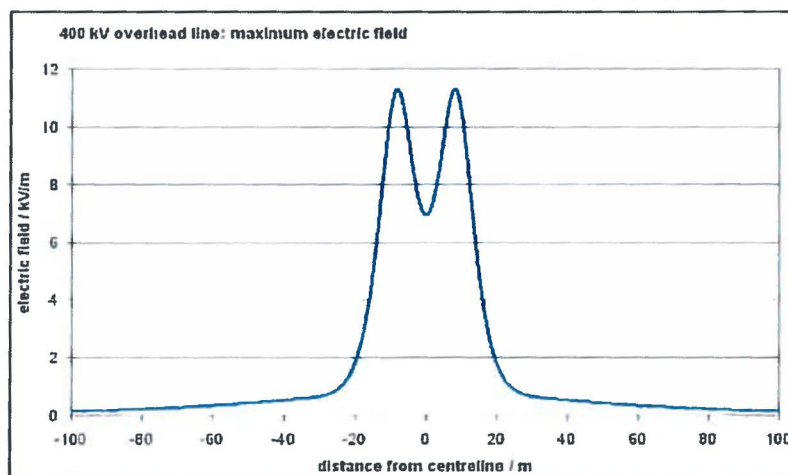


Figure 37 - Typical Electric Fields

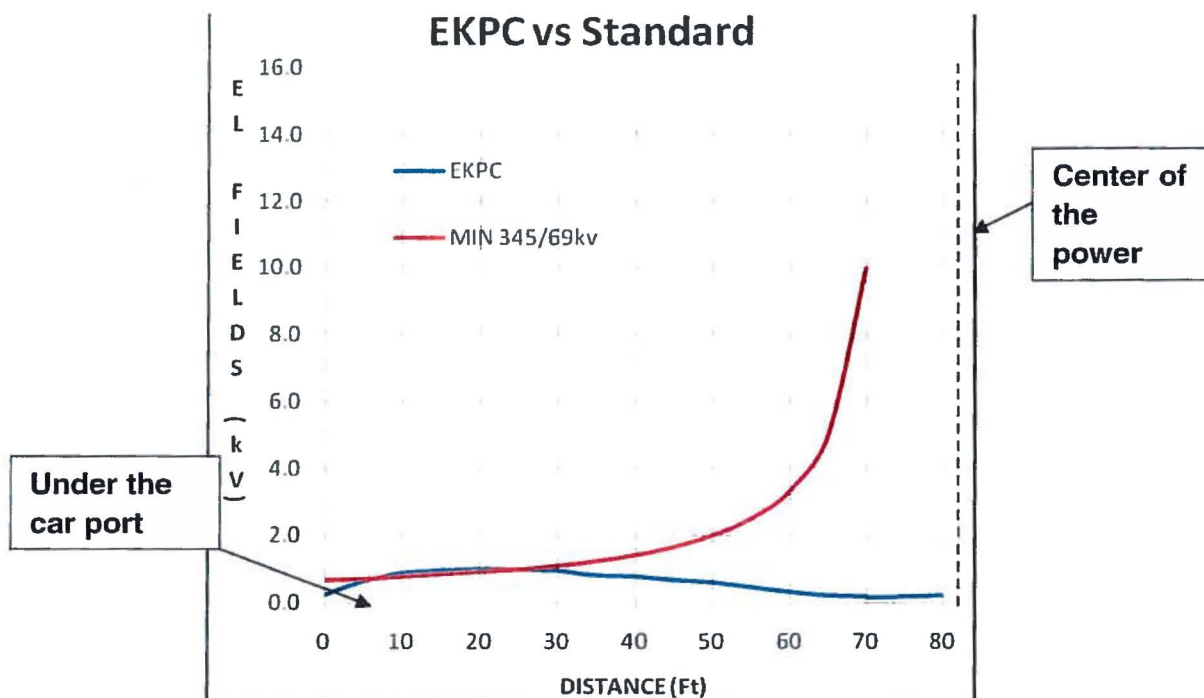


Figure 38 – EKPC Data as Compared With Calculated Data

The above figure shows the electric field model data (MIN 345/69Kv) and compares it to the measured values (EKPC). From 0 feet to 10 feet (x axis) the data goes in different directions. This is the area where field measurements were made under the carport, which partly blocked some of the field strength. As we go from 30 to 70 feet the ground is dropping off as we are approaching the transmission line, which has its centerline at 75 ft. Thus the only acceptable data is from 10 to 30 feet, which closely matches the calculated curve (MIN 345/69kV).

In developing our model we calculated the amount of sag in the lines and estimated the overall height of the poles. We were not able to determine the difference in elevation between the base of the pole and where the measurements were made. This height value is a constant and thus can be factored in our model based upon known measurement points.

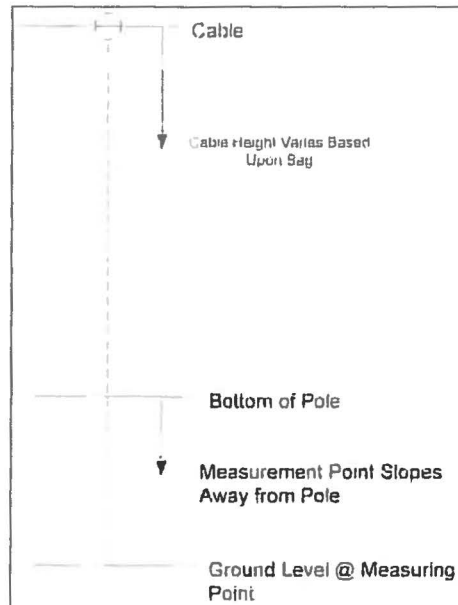


Figure 39 - Pole Height vs. Measuring Points

The model was expanded and we assumed that the 345 kv and 69 kv line fields were additive. That is, they can be added together.

In order to build this model we manually calculated the fields produced at one point. That point was at distance 25 ft. or 50 ft from the centerline of the transmission line. At this point electric fields were measured at 0.997 kV/m. From this starting point we extrapolated a standard curves which represented the 345 kv and 69 kv lines. When the two curves are added together they provide 0.997 kv/m at distance 25 ft.

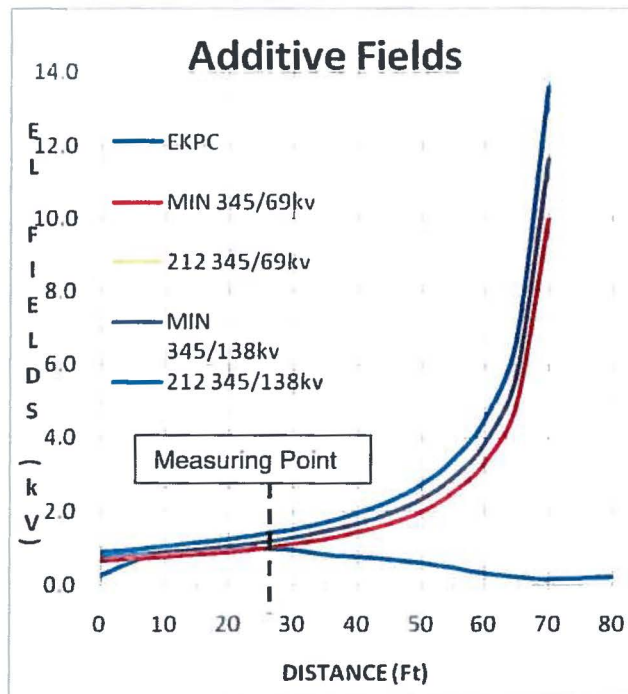


Figure 40 - Fields Assumed to be Additive

In the above figure the initial curve is labeled as MIN 354/69kV.

We next doubled the effect of the voltage on the lower line to approximate the effect of raising the voltage to 138kV, the lines design voltage. Both of these curves assume a current flow for the day the measurements were made.

Next, we assumed worse case conditions. That is, assume a maximum sag in the lines. This occurs when the current flowing will cause the lines to reach a temperature approaching 212 degrees F. Again two curves were produced for each voltage combination.

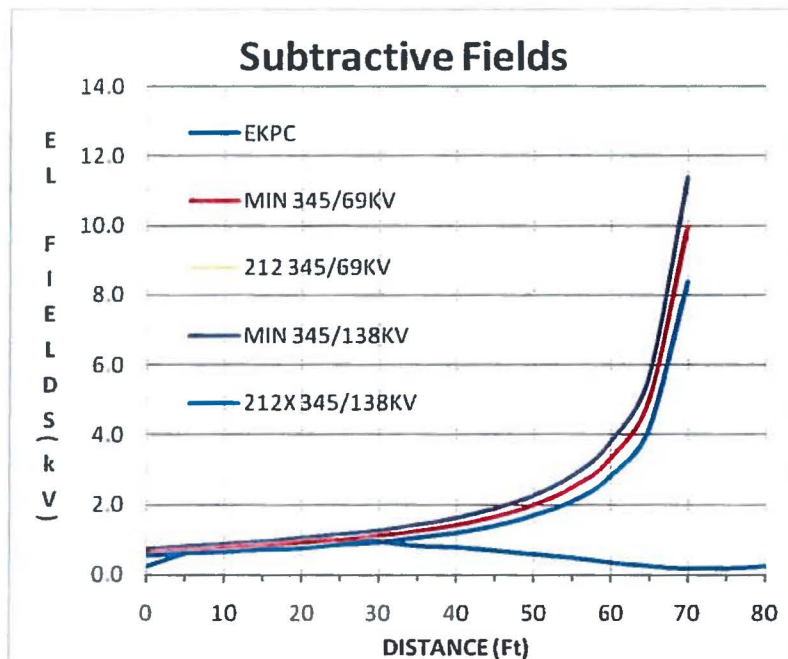


Figure 41 - Fields Assumed to be Subtractive

The next step was to adjust the model to have the two lines subtracting. Then regenerate the curves. The above figure shows the effects as if the fields were actually subtracting on the day of the test.

When we consider the lines as additive or subtractive it becomes apparent that if the lines were assumed to be additive and one line is turned off, the overall fields will be reduced. The opposite is true if the lines were subtractive when the measurements were made. In this case, if the 69kv line is turned off, the overall fields will increase.

In the next figure we illustrate the effect of the 69kv line being off at some time in the future if our base assumption at the time of measurement was that the fields were subtractive.

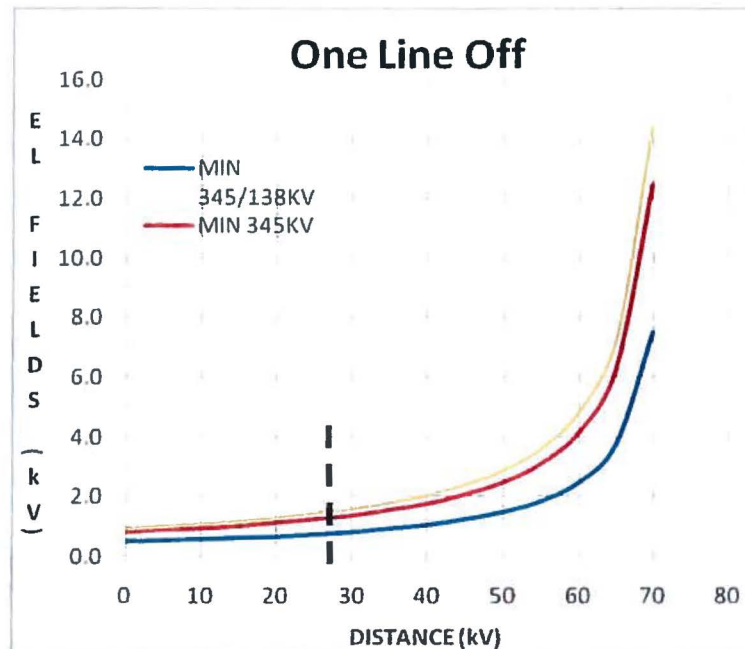


Figure 42 - Fields Subtractive with 138kV Line Turned Off

Results:

Edge of Driveway = Distance = 20 Ft.

345kV/69kV	Minimum Sag – Additive	0.997 kV/m
345kV/69kV	Maximum Sag – Additive	1.159 kV/m
345kV/138kV	Minimum Sag – Additive	1.163 kV/m
345kV/138kV	Maximum Sag – Additive	1.359 kV/m
345kV/69kV	Minimum Sag – Subtractive	0.997 kV/m
345kV/69kV	Minimum Sag – Subtractive	1.138 kV/m
345kV/138kV	Minimum Sag – Subtractive	0.748 kV/m
345kV/138kV	Maximum Sag – Subtractive	0.838 kV/m
345kV	Minimum Sag – Subtractive	1.246 kV/m
345kV	Maximum Sag – Subtractive	1.438 kV/m

From the above it is easy to see that the electric fields, in most cases, will be very close to 1kV/m or greater.

Magnetic Field Data

A similar approach was taken in analysis of the magnet fields. The figures below show the results of varying the current in the line and the resulting additional sag that was produced.

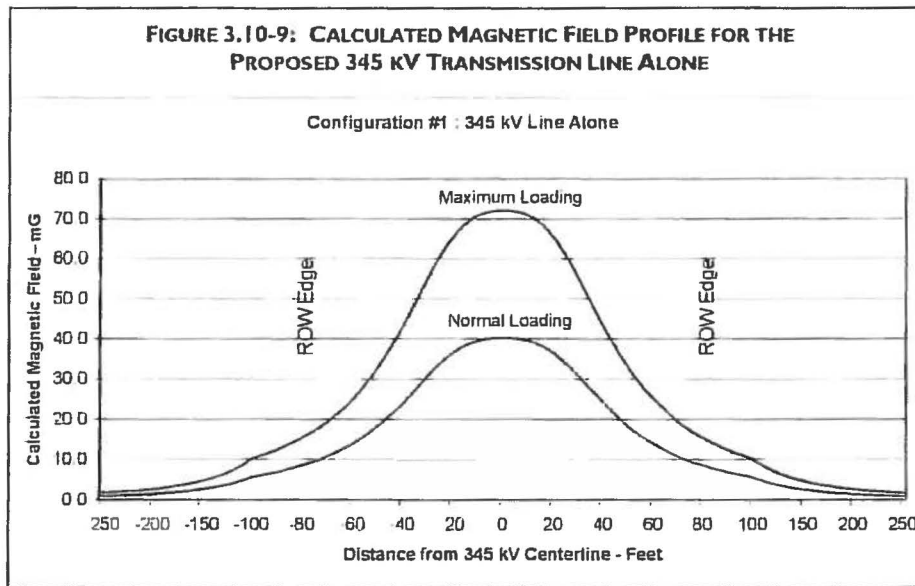


Figure 43 - Typical Electrical Fields for a 345kV Transmission Line – Single Circuit

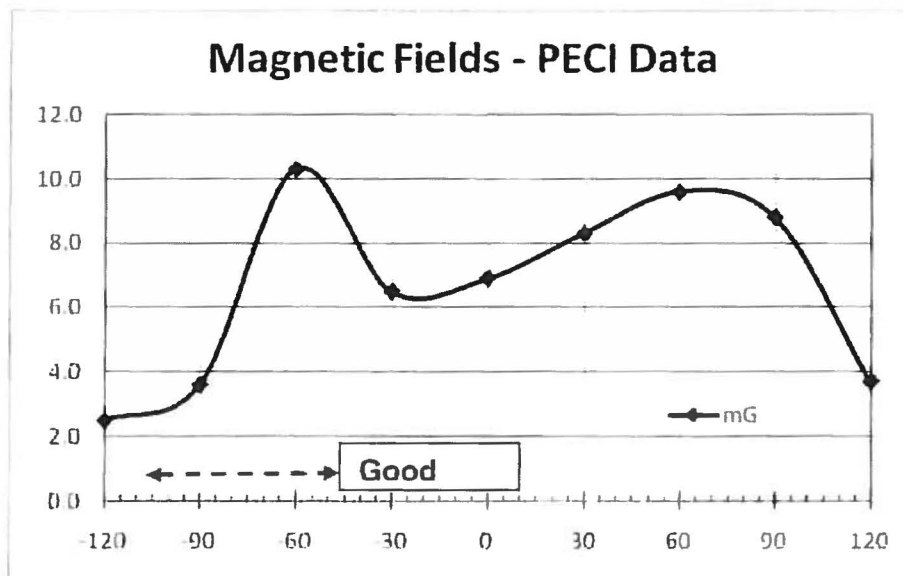


Figure 44 - Peci Magnetic Fields Measurements

As with the electric fields only a few data points could be used. The data points from -120ft to -60 ft. is the only good data as the remaining data is under the transmission lines.

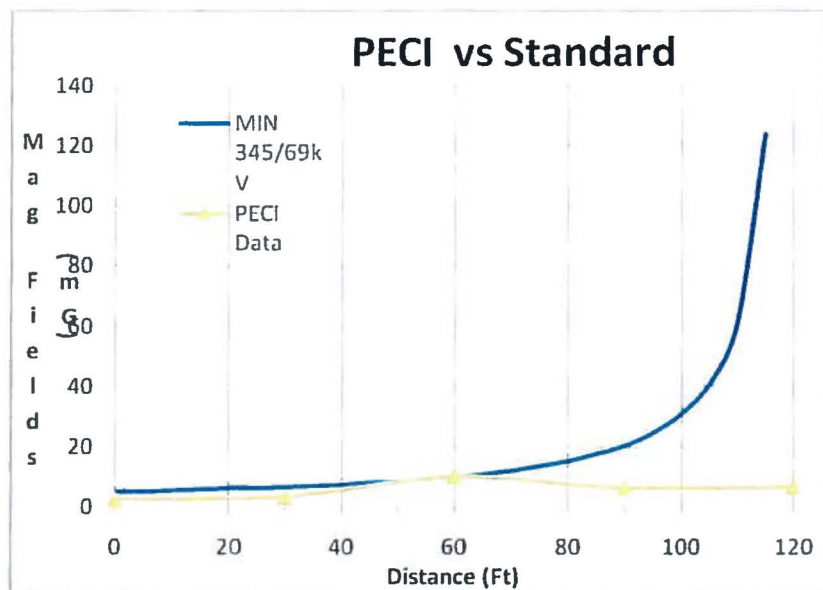


Figure 45 – PEGI Data as Compared With Calculated Data

The above figure shows the measured data (PEGI Data) and the calculated data (MIN 345/69kV). The base point for the calculations was the point at 60 ft from the centerline, which was measured at 10.3 mG. From this point and using the current flow data in each line the minimum field curves were generated. As seen in the figure above the first three data points match up fairly well with the calculated data.

With the currents measured in the power lines the day of our testing we established this a minimum loads on the line the same as we did for the electric fields. We also calculated curves for both additive fields and subtractive fields. Next, we determined what current would be flowing in each line at worse case conditions. For this we used EKPC's maximum conductor operating temperature values and their corresponding currents 3258 amps and 1468 amps for 345kv and 69kv lines in the winter.

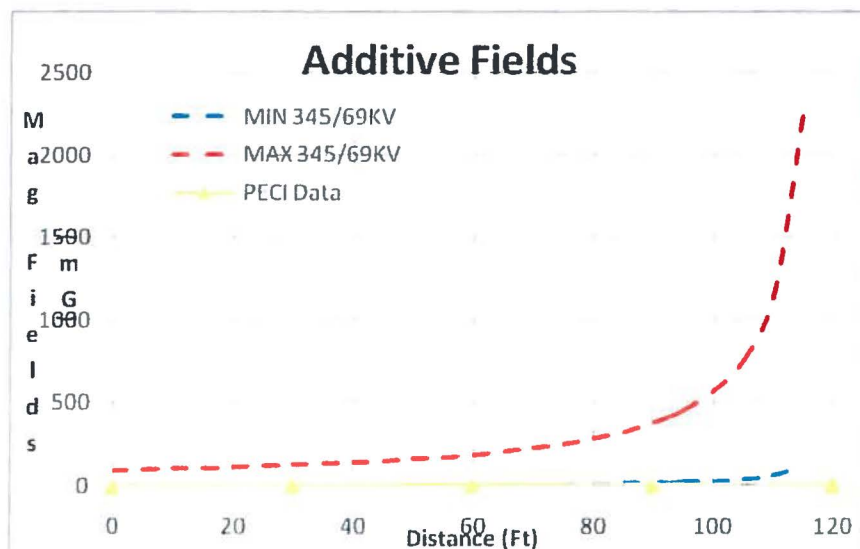


Figure 46 - Fields Assumed to be Additive

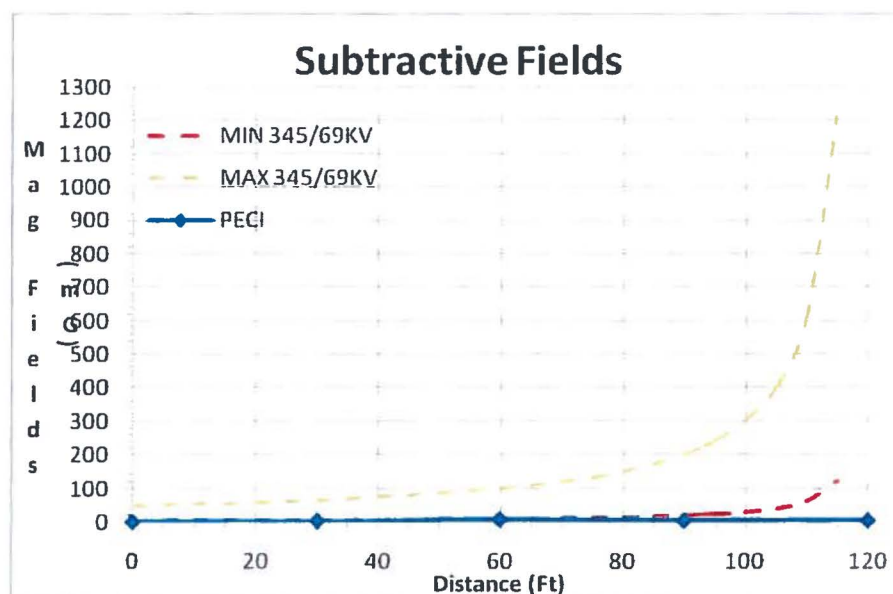


Figure 47 - Fields Assumed to be Subtractive

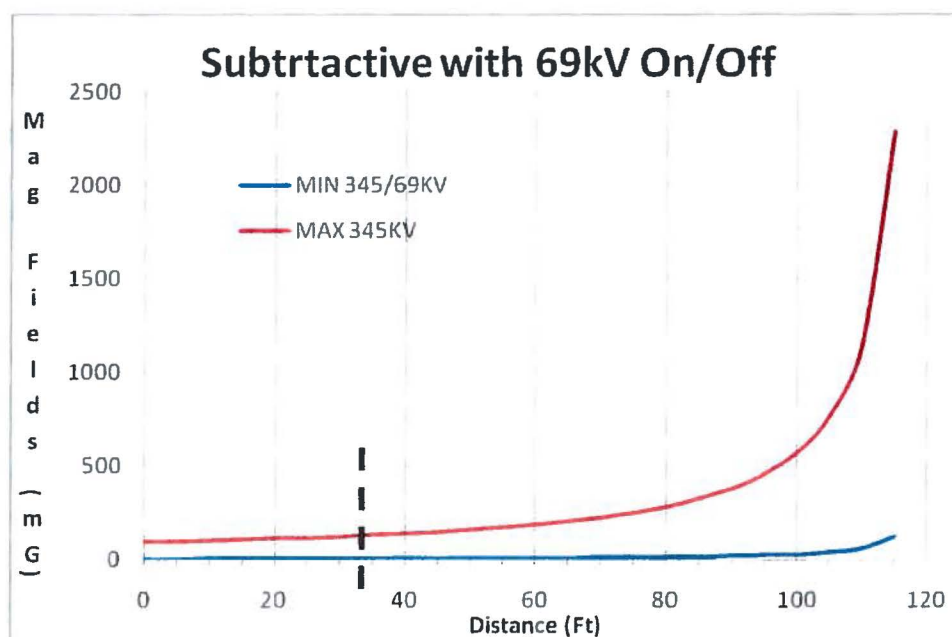


Figure 48 - Fields Subtractive with 69kV Line Turned Off

Results:

Edge of Driveway = Distance = 25 Ft.

345kV/69kV	Minimum Sag – Additive	10.3 mG
345kV/69kV	Maximum Sag – Additive	191 mG
345kV/69kV	Minimum Sag – Subtractive	10.3 mG
345kV/69kV	Minimum Sag – Subtractive	101.0 mG
345kV	Minimum Sag – Subtractive	190.7 mG

From the above it is easy to see that the magnetic fields will be varying between 10 mG and 191 mG.

XVIII. ANALYSIS of the MEASUREMENTS:

When we compare the EKPC electric field measurements with existing standards we can see that the electric field strength is right at the edge of the acceptable limits; 0.998 kV vs. 1.000 kV.

When we compare the magnetic field measurements with existing standards the measurements are below the existing standards but we expect that these fields will also go much higher. Our projected magnetic fields exceed one state's limit and approach another state's limit. In addition we believe that these standards will be lowered in the future.

According to David O. Carpenter, MD, Director, Institute for Health and the Environment University at Albany, East Campus, Rensselaer, New York, "new regulatory limits for Extremely Low Frequency (ELF) based on biologically relevant levels of ELF are warranted. ELF limits should be set below those exposure levels that have been linked in childhood leukemia studies to increased risk of disease, plus an additional safety factor. It is no longer acceptable to build new power lines and electrical facilities that place people in ELF environments that have been determined to be risky (at levels generally at 2 mG (0.2 μ T) and above).

While new ELF limits are being developed and implemented, a reasonable approach would be a 1 mG (0.1 μ T) planning limit for habitable space adjacent to all new or upgraded power lines and a 2 mG (0.2 μ T) limit for all other new construction. It is also recommended for that a 1 mG (0.1 μ T) limit be established for existing habitable space for children and/or women who are pregnant. This recommendation is based on the assumption that a higher burden of protection is required for children who cannot protect themselves, and who are at risk for childhood leukemia at rates that are traditionally high enough to trigger regulatory action. This situation in particular warrants extending the 1 mG (0.1 μ T) limit to existing occupied space. "Establish" in this case probably means formal public advisories from relevant health agencies."⁴⁹

49 Section 17 - Key Scientific Evidence And Public Health Policy Recommendations, BioInitiative Working Group, July 2007

EMF and Childhood Leukemia, by Robert Syfers, Spring 2006 – a EPRI publication

"Decades of research have studied possible effects of exposure to electric and magnetic fields. While the great majority of studies have shown no link between EMF and a variety of maladies, several key epidemiologic studies have caused expert scientific panels to conclude that there is indeed a statistically significant association between power-frequency magnetic fields and the development of childhood leukemia. Nevertheless, laboratory confirmation and a convincing explanation of the link eluded researchers and health theorist for some years. EPRI is now addressing two theories that may finally clarify the issue."

National Institute of Environmental Health Sciences (NIEHS) report shows the following state standards for transmission lines.

NIEHS June 2002	On ROW	Edge of ROW		
Florida	8 kV/m	2 kV/m	150 mG	69 - 230kv
	10 kV/m	2 kV/m	200 mG	500kv
			250 mG	500kv
Minnesota	8 kV/m			
Montana	7 kV/m	1 kV/m		
New Jersey		3 kV/m		
New York	11.8 kV/m	1.6 kV/m	200 mG	max. loads
	11 kV/m			
	7 kV/m			
North Dakota	9 kV/m			
Oregon	9 kV/m			

Figure 49 - Table of State EMF Regulations

Electric Fields

State requirement range:	1 to 3 kV/m ⁵⁰
ACGIH	25 kV/m
ACGIH – workers with pacemakers	1 kV/m ⁵¹
Measured fields	0.997 kV/m EKPC
Expected Fields	1.371 kV/m Potential Danger

Magnetic Fields:

State requirement range:	150 mG to 250 mG
ACGIH– workers with pacemakers	1000 mG
AIHA	833 mG

50 EMF Electric and Magnetic Field Association with the use of Electric Power – 6/2002 sponsored by NIEHS/DOE Rapid Program

51 ACGIH exposure for workers with cardiac pacemakers

British NRPB	833 mG	
California Safety Limits for Public Schools	1.2 mG ⁵²	
Swiss Standard	2.5 mG ELF ⁵³	
Swedish standard	1.0 mG ⁵⁴	
Dr. David Carpenter	2.0 mG	
Measured Fields	10.3 mG	PECI
Expected Fields	191 mG	Potential Danger

Definitions:

U.S. National Institute of Environmental Health Sciences (NIEHS)

American Conference of Governmental Industrial Hygienists (ACGIH)

XIX. OPINIONS of EKPC

A. EKPC's Opinion:

EKPC's opinion as expressed by Dr. Paul A. Dolloff:

Dr. Paul A. Dolloff, EKPC Senior Engineer, Research & Development Group

A member of the following organizations:

- Electric Power Research Institute (EPRI) Working Groups and Task Forces
- International Council on Large Electric Systems (CIGRE)
- National Rural Electric Cooperative Association (NRECA) Engineering Planning Subcommittee

EPRI is one of the key technical organizations studying the effects of EMF produced by transmission lines on public health. This organization has produced many articles on EMF and has reviewed hundreds of other articles. Please see the lists at the end of this report.

Per the meeting with Dr. Paul A. Dolloff, Ph. D of East Kentucky Power Cooperative, December, 2008:

- EMF consists of electrical fields and magnetic fields.
- The electric fields cause problems of electric shock as has been experienced on the Barker farm.
- Electric fields are a function of voltage, i.e. the power line voltage (345kV)
- Magnetic fields are a function of current, i.e. the power line current flow.
- There are no standards with respect to EMF health concerns applicable to EKPC or the State of Kentucky.

⁵² EMF Levels & Safety, ScanTech Consultants, www.scantech7.com

⁵³ EMF Levels & Safety, ScanTech Consultants, www.scantech7.com

⁵⁴ EMF Levels & Safety, ScanTech Consultants, www.scantech7.com

- Dr. Paul A. Dolloff stated that he knew of no standards anywhere.

EKPC stated that there are "no structures would be located close enough to the proposed transmission line to experience increased EMF levels."⁵⁵

Dr. Dolloff has been exposed to the issues concerning EMF and thus should have been aware of the state of standards development in the U.S. utility industry.

He stated that he knew of no standards anywhere concerning EMF and transmission lines. This is clearly an inaccurate statement on his part. As stated above there are definitely international standards and state standards regarding EMF levels at or near transmission lines. Since Dr. Dolloff is part of EKPC's research and development department it should have been part of his group's responsibility to keep up on such standards.

B. EKPC Environmental Report:

EKPC Environmental Report produced by the Gilpin Group, May 2006, stated that "no structures would be located close enough to the proposed transmission line to experience increased EMF levels."⁵⁶ This is clearly an inaccurate statement.

XX. CORRECTIVE ACTION By EKPC

EKPC personnel have taken some steps to reduce the effects of the EMF produced by the new transmission lines. Shown below are photographs of grounding installed at two locations along the fence that runs parallel to the Barkers' driveway. This grounding was installed at the time of the installation of the new transmission lines.

This grounding was installed as a precautionary measure as EKPC knew that the fence will charge due to the electric fields producing micro-shocks to persons touching the fence. This grounding will only help reduce the effects of the electric fields and will have no effect on the magnetic fields.

55 EKPC Environmental Report... May 2006

56 EKPC Environmental Report... May 2006, Page 54



Figure 50 - Fence Grounding at House



Figure 51 - Additional Fence Grounding on the Farm

Even with the grounding of the fence along the driveway people are still getting shocked when they touch vehicles in the driveway and high voltage can still be measured from a vehicle to the earth.

XXI. REDUCTION of EFFECTS:

There are a number of ways to reduce the effects of EMF generated by transmission lines. Below are a few of the common methods.

Rotate the phase sequence of one of the circuits as shown below

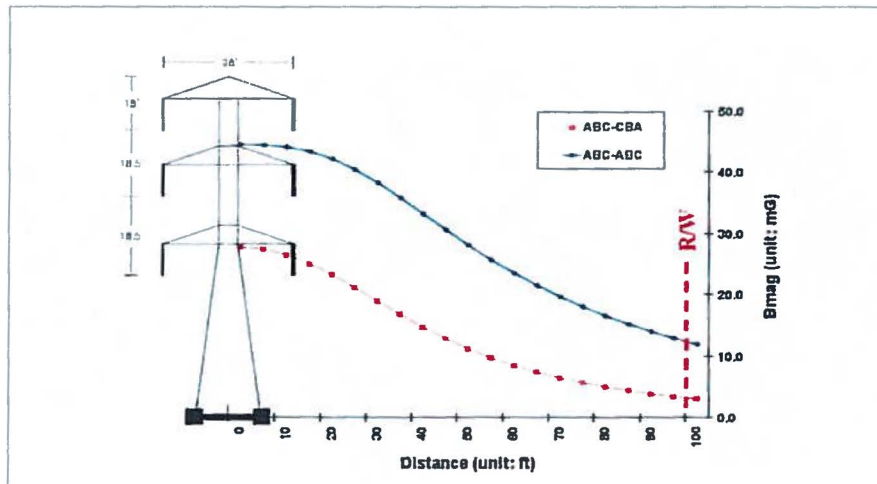


Figure 52 - Effects of Phasing⁵⁷

Increase the height of the poles.

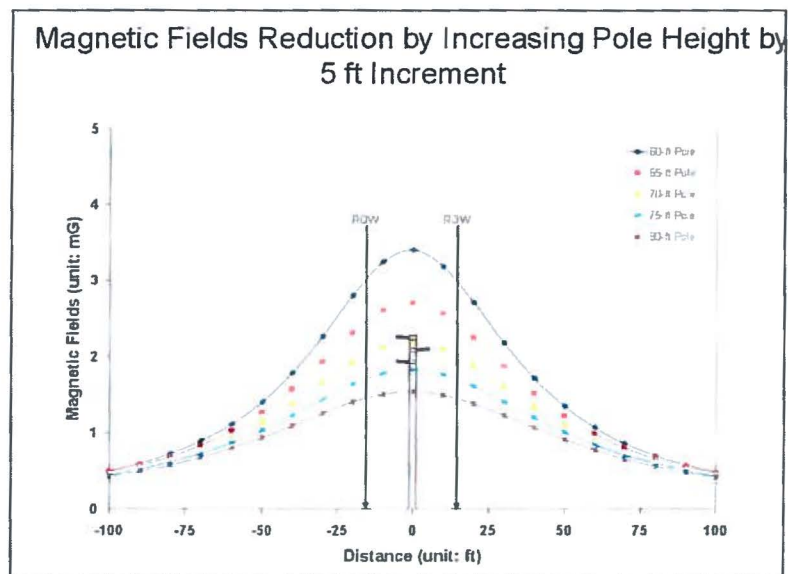


Figure 53 - Effects of Pole Height⁵⁸

⁵⁷ California's EMF Policy, California Public Utilities Commission, Jack Sahl, Southern California Edison

⁵⁸ California's EMF Policy, California Public Utilities Commission, Jack Sahl, Southern California Edison

Move the line further away from the house.

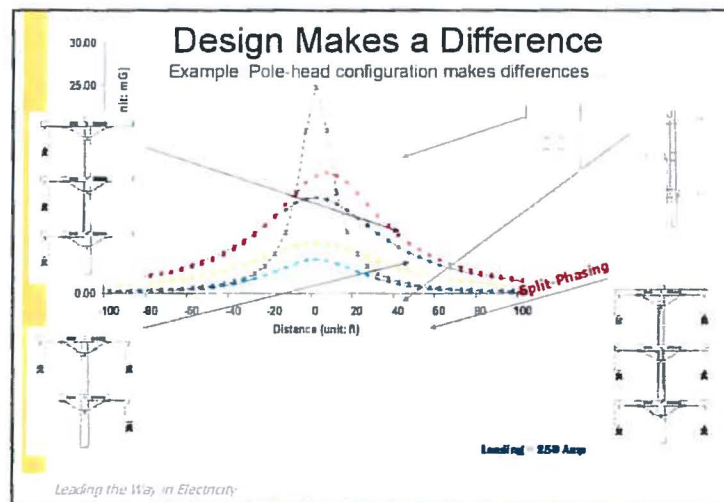


Figure 54 – Effects of distance from Power Line⁵⁹

XXII. REROUTING OPTIONS:

Two slightly different routing options are shown below for the transmission line. First the transmission line is shown as it was run. This is followed by a picture of the actual transmission lines as they run very close to the Barker house.

⁵⁹ California's EMF Policy, California Public Utilities Commission, Jack Sahl, Southern California Edison



Figure 55 - Route of the new transmission line



Figure 56 - Transmission Line Location

In the above picture it is hard to discern the line as they were very light in the Google Earth image. This picture shows approximately the location of the lines as they are today. What follows are two diagrams that show optional routes the lines could have taken in order to provide additional space between the transmission lines and the house. As we move the lines further to the east we reduce the amount of EMF and thus reduce the potential health hazards and reduce the concern of visitors to the Barker store.

We chose the two options to be to the east, however, the lines could be moved to the west.



Figure 57 - Transmission Line Relocation - Option 1 - Move 221 Ft. to East



Figure 58 - Option 2 – Move 309 Ft. to East

The options reposition the lines resulting in moving the centerline of the transmission line 222 feet, option 1 or 309 feet, option 2 further away from the house. In doing this the length of the conductors will increased. See the table below.

The cost of a section of the transmission line can be broken into the following:

- Design
- Right of Way expense
- Surveying
- Cable
- Poles
- Construction

Of all of these cost items the only item that would have been affected would be the cost of the cable if the change had been implemented when EKPC moved the poles from next to the Barker house to a point 400 ft. to the north. The design and surveying cost would be the same. The right of way had to be expanded under all options thus no additional cost. There is no increase in the number of poles and the cost of construction would not go up. Only the cost of the cable would increase. The following table shows the additional cable that would have had to be purchased and these costs are based upon Alcan's current base cost for this type of cable. Thus the cost of having the transmission line being further to the east from the beginning is minimal.

	Centerline of line to the house	Increase in line length	Additional 345kV line	Additional 138kV line	345kV line Base cost of wire	138kV line Base cost of wire	Total Cost
Existing	55.6 ft	0					
Option 1	221.5 ft	54 Ft	324 ft.	162 ft	\$1,389.38	\$458.29	\$1,848.35
Option 2	309 ft.	118 Ft	708 ft	354 ft.	\$3,040.31	\$1,004.33	\$4,044.64

XXIII. Effects of doing nothing:

1. Increased magnetic fields
2. Increased electric fields
3. Increased risk to people with pace makers and similar implanted devices
4. Increased risk of cancer and leukemia
5. Increased noise (hum) as the cable load increases
6. Worse problems with micro-shocks
7. Reduced property value

SECTION 8 – REFERENCES

XXIV. References:

The following references are in addition to documents sited above"

- National Electrical Code
- National Electrical Safety Code
- National Fire Protection Association, NFPA 921
- O.S.H.A.
- RUS Bulletin 1724E-200, Design Manual for High Voltage Transmission Lines, May 2009
- RUS BULLETIN 1724E-203
- Chapter 14, Sag and Tension of Conductors, D. A. Douglass Power Delivery Consultants Inc. and Ridley Thrash, Southwire Corporation
- PJM Design and Application of Overhead Transmission Lines 69kV and Above, Section V.A of PJM TSDS Technical Requirements 5/20/2002
- CHAPTER 3: AFFECTED ENVIRONMENT & ENVIRONMENTAL CONSEQUENCES, FINAL EIS AND PROPOSED RMP AMENDMENTS
- Amended Declaration of Dr. David O. Carpenter, M.D. Civil Action No. 3:11-cv-00739-MO, United States District Court, District of Oregon, Portland Division
- TESTIMONY OF DAVID O. CARPENTER, PUC DOCKET NO. ET2/TL-08-1474, OAH DOCKET NO. 7-2500-20283-2
- BioInitiative Working Group, August 2007
- Calculation and measurement of the magnetic field of power transmission lines, CIGRE ŠK C3 – 1
- Current Status of Scientific Research, Consensus, and Regulation Regarding Potential Health Effects of Power-Line Electric and Magnetic Fields (EMF) January 2006
- Assessment of Health Effects from Exposure to Power-Line Frequency Electric and Magnetic Fields - Working Group Report, NIEHS with support of the EMF Research and Public Information Dissemination (EMFRAPID) Program through the United States

Department of Energy and the National Institute of Environmental Health
Sciences/National Institutes of Health.

- International Commission On Non-Ionizing Radiation Protection - Icnirp Publication –

2010 Icnirp Guidelines For Limiting Exposure To Time-Varying Electric And Magnetic

Fields (1 Hz – 100 KHz) Published In: Health Physics 99(6):818-836; 2010

- EMF Electric and Magnetic Fields Associated with the Use of Electric Power, June 2002, National Institute of Health
- ELF Electromagnetic Fields and Cancer, Report of an Advisory Group on Non-ionizing Radiation, 2001
- Final Report Focused Review of Documentation Filed by East Kentucky Power Cooperative, Inc. For a Proposed 345 kV Transmission Line Within Kentucky Case No. 2006-00463
- APPLICANT'S RESPONSE TO COMMISSION STAFF'S FIRST DATA REQUEST DATED JULY 6,2007
- Electrical Field around the overhead Transmission Lines, S.S. Razavipour, M. Jahangiri, H. Sadeghipoor
- EMF Health Risk Evaluations, EPRI
- EMF and Childhood Leukemia, Robert Syfers
- EMF Research News, EPRI, December 2011
- Pacemaker Interference by 60-Hz Contact Currents, IEEE

- Interference in Implanted Cardiac Devices, Part I, SERGIO L. PINSKI and RICHARD G. TROHMAN
- Interference in Implanted Cardiac Devices, Part II, SERGIO L. PINSKI and RICHARD G. TROHMAN
- Living and Working Safely AROUND HIGH-VOLTAGE POWER LINES. Bonneyville Power Administration
- MANUAL FOR MEASURING OCCUPATIONAL
- ELECTRIC AND MAGNETIC FIELD EXPOSURES, OSHA
- Power-line radiation and childhood leukemia: this cold case may finally be solved: Tekla Perry, December 16, 2008
- EMF – Electric & Magnetic Fields, Public service commission of Wisconsin, January 2008
- EMF Levels & Safety, Scantech
- ICNIRP GUIDELINES, FOR LIMITING EXPOSURE TO TIME-VARYING ELECTRIC

AND MAGNETIC FIELDS (1 HZ – 100 KHZ), HEALTH PHYSICS 99(6):818-836; 2010

- EPRI Comments on the IEEE Standard for Safety Levels With Respect to Human Exposure to Electromagnetic Fields, 0 to 3 kHz (2002)
- IEEE Standard for Safety Levels with Respect to Human Exposure to Electromagnetic Fields, 0–3 kHz, IEEE C95.6-2002

SECTION 9 – EPCI

XXV. EPRI EMF Research Literature

Abstracts for Recent Studies

1. An integrated job exposure matrix for electrical exposures of utility workers. Bracken TD, Kavet R, Patterson RM, Fordyce TA. *Journal of Occupational and Environmental Hygiene* 2009;6(8):499–509. Job-exposure matrices are arrays of rows and columns that match various job titles, tasks, and work environments with exposures workers are likely to encounter on the job. At electric power companies, workers may be exposed to magnetic fields, electric fields, perceptible nuisance shocks, and imperceptible contact currents. Workers may also experience electrical injuries. This paper describes a job-exposure matrix that improves upon previous matrices, which focused on magnetic fields, by addressing all of these factors for 22 job categories. The integrated job-exposure matrix indicates that the highest exposures for all factors combined occur in 4 job categories that involve work near electrical equipment: cable splicers, electricians, line workers, and substation operators.
2. **Future Needs of Occupational Epidemiology of Extremely Low Frequency (ELF) Electric and Magnetic Fields (EMF): Review and Recommendations.** Kheifets L, Bowman JD, Checkoway H, Feychting M, Harrington M, Kavet R, Marsh G, Mezei G, Renew DC, van Wijngaarden E. *Occupational and Environmental Medicine* advance online publication, 19 Sep 2008; doi:10.1136/oem.2007.037994. This paper summarizes the proceedings of a 2006 occupational EMF epidemiology workshop sponsored by the UK's Energy Networks Association. The paper reviews the epidemiologic literature on occupational EMF and health, identifies the highest priority research needs, and proposes steps to address remaining uncertainties. The authors conclude that although the existing epidemiologic evidence does not indicate strong or consistent associations between occupational exposure to EMF and adverse health effects, further research is needed. Identifying exposure assessment improvements and research on the neurodegenerative disease amyotrophic lateral sclerosis (ALS, or Lou Gehrig's disease) as the top research priorities, they recommend development of a holistic job-exposure matrix and an international collaborative study of ALS and electrical occupations.
3. **Occupational Electromagnetic Fields and Leukemia and Brain Cancer: An Update to Two Meta-Analyses.** Kheifets L, Monroe J, Vergara X, Mezei G, Afifi A. *Journal of Occupational and Environmental Medicine* 2008;50:677–88. The aim of this work was to use meta-analysis, a statistical method that combines published data from individual epidemiologic studies, to clarify inconsistent and inconclusive study results on occupational EMF exposure and adult brain cancer and leukemia. As the World Health Organization recommended in its 2007 EMF health risk evaluation, the authors incorporated results from new studies into meta-analyses they published in 1995 and 1997. In addition to the previously included studies, the updated meta-analyses include 20 new brain cancer studies and 21 new leukemia studies. Although combining data from the new studies yielded small risk increases

(10–13%) for brain cancer and leukemia, combining data from new and previous studies yielded lower risk estimates for both diseases than those reported in the original meta-analyses. In addition, risk for leukemia subtypes was inconsistent in a comparison of the updated meta-analyses with the previous ones, and there was no clear pattern for workplace EMF exposure and risk of either leukemia or brain cancer. The authors concluded that these results do not support the hypothesis that occupational EMF exposure is responsible for the risk increases.

4. Exposure to 50 Hz Magnetic Field in Apartment Buildings with Built-In Transformer Stations in Hungary. Thuróczy G, Jánosy G, Nagy N, Bakos J, Szabó J, Mezei G. Radiation Protection Dosimetry advance online publication, 30 Jul 2008; doi: 10.1093/rpd/ncn199. Multilevel apartment buildings with built-in electricity transformer rooms are common in many countries. In this study in Hungary, Thuróczy et al. measured magnetic field levels in apartments in 31 buildings with basement or ground-floor transformer rooms. They found that apartments located immediately above transformer rooms had considerably higher power-frequency (50 hertz [Hz] in Europe) magnetic field levels than those farther away. The authors concluded that the location of apartments relative to transformer rooms reliably predicts magnetic field exposures. These results support the idea that in an epidemiologic study, magnetic field exposures in apartments in buildings with transformer rooms could be assessed without access to apartments or contact with residents. Such a study would avoid selection bias, a form of inadvertent error in epidemiologic studies that arises during the process of study participant selection. This measurement study is part of a feasibility assessment for an international study with minimal selection bias to further investigate the reported epidemiologic association between magnetic fields and childhood leukemia.
5. Assessment of Selection Bias in the Canadian Case-Control Study of Residential Magnetic Field Exposure and Childhood Leukemia. Mezei G, Spinelli JJ, Wong P, Borugian M, McBride ML. American Journal of Epidemiology 2008;167(12):1504–10. Selection bias is a common methodological error that occurs in epidemiologic studies when those selected for study participation who agree to participate differ in ways that affect study results from those who are not selected or do not agree to participate. This assessment evaluates selection bias in a 1999 case-control study of magnetic field exposure and childhood leukemia in Canada (McBride et al.) that found a weak association. In the original study, the investigators assessed exposure using personal and residential magnetic field measurements and wire coding, a less accurate method based on the characteristics of power lines near residences. In the selection bias evaluation, Mezei et al. used wire coding alone because it is the only method available for assessing exposure for nonparticipants. When they included only actual, participating controls in the analyses, they found a moderate increase in the risk of childhood leukemia for children residing near power lines with the highest wire codes; when they included nonparticipating controls as well, the risk was lower. The authors conclude that although these results suggest that some selection bias may be present in the Canadian study, it may not entirely account for the observed risk increase. They also caution that the use of wire coding rather than field measurements to assess exposure limits interpretation of the results.

6. Recent Advances in Research Relevant to Electric and Magnetic Field Exposure Guidelines. Kavet R, Bailey WH, Bracken TD, Patterson RM. *Bioelectromagnetics* 2008;29(7):499–526. This review paper summarizes recent scientific advances relevant to the development and implementation of new or revised EMF exposure guidelines. National and international guidelines limit occupational and public exposure to electric fields, magnetic fields, and contact current (current that flows through the body when it is in simultaneous contact with two conductive surfaces carrying different voltages). Exposure limits are set to prevent known nerve stimulation effects, such as annoyance, startle, and pain. Magnetic field exposure limits are based on prevention of the magnetophosphene effect (perception of a flickering light when exposure exceeds a nerve stimulation threshold, that is, the minimum level for an effect). This paper examines nerve stimulation thresholds and the relevance of magnetophosphenes to guideline limit setting. It also covers dose to body tissues from exposure to contact current and dose to tissues and cells from exposure to spark discharges, or microshocks. In addition, the paper discusses assessment of exposure to high electric fields in real-life situations (such as line work on transmission towers), exposure to nonuniform magnetic fields, and exposures in the workplace.
7. Calculated SAR distributions in a human voxel phantom due to the reflection of electromagnetic fields from a ground plane between 65 MHz and 2 GHz. Findlay RP, Dimbylow PJ. *Physics in Medicine and Biology* 2008;53:2277–89. National and international guideline-setting organizations specify limits for exposure to radio-frequency (RF) electromagnetic fields from sources such as radio and television broadcast towers and mobile telecommunications antennas. RF fields deposit thermal energy in the bodies of exposed persons; to protect against excessive heating, guidelines specify basic restrictions limiting the rate at which body tissues may absorb RF energy (the specific absorption rate, or SAR). Because the SAR is difficult to measure, guidelines include limits for corresponding maximum permissible exposures (MPEs) for external field levels, which are easier to measure. This paper describes research to more accurately estimate tissue absorption rates and corresponding field levels. Researchers used accurate computer models of the human body called voxel phantoms to investigate RF energy absorption under various exposure conditions. Results show that guideline basic restrictions and MPE limits provide adequate protection.
8. Residential Magnetic Field Exposure and Childhood Brain Cancer: A Meta-Analysis. Mezei G, Gadallah M, Kheifets L. *Epidemiology* 2008;19:424–30. Epidemiologic studies investigating the possibility that residential magnetic field exposure might be associated with childhood brain cancer have yielded inconsistent results. To elucidate the reasons for differences in the results and to provide a statistically robust risk estimate, the authors conducted a meta-analysis of 13 studies. (Meta-analysis is a statistical method that combines published data from individual epidemiologic studies. It is often used when individual studies are too small to permit definite conclusions.) The meta-analysis showed no association of childhood brain cancer with residential distances less than 50 meters from power lines or with wire codes (a surrogate for magnetic field exposure based on power line characteristics) or lower levels of calculated or measured magnetic fields. Although there was a

suggestion of an association with measured or calculated fields above 0.3 0.4 microtesla (3 4 milligauss), the association was not statistically significant. The authors conclude that a moderate risk increase cannot be excluded with certainty at higher exposure levels.

9. Indoor Transformer Stations as Predictors of Residential ELF Magnetic Field Exposure. Ilonen K, Markkanen A, Mezei G, Juutilainen J. *Bioelectromagnetics* 2008;29:213–8. Epidemiologic studies have reported an association between exposure to magnetic fields and childhood leukemia. However, a causal relationship is not the only explanation: major EMF health risk evaluations note that the association could result from another exposure that is present along with magnetic fields or from inadvertent error in the selection of study participants. To further investigate this possibility, EPRI is planning an international study that will evaluate leukemia incidence among children living in apartment buildings with electricity transformer rooms. The study design avoids errors in participant selection through both selection from cancer and population registries and magnetic field exposure assessment that does not require subject participation. In addition, the study will include larger numbers of children with higher exposures (those whose apartments are adjacent to transformer rooms) than previous studies. This paper reports the results of a preliminary magnetic field measurement study in Finland indicating that exposure in apartments can reliably be predicted according to their location with respect to transformers.
10. Nighttime Exposure to Electromagnetic Fields and Childhood Leukemia: An Extended Pooled Analysis. Schüz J, Svendsen AL, Linet MS, McBride ML, Roman E, Feychting M, et al. *American Journal of Epidemiology* 2007;166:263–9. This analysis extended a 2000 pooled analysis of nine childhood leukemia studies (Ahlborn et al.) to determine whether nighttime magnetic field measurements more accurately represent actual exposure than 24- or 48-hour measurements. (Pooled analyses combine original data from individual epidemiologic studies to better discern exposure-disease relationships for a larger number of study participants.) The authors reasoned that nighttime bedroom measurements might be more accurate because children would tend to be in their rooms during the entire measurement period. In addition, nighttime exposure could be more biologically relevant owing to the possibility that magnetic fields might suppress normal nocturnal levels of melatonin, a pineal gland hormone that may protect against cancer development. Results showing similar risk estimates for 24- or 48-hour and nighttime magnetic field exposures do not support these hypotheses.
11. Survey of Residential Extremely-Low-Frequency Magnetic Field Exposure among Children in Taiwan. Li CY, Mezei G, Sung FC, Silva M, Chen PC, Lee PC, et al. *Environment International* 2007;33:233–8. Several factors complicate interpretation of epidemiologic results indicating an association between magnetic fields above 0.3 0.4 microtesla and childhood leukemia risk. Among these factors are inadvertent error in study participant selection and the possibility that another exposure occurring along with magnetic fields actually increases risk. Another factor is the unreliability of risk estimates in many studies, owing mainly to small numbers of study participants with higher magnetic field exposures. Future studies to clarify the

magnetic field childhood leukemia association will be useful only if they include sufficient numbers of children with higher exposures. A study in Taiwan, a densely populated, industrialized country with reportedly higher residential magnetic field levels, is a possibility. In an EPRI-funded survey, about 57 percent of 2214 homes in Taiwan with children under age 7 had measured magnetic field levels above 0.3–0.4 microtesla. These results indicate that a greater percentage of children in Taiwan have higher magnetic field exposures than in North America and Europe, where most epidemiologic studies of EMF and childhood leukemia were conducted.

12. Assessment of Non-Response Bias in a Survey of Residential Magnetic Field Exposure in Taiwan. Li CY, Mezei G, Sung FC, Silva M, Lee PC, Chen PC, et al. *Bioelectromagnetics* 2007;28:340–8. In this paper, researchers report the results of an assessment of nonresponse bias in the Taiwan residential magnetic field exposure survey described above. Nonresponse bias is a common form of inadvertent error in the selection of epidemiologic study participants that can occur when people identified as potential study subjects cannot or will not respond to requests to participate. Bias occurs if nonrespondents differ from respondents with respect to exposure or disease status. To assess nonresponse bias in the Taiwan survey, the authors conducted a second magnetic field measurement survey among households that had declined participation and compared the results with those of the original survey. The finding that results are similar indicates little nonresponse bias.
13. Extremely-Low-Frequency Magnetic Field Exposure of Children at Schools near High Voltage Transmission Lines. Li CY, Sung FC, Chen FL, Lee PC, Silva M, Mezei G. *The Science of the Total Environment* 2007;376:151–9. This magnetic field measurement study in Taiwan compared children attending schools near high-voltage transmission lines (HVTL) with children whose schools were at least 100 meters from HVTL. The study included both 24-hour personal magnetic field exposure monitoring and measurements at selected classrooms and playgrounds located within 30 meters of HVTL. The results indicate that the two groups of children had a similar mean exposure and a similar proportion of 24-hour exposure above 0.4 microtesla. However, a higher percentage of children at schools close to HVTL had mean exposures greater than 0.4 microtesla during school hours. Mean exposures were particularly high (0.7 microtesla) on playgrounds near HVTL.
14. Magnetic Field Exposure and Prognostic Factors in Childhood Leukemia. Foliart DE, Mezei G, Iriye R, Silva JM, Ebi KL, Kheifets L, et al. *Bioelectromagnetics* 2007;28:69–71. This analysis of data from a 2006 study of magnetic field exposure and long-term survival among children with leukemia (Foliart et al.) examined the possibility that magnetic field exposure might be associated with unfavorable prognostic factors. White blood cell count, genetic abnormalities, and other prognostic factors for leukemia are used to estimate the chance that a child will recover from the disease and the chance that the disease might recur after treatment. This analysis found no association between exposure to magnetic fields and the presence of unfavorable prognostic factors.
15. Magnetic Field Exposure and Long-Term Survival among Children with Leukaemia. Foliart DE, Pollock BH, Mezei G, Iriye R, Silva JM, Ebi KL, et al. *British Journal of*

Cancer 2006;94:161–4. In contrast to previous studies investigating the relation between magnetic field exposure and childhood leukemia incidence (the occurrence of new cases), this study examined whether magnetic field exposure influences relapse and survival rates in children who already have leukemia. The authors report that children whose homes had higher measured magnetic fields (above 0.3 microtesla) experienced more complications during the follow-up period after diagnosis, but this finding was not statistically significant. These children also experienced poorer survival; this finding was statistically significant. However, because these results are based on very small numbers of leukemia cases, they are imprecise. The authors note that independent confirmation of the results is needed since the study is the first of its kind.

16. Socioeconomic Status and Childhood Solid Tumor and Lymphoma Incidence in Canada. Mezei G, Borugian MJ, Spinelli JJ, Wilkins R, Abanto Z, McBride ML. American Journal of Epidemiology 2006 advance online publication, 8 March 2006; doi:10.1093/aje/kwj118. This study follows up a 2005 study (Borugian et al.) in which the same team of researchers used neighborhood income to measure socioeconomic status (SES) among childhood leukemia cases identified from Canadian cancer registries. In the 2005 study, children from the poorest neighborhoods had a modestly decreased risk of acute lymphoid leukemia, the most common form of childhood leukemia, compared to children from the richest neighborhoods. In the new study, the relationship between SES and other types of childhood cancer was examined. A moderately lower risk of carcinomas and renal tumors was observed among the poorest children. Although these results could indicate a relation between SES and these types of cancer, the authors note that they could be due to chance. No consistent relation was observed between SES and various other childhood cancers; this may argue against a causal role for environmental exposures that are strongly linked to SES.
17. Physical Activity and Magnetic Field Exposure in Pregnancy. Savitz DA, Herring AH, Mezei G, Evenson KR, Terry JW, Jr., Kavet R. Epidemiology 2006;17:222–5. Two 2002 studies by Lee et al. and Li et al. reported that high peak magnetic field exposure (the highest exposure encountered during a day) was associated with increased miscarriage risk. However, previous evidence provides little support for a magnetic field?miscarriage association. In a commentary published along with the 2002 studies, epidemiologist David Savitz suggested that the association might be explained by differences in physical activity between women who had normal pregnancies and women who miscarried: owing to less nausea and vomiting in early pregnancy and more mobility and energy in later pregnancy, women who miscarried would move around more, encountering more sources of high magnetic fields (for example, household appliances, office equipment, and electric power lines). To test this hypothesis, Savitz and his team investigated the relation between physical activity level, measured with an activity meter, and magnetic field exposure among pregnant women. They found that women with higher activity levels were more likely to encounter high peak magnetic fields. These results support Savitz's hypothesis, but more research is needed to address the relation between physical activity and symptoms associated with pregnancy outcomes.

18. Physical Activity and Magnetic Field Exposure in Pregnancy. Savitz DA, Herring AH, Mezei G, Evenson KR, Terry JW, Jr., Kavet R. *Epidemiology* 2006;17:222–5. Two 2002 studies by Lee et al. and Li et al. reported that high peak magnetic field exposure (the highest exposure encountered during a day) was associated with increased miscarriage risk. However, previous evidence provides little support for a magnetic field?miscarriage association. In a commentary published along with the 2002 studies, epidemiologist David Savitz suggested that the association might be explained by differences in physical activity between women who had normal pregnancies and women who miscarried: owing to less nausea and vomiting in early pregnancy and more mobility and energy in later pregnancy, women who miscarried would move around more, encountering more sources of high magnetic fields (for example, household appliances, office equipment, and electric power lines). To test this hypothesis, Savitz and his team investigated the relation between physical activity level, measured with an activity meter, and magnetic field exposure among pregnant women. They found that women with higher activity levels were more likely to encounter high peak magnetic fields. These results support Savitz's hypothesis, but more research is needed to address the relation between physical activity and symptoms associated with pregnancy outcomes.
19. Analyses of Magnetic-Field Peak-Exposure Summary Measures. Mezei G, Bracken TD, Senior R, Kavet R. *Journal of Exposure Analysis and Environmental Epidemiology* advance online publication, 12 October 2005; doi:10.1038/sj.jea.7500457. To shed light on the magnetic field?miscarriage association reported by Lee et al. and Li et al. in their 2002 studies, this analysis investigated the characteristics of peak magnetic field exposure measures. The analysis examined activity level information and magnetic field exposure data from the Li et al. study and three previous studies that measured personal exposure to residential magnetic fields. The results showed that the magnitude of measured peak magnetic fields depended on the sampling interval set for the exposure meter and that maximum measurement values varied when measurements were repeated. Also, study subjects (both men and women) with higher activity levels had higher peak magnetic field exposures. This analysis lends support to the hypothesis that the association between magnetic fields and miscarriage in the 2002 studies may be due to higher activity levels among women who miscarry.
20. Selection Bias and its Implications for Case-Control Studies: A Case Study of Magnetic Field Exposure and Childhood Leukemia. Mezei G, Kheifets L. *International Journal of Epidemiology* advance online publication, 22 November 2005; doi:10.1093/ije/dyi245. EMF health risk evaluation panels have noted that the association between magnetic fields and childhood leukemia observed in epidemiologic case-control studies could at least partly result from selection bias, a form of inadvertent error that may arise during the process of study participant selection. The authors of this case study examined epidemiologic studies of magnetic fields and childhood leukemia to evaluate the potential for selection bias in these studies. They found evidence both for and against selection bias; in many studies, however, reporting of selection processes was inaccurate and incomplete, making evaluation difficult. The authors conclude that better reporting and evaluation are needed, along with new methods for selecting and recruiting controls.

21. Childhood Leukemia and Socioeconomic Status in Canada. Borugian MJ, Spinelli JJ, Mezei G, Wilkins R, Abanto Z, McBride ML. *Epidemiology* 2005;16:526–31. Early childhood leukemia studies reported a higher leukemia incidence in children from families with higher socioeconomic status (SES). However, more recent case-control studies of magnetic field exposure and childhood leukemia have reported a higher incidence among children with lower SES. To investigate whether the shift in incidence is real or a result of unintentional error (bias) due to case selection or study participation, researchers used neighborhood income as a measure of SES in a study of childhood leukemia cases identified from population-based Canadian cancer registries. They found that children in the poorest neighborhoods had a moderately lower risk of acute lymphoid leukemia, the most common form of childhood leukemia, than children in the richest neighborhoods. These results suggest that high SES may be a risk factor for childhood leukemia and that inconsistent results in previous studies may stem from differences in case selection or study participation.
22. The Interaction between ELF Electric Fields and RF Survey Meters: Theory and Experiment. Olsen RG, Yamazaki K. *IEEE Transactions on Electromagnetic Compatibility* 2005;47:86–96. Radio-frequency (RF) survey meters, used to measure workers' personal exposure to RF electromagnetic fields, may give erroneous readings in the presence of strong extremely low frequency (ELF) fields. This paper presents theoretical and experimental information that contributes to accurate assessment of electric power company worker exposure near high-voltage transmission towers and distribution facilities hosting RF communications antennas.
23. Animal Models for the Study of Childhood Leukemia: Considerations for Model Identification and Optimization to Identify Potential Risk Factors. McCormick DL, Kavet R. *International Journal of Toxicology* 2004;23:149–61. In this paper, authors David McCormick of IIT Research Institute and Rob Kavet of EPRI discuss the technical challenges involved in identifying and optimizing a mouse model suitable for studying the potential role of environmental agents in childhood leukemia development. The paper won the American College of Toxicology President's Award for the best paper published in 2004 in the *International Journal of Toxicology*.
24. Association of Residential Magnetic Fields with Contact Voltage. Kavet R, Zaffanella LE, Pearson RL, Dallapiazza J. *Bioelectromagnetics* 2004;25:530–6. Grounding of the electrical service in a U.S. home to the home's water line, as required by the National Electrical Code, results in a voltage between the water line and the earth. This voltage, in turn, drives a voltage between water fixtures and conductive drain pipes that can be a source of contact current exposure to a bathing child touching the water fixtures or water stream. In this study of 191 single-family Denver homes, both voltages were positively associated with spot-measured average residential magnetic fields. These results support the hypothesis that exposure to contact current may be responsible for the association found in epidemiologic studies between magnetic fields and childhood leukemia.

XXVI. EPRI EMF Health Assessment Bibliography of Peer-Reviewed Papers

1. Bracken TD, Kavet R, Patterson RM, Fordyce TA. An integrated job exposure matrix for electrical exposures of utility workers. *J Occup Environ Hyg* 2009;6(8):499–509.
2. Kheifets L, Bowman JD, Checkoway H, Feychting M, Harrington M, Kavet R, Marsh G, Mezei G, Renew DC, van Wijngaarden E. Future needs of occupational epidemiology of extremely low frequency (ELF) electric and magnetic fields (EMF): review and recommendations. *Occup Environ Med* advance online publication, 19 Sep 2008; doi:10.1136/oem.2007.037994.
3. Kheifets L, Monroe J, Vergara X, Mezei G, Afifi A. Occupational electromagnetic fields and leukemia and brain cancer: an update to two meta-analyses. *J Occup Environ Med* 2008;50:677–88.
4. Thuróczy G, Jánossy G, Nagy N, Bakos J, Szabó J, Mezei G. Exposure to 50 Hz magnetic field in apartment buildings with built-in transformer stations in Hungary. *Radiat Prot Dosimetry* 2008;131:469–73.
5. Mezei G, Spinelli JJ, Wong P, Borugian M, McBride ML. Assessment of selection bias in the Canadian case-control study of residential magnetic field exposure and childhood leukemia. *Am J Epidemiol* 2008;167:1504–10.
6. Kavet R, Bailey WH, Bracken TD, Patterson RM. Recent advances in research relevant to electric and magnetic field exposure guidelines. *Bioelectromagnetics* 2008;29:499–526.
7. Findlay RP, Dimbylow PJ. Calculated SAR distributions in a human voxel phantom due to the reflection of electromagnetic fields from a ground plane between 65 MHz and 2 GHz. *Phys Med Biol* 2008;53:2277–89.
8. Mezei G, Gadallah M, Kheifets L. Residential magnetic field exposure and childhood brain cancer: a meta-analysis. *Epidemiology* 2008;19:424–30.
9. Ilonen K, Markkanen A, Mezei G, Juutilainen J. Indoor transformer stations as predictors of residential ELF magnetic field exposure. *Bioelectromagnetics* 2008;29:213–8.
10. Schüz J, Svendsen AL, Linet MS, McBride ML, Roman E, Feychting M, Kheifets L, Lightfoot T, Mezei G, Simpson J, Ahlbom A. Nighttime exposure to electromagnetic fields and childhood leukemia: an extended pooled analysis. *Am J Epidemiol* advance online publication, 7 May 2007; doi:10.1093/aje/kwm080.
11. Li CY, Mezei G, Sung FC, Silva M, Lee PC, Chen PC, Chen LM. Assessment of non-response bias in a survey of residential magnetic field exposure in Taiwan. *Bioelectromagnetics* advance online publication, 16 Apr 2007; doi: 10.1002/bem.20306.
12. Li CY, Sung FC, Chen FL, Lee PC, Silva M, Mezei G. Extremely-low-frequency magnetic field exposure of children at schools near high voltage transmission lines. *Sci Total Environ* 2007;376:151–9.

13. Li CY, Mezei G, Sung FC, Silva M, Chen PC, Lee PC, Chen LM. Survey of residential extremely-low-frequency magnetic field exposure among children in Taiwan. *Environ Int* 2007;33:233–8.
14. Foliart DE, Mezei G, Iriye R, Silva JM, Ebi KL, Kheifets L, Link MP, Kavet R, Pollock BH. Magnetic field exposure and prognostic factors in childhood leukemia. *Bioelectromagnetics* 2007;28:69–71.
15. Mezei G, Benyi M, Muller A. Mobile phone ownership and use among school children in three Hungarian cities. *Bioelectromagnetics* 2007; 28:309– 15.
16. Bowman J, Niple J, Kavet R. Pilot measurements of ELF contact currents in some electric utility occupations. *J Occup Environ Hyg* 2006;3:323–33.
17. Kavet R, Daigle JP, Zaffanella LE. Residential magnetic fields, contact voltage and their relationship: the effects of distribution unbalance and residential proximity to a transmission line. *Health Phys* 2006;91:592–607.
18. Mezei G, Borugian MJ, Spinelli JJ, Wilkins R, Abarito Z, McBride ML. Socioeconomic status and childhood solid tumor and lymphoma incidence in Canada. *Am J Epidemiol* 2006;164:170–5.
19. Mezei G, Bracken TD, Senior R, Kavet R. Analyses of magnetic-field peak-exposure summary measures. *J Expo Sci Environ Epidemiol* 2006;16:477–85.
20. Mezei G, Kheifets L. Selection bias and its implications for case-control studies: a case study of magnetic field exposure and childhood leukaemia. *Int J Epidemiol* 2006;35:397–406.
21. Poole C, Greenland S, Luetters C, Kelsey JL, Mezei G. Socioeconomic status and childhood leukaemia: a review. *Int J Epidemiol* 2006;35:370–84.
22. Szabo J, Mezei K, Thuroczy G, Mezei G. Occupational 50 Hz magnetic field exposure measurements among female sewing machine operators in Hungary. *Bioelectromagnetics* 2006;27:451–7.
23. Savitz DA, Herring AH, Mezei G, Evenson K, Terry J, Kavet R. Physical activity and magnetic field exposure in pregnancy. *Epidemiology* 2006;17:222–5.
24. Foliart DE, Pollock BH, Mezei G, Iriye R, Silva JM, Ebi KL, Kheifets L, Link MP, Kavet R. Magnetic field exposure and long-term survival among children with leukaemia. *Br J Cancer* 2006;94:161–4.
25. Peck SC, Kavet R. Research strategies for magnetic fields and cancer. *Risk Anal* 2005;25:179–88.
26. Patterson RM, Bracken TD, Alldredge JR. Assessing compliance with 60-Hertz magnetic-field exposure guidelines. *J Occup Environ Hyg* 2005;2:77–85.
27. Stuchly MA, Kavet R. Numerical modeling of pacemaker interference in the electric utility environment. *IEEE Trans Device Mater Reliab* 2005;5:481–487.
28. Niple JC, Sahl JD, Kelsh MA, Kavet R. Equipment grounding affects contact current

- exposure: a case study of sewing machines. *Ann Occup Hyg* 2005;49:673–82.
29. Mezei G, Cher D, Kelsh M, Edinboro C, Chapman P, Kavet R. Occupational magnetic field exposure, cardiovascular disease mortality, and potential confounding by smoking. *Ann Epidemiol* 2005;15:622–9.
 30. Kheifets L, Sahl JD, Shimkhada R, Repacholi MH. Developing policy in the face of scientific uncertainty: Interpreting 0.3 mT or 0.4 mT cutpoints from EMF epidemiologic studies. *Risk Anal* 2005;25:927–35.
 31. Kavet R. Contact current hypothesis: Summary of results to date. *Bioelectromagnetics* 2005;26:S75–S85.
 32. Bracken TD. 60-Hertz electric-field exposures in transmission line towers. *J Occup Environ Hyg* 2005;2:444–455.
 33. Bracken TD, Senior RS, Bailey WH. DC electric fields from corona-generated space charge near AC transmission lines. *IEEE Trans Power Delivery* 2005;20:1692–1702.
 34. Borugian MJ, Spinelli JJ, Mezei G, Wilkins R, Abanto Z, McBride ML. Childhood leukemia and socioeconomic status in Canada. *Epidemiology* 2005;16:526–31.
 35. Bailey WH, Nyenhuis JA. Thresholds for 60 Hz magnetic field stimulation of peripheral nerves in human subjects. *Bioelectromagnetics* 2005;26:462–8.
 36. Niple JC, Daigle JP, Zaffanella LE, Sullivan T, Kavet R. A portable meter for measuring low frequency currents in the human body. *Bioelectromagnetics* 2004;25:369–73.
 37. McCormick DL, Kavet R. Animal models for the study of childhood leukemia: considerations for model identification and optimization to identify potential risk factors. *Int J Toxicol* 2004;23:149–61.
 38. Kavet R, Zaffanella LE, Pearson RL, Dallapiazza J. Association of residential magnetic fields with contact voltage. *Bioelectromagnetics* 2004;25:530–6.
 39. Forssen UM, Mezei G, Nise G, Feychting M. Occupational magnetic field exposure among women in Stockholm County, Sweden. *Occup Environ Med* 2004;61:594–602.
 40. Dawson TW, Stuchly MA, Kavet R. Electric fields in the human body due to electrostatic discharges. *IEEE Trans Biomed Eng* 2004;51:1460–8.
 41. Dawson TW, Stuchly MA, Kavet R. Evaluation of interactions of electric fields due to electrostatic discharge with human tissue. *IEEE Trans Biomed Eng* 2004;51:2194–8.
 42. Kelsh MA, Bracken TD, Sahl JD, Shum M, Ebi KL. Occupational magnetic field exposures of garment workers: results of personal and survey measurements. *Bioelectromagnetics* 2003;24:316–26.
 43. Dawson TW, Caputa K, Stuchly MA, Kavet R. Comparison of electric fields induced in humans and rodents by 60-Hz contact currents. *IEEE Trans Biomed Eng* 2003;50:744–53.
 44. Brain JD, Kavet R, McCormick DL, Poole C, Silverman LB, Smith TJ, Valberg PA, Van Etten RA, Weaver JC. Childhood leukemia: electric and magnetic fields as

- possible risk factors. *Environ Health Perspect* 2003;111:962–70.
45. Yamaguchi DT, Huang J, Ma D, Wang PK. Inhibition of gap junction intercellular communication by extremely low- frequency electromagnetic fields in osteoblast-like models is dependent on cell differentiation. *J Cell Physiol* 2002;190:180–8.
 46. Swanson J. A transmission utility's experience of applying EMF exposure standards. *Health Phys* 2002;83:417–25.
 47. Stuchly MA, Dawson TW. Human body exposure to power lines: relation of induced quantities to external magnetic fields. *Health Phys* 2002;83:333–40.
 48. Sheppard AR, Kavet R, Renew DC. Exposure guidelines for low-frequency electric and magnetic fields: report from the Brussels workshop. *Health Phys* 2002;83:324–32.
 49. Saunders RD, Jefferys JG. Weak electric field interactions in the central nervous system. *Health Phys* 2002;83:366–75.
 50. Sastre A, Kavet R. Candidate sites of action for microdosimetry associated with exposure to extremely-low-frequency magnetic fields, electric fields and contact currents. *Health Phys* 2002;83:387–94.
 51. Sahl J, Mezei G, Kavet R, McMillan A, Silvers A, Sastre A, Kheifets L. Occupational magnetic field exposure and cardiovascular mortality in a cohort of electric utility workers. *Am J Epidemiol*. 2002;156:913–918.
 52. Renew DC, Glover ID. Basic restrictions in EMF exposure guidelines. *Health Phys* 2002;83:395–401.
 53. Reilly JP, Diamant AM. Neuroelectric mechanisms applied to low frequency electric and magnetic field exposure guidelines--part II: non sinusoidal waveforms. *Health Phys* 2002;83:356–65.
 54. Reilly JP. Neuroelectric mechanisms applied to low frequency electric and magnetic field exposure guidelines--part I: sinusoidal waveforms. *Health Phys* 2002;83:341–55.
 55. Rankin RF, Dan Bracken T, Senior RS, Kavet R, Montgomery JH. Results of a multisite study of U.S. residential magnetic fields. *J Expo Anal Environ Epidemiol* 2002;12:9–20.
 56. Mezei G, Kheifets LI. Clues to the possible viral etiology of childhood leukemia. *Technology* 2002;9:3–14.
 57. Kavet R, Zaffanella LE. Contact voltage measured in residences: implications to the association between magnetic fields and childhood leukemia. *Bioelectromagnetics* 2002;23:464–474.
 58. Kaune WT, Dovan T, Kavet RI, Savitz DA, Neutra RR. Study of high- and low-current-configuration homes from the 1988 Denver childhood cancer study. *Bioelectromagnetics* 2002;23:177–88.
 59. Johnson KC, Goodman M, Kelsh M, Iannuzzi J, Ebi K, Langholz B. Passive and active smoking as possible confounders in studies of breast cancer risk.

- Epidemiology 2002;13:610; discussion 610–1.
60. Goodman M, Kelsh M, Ebi K, Iannuzzi J, Langholz B. Evaluation of potential confounders in planning a study of occupational magnetic field exposure and female breast cancer. *Epidemiology* 2002;13:50–8.
 61. Foliat DE, Iriye RN, Silva JM, Mezei G, Tarr KJ, Ebi KL. Correlation of year-to-year magnetic field exposure metrics among children in a leukemia survival study. *J Expo Anal Environ Epidemiol* 2002;12:441–7.
 62. Dawson TW, Caputa K, Stuchly MA, Shepard RB, Kavet R, Sastre A. Pacemaker interference by magnetic fields at power line frequencies. *IEEE Trans Biomed Eng* 2002;49:254–62.
 63. Dawson TW, Caputa K, Stuchly MA, Kavet R. Pacemaker interference by 60-Hz contact currents. *IEEE Trans Biomed Eng* 2002;49:878–886.
 64. Dawson TW, Caputa K, Stuchly MA. Magnetic field exposures for UK live-line workers. *Phys Med Biol* 2002;47:995–1012.
 65. Dawson TW, Caputa K, Stuchly MA. Electric fields induced in humans and rodents by 60 Hz magnetic fields. *Phys Med Biol* 2002;47:2561–8.
 66. Bracken TD. Assessing compliance with power-frequency magnetic-field guidelines. *Health Phys* 2002;83:409–16.
 67. Bailey WH. Dealing with uncertainty in formulating occupational and public exposure limits. *Health Phys* 2002;83:402–8.
 68. Bailey WH. Health effects relevant to the setting of EMF exposure limits. *Health Phys* 2002;83:376–86.
 69. van Wijngaarden E, Savitz DA, Kleckner RC, Kavet R, Loomis D. Mortality patterns by occupation in a cohort of electric utility workers. *Am J Ind Med* 2001;40:667–73.
 70. Mezei G, Kheifets LI, Nelson LM, Mills KM, Iriye R, Kelsey JL. Household appliance use and residential exposure to 60-hz magnetic fields. *J Expo Anal Environ Epidemiol* 2001;11:41–9.
 71. Kheifets LI. Electric and magnetic field exposure and brain cancer: a review. *Bioelectromagnetics* 2001;Suppl:S120–31.
 72. Kheifets LI, Greenberg RS, Neutra RR, Hester GL, Poole CL, Rall DP, Lundell G. Electric and magnetic fields and cancer: case study. *Am J Epidemiol* 2001;154:S50–9.
 73. Kavet R, Stuchly MA, Bailey WH, Bracken TD. Evaluation of biological effects, dosimetric models, and exposure assessment related to ELF electric- and magnetic-field guidelines. *Appl Occup Environ Hyg* 2001;16:1118–38.
 74. Kaune WT, Davis S, Stevens RG, Mirick DK, Kheifets L. Measuring temporal variability in residential magnetic field exposures. *Bioelectromagnetics* 2001;22:232–45.
 75. Hefeneider SH, McCoy SL, Hausman FA, Christensen HL, Takahashi D, Perrin N, Bracken TD, Shin KY, Hall AS. Long-term effects of 60-Hz electric vs. magnetic

- fields on IL-1 and IL-2 activity in sheep. *Bioelectromagnetics* 2001;22:170-7.
76. Guttman JL, Niple J, Kavet R, Johnson GB. Measurement instrumentation for transient magnetic fields and currents. *Proc IEEE EMC Int Symp* 2001;1:419-424.
77. Guttman JL, Kavet R, Johnson GB. Transient magnetic fields and currents in residences. *Proc IEEE EMC Int Symp*. Montreal, Canada, 2001;227-232.
78. Foliart DE, Iriye RN, Tarr KJ, Silva JM, Kavet R, Ebi KL. Alternative magnetic field exposure metrics: relationship to TWA, appliance use, and demographic characteristics of children in a leukemia survival study. *Bioelectromagnetics* 2001;22:574-580.
79. Dawson TW, Caputa K, Stuchly MA, Kavet R. Electric fields in the human body resulting from 60-Hz contact currents. *IEEE Trans Biomed Eng* 2001;48:1020-1026.
80. Davis S, Kaune WT, Mirick DK, Chen C, Stevens RG. Residential magnetic fields, light-at-night, and nocturnal urinary 6- sulfatoxymelatonin concentration in women. *Am J Epidemiol* 2001;154:591-600.
81. Bracken TD, Rankin RF, Senior RS, Kavet R, Geissinger LG. Magnetic-field exposures of cable splicers in electrical network distribution vaults. *Appl Occup Environ Hyg* 2001;16:369-79.
82. Anderson LE, Morris JE, Miller DL, Rafferty CN, Ebi KL, Sasser LB. Large granular lymphocytic (LGL) leukemia in rats exposed to intermittent 60 Hz magnetic fields. *Bioelectromagnetics* 2001;22:185-93.
83. van Wijngaarden E, Savitz DA. Occupational sunlight exposure in relation to suicide among electric utility workers. *Am J Ind Med* 2000;38:149-54.
84. van Wijngaarden E, Savitz DA, Kleckner RC, Cai J, Loomis D. Exposure to electromagnetic fields and suicide among electric utility workers: a nested case-control study. *West J Med* 2000;173:94-100.
85. Stevens RG, Davis S, Mirick DK, Kheifets L, Kaune W. Alcohol consumption and urinary concentration of 6-sulfatoxymelatonin in healthy women. *Epidemiology* 2000;11:660-5.
86. Savitz DA, Cai J, van Wijngaarden E, Loomis D, Mihlan G, Dufort V, Kleckner RC, Nylander-French L, Kromhout H, Zhou H. Case-cohort analysis of brain cancer and leukemia in electric utility workers using a refined magnetic field job-exposure matrix. *Am J Ind Med* 2000;38:417-25.
87. Mills KM, Kheifets LI, Nelson LM, Bloch DA, Takemoto-Hambleton R, Kelsey JL. Reliability of proxy-reported and self-reported household appliance use. *Epidemiology* 2000;11:581-8.
88. McCann J, Kavet R, Rafferty CN. Assessing the potential carcinogenic activity of magnetic fields using animal models. *Environ Health Perspect* 2000;108 Suppl 1:79-100.
89. Kavet R, Zaffanella LE, Daigle JP, Ebi KL. The possible role of contact current in cancer risk associated with residential magnetic fields. *Bioelectromagnetics*

- 2000;21:538-53.
90. Kaune WT, Bracken TD, Senior RS, Rankin RF, Niple JC, Kavet R. Rate of occurrence of transient magnetic field events in U.S. residences. *Bioelectromagnetics* 2000;21:197-213.
 91. Graham C, Sastre A, Cook MR, Kavet R. Heart rate variability and physiological arousal in men exposed to 60 Hz magnetic fields. *Bioelectromagnetics* 2000;21:480-2.
 92. Graham C, Sastre A, Cook MR, Kavet R, Gerkovich MM, Riffle DW. Exposure to strong ELF magnetic fields does not alter cardiac autonomic control mechanisms. *Bioelectromagnetics* 2000;21:413-21.
 93. Graham C, Cook MR, Sastre A, Gerkovich MM, Kavet R. Cardiac autonomic control mechanisms in power-frequency magnetic fields: a multistudy analysis. *Environ Health Perspect* 2000;108:737-742.
 94. Ebi KL, Kheifets LI, Pearson RL, Wachtel H. Description of a new computer wire coding method and its application to evaluate potential control selection bias in the Savitz et al. childhood cancer study. *Bioelectromagnetics* 2000;21:346-53.
 95. Dawson TW, Stuchly MA, Caputa K, Sastre A, Shepard RB, Kavet R. Pacemaker interference and low-frequency electric induction in humans by external fields and electrodes. *IEEE Trans Biomed Eng* 2000;47:1211-1218.
 96. Cook MR, Graham C, Kavet R, Stevens RG, Davis S, Kheifets L. Morning urinary assessment of nocturnal melatonin secretion in older women. *J Pineal Res* 2000;28:41-7.
 97. Chen G, Upham BL, Sun W, Chang CC, Rothwell EJ, Chen KM, Yamasaki H, Trosko JE. Effect of electromagnetic field exposure on chemically induced differentiation of friend erythroleukemia cells. *Environ Health Perspect* 2000;108:967-72.
 98. Boorman GA, Rafferty CN, Ward JM, Sills RC. Leukemia and lymphoma incidence in rodents exposed to low-frequency magnetic fields. *Radiat Res* 2000;153:627-36.
 99. Babbitt JT, Kharazi AI, Taylor JM, Bonds CB, Mirell SG, Frumkin E, Zhuang D, Hahn TJ. Hematopoietic neoplasia in C57BL/6 mice exposed to split-dose ionizing radiation and circularly polarized 60 Hz magnetic fields. *Carcinogenesis* 2000;21:1379-89.
 100. Williams JR, Zhang Y, Zhou H, Osman M, Cha D, Kavet R, Cuccinotta F, Dicello JF, Dillehay LE. Predicting cancer rates in astronauts from animal carcinogenesis studies and cellular markers. *Mutat Res* 1999;430:255-69.
 101. van Wijngaarden E, Savitz DA, Kleckner RC, Mihlan G, Nylander-French LA, Dufort V, Cai J, Loomis D, Kromhout H. Refinements in magnetic field exposure assignment for a case-cohort study of electrical utility workers. *Ann Occup Hyg* 1999;43:485-92.
 102. Savitz DA, Liao D, Sastre A, Kleckner RC, Kavet R. Magnetic field exposure and cardiovascular disease mortality among electric utility workers [see comments]. *Am*

- J Epidemiol 1999;149:135-42.
103. Savitz DA, Liao D, Sastre A, Kleckner RC, Kavet R. Magnetic field exposure and cardiovascular disease mortality among electric utility workers. *Am J Epidemiol* 1999;149:135-42.
 104. Morris JE, Sasser LB, Miller DL, Dagle GE, Rafferty CN, Ebi KL, Anderson LE. Clinical progression of transplanted large granular lymphocytic leukemia in Fischer 344 rats exposed to 60 Hz magnetic fields. *Bioelectromagnetics* 1999;20:48-56.
 105. McBride ML, Gallagher RP, Theriault G, Armstrong BG, Tamaro S, Spinelli JJ, Deadman JE, Fincham S, Robson D, Choi W. Power-frequency electric and magnetic fields and risk of childhood leukemia in Canada. *Am J Epidemiol* 1999;149:831-42.
 106. Loomis D, Dufort V, Kleckner RC, Savitz DA. Fatal occupational injuries among electric power company workers. *Am J Ind Med* 1999;35:302-9.
 107. Kheifets L. Occupational exposure assessment in epidemiological studies of EMF. *Radiat. Prot. Dosimetry* 1999;83:61-69.
 108. Kheifets LI, Sussman SS, Preston-Martin S. Childhood brain tumors and residential electromagnetic fields (EMF). *Rev Environ Contam Toxicol* 1999;159:111-29.
 109. Kheifets LI, Matkin CC. Industrialization, electromagnetic fields, and breast cancer risk. *Environ Health Perspect* 1999;107 Suppl 1:145-54.
 110. Kheifets LI, Gilbert ES, Sussman SS, Guenel P, Sahl JD, Savitz DA, Theriault G. Comparative analyses of the studies of magnetic fields and cancer in electric utility workers: studies from France, Canada, and the United States. *Occup Environ Med* 1999;56:567-74.
 111. Kavet R, Ulrich RM, Kaune WT, Johnson GB, Powers T. Determinants of power-frequency magnetic fields in residences located away from overhead power lines. *Bioelectromagnetics* 1999;20:306-18.
 112. Kavet R. ELF magnetic fields, transients and TWA metrics. *Radiat. Prot. Dosimetry* 1999;83:29-40.
 113. Ebi KL. Developments in the generation and interpretation of wire codes. *Radiat. Prot. Dosimetry* 1999;83:71-78.
 114. Ebi KL, Zaffanella LE, Greenland S. Application of the case-specular method to two studies of wire codes and childhood cancers. *Epidemiology* 1999;10:398-404.
 115. DiGiovanni J, Johnston DA, Rupp T, Sasser LB, Anderson LE, Morris JE, Miller DL, Kavet R, Walborg EF, Jr. Lack of effect of a 60 Hz magnetic field on biomarkers of tumor promotion in the skin of SENCAR mice. *Carcinogenesis* 1999;20:685-9.
 116. Dawson TW, Caputa K, Stuchly MA. Magnetic induction at 60 Hz in the human heart: a comparison between the in situ and isolated scenarios. *Bioelectromagnetics* 1999;20:233-43.
 117. Dawson TW, Caputa K, Stuchly MA. Numerical evaluation of 60 Hz magnetic

- induction in the human body in complex occupational environments. *Phys Med Biol* 1999;44:1025-40.
118. Brainard GC, Kavet R, Kheifets LI. The relationship between electromagnetic field and light exposures to melatonin and breast cancer risk: a review of the relevant literature. *J Pineal Res* 1999;26:65-100.
 119. Bailey WH, Su SH, Dan Bracken T. Probabilistic approach to ranking sources of uncertainty in ELF magnetic field exposure limits. *Health Phys* 1999;77:282-90.
 120. Zaffanella LE, Savitz DA, Greenland S, Ebi KL. The residential case-specular method to study wire codes, magnetic fields, and disease. *Epidemiology* 1998;9:16-20.
 121. Savitz DA, Checkoway H, Loomis DP. Magnetic field exposure and neurodegenerative disease mortality among electric utility workers. *Epidemiology* 1998;9:398-404.
 122. Sasser LB, Anderson LE, Morris JE, Miller DL, Walborg EF, Jr., Kavet R, Johnston DA, DiGiovanni J. Lack of a co-promoting effect of a 60 Hz magnetic field on skin tumorigenesis in SENCAR mice. *Carcinogenesis* 1998;19:1617-21.
 123. Reiter RJ, Tan DX, Poeggeler B, Kavet R. Inconsistent suppression of nocturnal pineal melatonin synthesis and serum melatonin levels in rats exposed to pulsed DC magnetic fields. *Bioelectromagnetics* 1998;19:318-29.
 124. McCann J. Cancer risk assessment of extremely low frequency electric and magnetic fields: a critical review of methodology. *Environ Health Perspect* 1998;106:701-17.
 125. McCann J, Dietrich F, Rafferty C. The genotoxic potential of electric and magnetic fields: an update. *Mutat Res* 1998;411:45-86.
 126. Loomis A, Kromhout H, Kleckner RC, Savitz DA. Effects of the analytical treatment of exposure data on associations of cancer and occupational magnetic field exposure. *Am J Ind Med* 1998;34:49-56.
 127. Graham C, Cook MR, Kavet R, Sastre A, Smith DK. Prediction of nocturnal plasma melatonin from morning urinary measures [published erratum appears in *J Pineal Res* 1999 Mar;26(2):128]. *J Pineal Res* 1998;24:230-8.
 128. Bracken MB, Belanger K, Hellenbrand K, Addesso K, Patel S, Triche E, Leaderer BP. Correlates of residential wiring code used in studies of health effects of residential electromagnetic fields. *Am J Epidemiol* 1998;148:467-74.
 129. Belanger K, Leaderer B, Hellenbrand K, Holford TR, McSharry J, Power ME, Bracken MB. Spontaneous abortion and exposure to electric blankets and heated water beds. *Epidemiology* 1998;9:36-42.
 130. Zaffanella LE, Kavet R, Pappa JR, Sullivan TP. Modeling magnetic fields in residences: validation of the resicalc program. *J Expo Anal Environ Epidemiol* 1997;7:241-59.
 131. Valberg PA, Kavet R, Rafferty CN. Can low-level 50/60 Hz electric and magnetic

- fields cause biological effects? [see comments] [published erratum appears in Radiat Res 1997 Nov;148(5):528]. Radiat Res 1997;148:2-21.
132. Valberg PA, Kavet R, Rafferty CN. Can low-level 50/60 Hz electric and magnetic fields cause biological effects? Radiat Res 1997;148:2-21.
 133. Schroeder JC, Savitz DA. Lymphoma and multiple myeloma mortality in relation to magnetic field exposure among electric utility workers. Am J Ind Med 1997;32:392-402.
 134. Savitz DA, Dufort V, Armstrong B, Theriault G. Lung cancer in relation to employment in the electrical utility industry and exposure to magnetic fields. Occup Environ Med 1997;54:396-402.
 135. McCann J, Kavet R, Rafferty CN. Testing electromagnetic fields for potential carcinogenic activity: a critical review of animal models. Environ Health Perspect 1997;105 Suppl 1:81-103.
 136. Loomis D, Browning SR, Schenck AP, Gregory E, Savitz DA. Cancer mortality among electric utility workers exposed to polychlorinated biphenyls. Occup Environ Med 1997;54:720-8.
 137. Kromhout H, Loomis DP, Kleckner RC, Savitz DA. Sensitivity of the relation between cumulative magnetic field exposure and brain cancer mortality to choice of monitoring data grouping scheme. Epidemiology 1997;8:442-5.
 138. Kheifets LI, Kavet R, Sussman SS. Wire codes, magnetic fields, and childhood cancer. Bioelectromagnetics 1997;18:99-110.
 139. Kheifets LI, Afifi AA, Buffler PA, Zhang ZW, Matkin CC. Occupational electric and magnetic field exposure and leukemia. A meta-analysis. J Occup Environ Med 1997;39:1074-91.
 140. Kheifets LI, London SJ, Peters JM. Leukemia risk and occupational electric field exposure in Los Angeles County, California. Am J Epidemiol 1997;146:87-90.
 141. Kaune WT, Guttman JL, Kavet R. Comparison of coupling of humans to electric and magnetic fields with frequencies between 100 Hz and 100 kHz. Bioelectromagnetics 1997;18:67-76.
 142. Graham C, Cook MR, Riffle DW. Human melatonin during continuous magnetic field exposure. Bioelectromagnetics 1997;18:166-71.
 143. Bracken TD, Senior RS, Rankin RF, Bailey WH, Kavet R. Magnetic field exposures in the electric utility industry relevant to occupational guideline levels. Appl. Occup. Environ. Hyg. 1997;12:756-768.
 144. Bailey WH, Su SH, Bracken TD, Kavet R. Summary and evaluation of guidelines for occupational exposure to power frequency electric and magnetic fields. Health Phys 1997;73:433-53.
 145. Sussman SS, Kheifets LI. Re: "Adult leukemia risk and personal appliance use: a preliminary study". Am J Epidemiol 1996;143:743-4.
 146. Sasser LB, Morris JE, Miller DL, Rafferty CN, Ebi KL, Anderson LE. Exposure to

- 60 Hz magnetic fields does not alter clinical progression of LGL leukemia in Fischer rats. *Carcinogenesis* 1996;17:2681-7.
147. Kavet R. EMF and current cancer concepts. *Bioelectromagnetics* 1996;17:339-57.
148. Graham C, Cook MR, Riffle DW, Gerkovich MM, Cohen HD. Nocturnal melatonin levels in human volunteers exposed to intermittent 60 Hz magnetic fields. *Bioelectromagnetics* 1996;17:263-73.
149. Savitz DA, Loomis DP. Magnetic field exposure in relation to leukemia and brain cancer mortality among electric utility workers. *Am J Epidemiol* 1995;141:123-34.
150. Kromhout H, Loomis DP, Mihlan GJ, Peipins LA, Kleckner RC, Iriye R, Savitz DA. Assessment and grouping of occupational magnetic field exposure in five electric utility companies. *Scand J Work Environ Health* 1995;21:43-50.
151. Kheifets LI, Afifi AA, Buffler PA, Zhang ZW. Occupational electric and magnetic field exposure and brain cancer: a meta-analysis. *J Occup Environ Med* 1995;37:1327-41.
152. Kavet R. Magnetic field exposure assessment. In: Blank M, ed. *Electromagnetic Fields: Biological Interactions and Mechanisms*. Washington, DC : American Chemical Society, 1995;191-223.
153. Savitz DA, Ohya T, Loomis DP, Senior RS, Bracken TD, Howard RL. Correlations among indices of electric and magnetic field exposure in electric utility workers. *Bioelectromagnetics* 1994;15:193-204.
154. Loomis DP, Kromhout H, Peipins LA, Kleckner RC, Iriye R, Savitz DA. Sampling design and field methods of a large, randomized, multisite survey of occupational magnetic field exposure. *Appl. Occup. Ind. Hyg.* 1994;9:49-52.
155. Loomis DP, Peipins LA, Browning SR, Howard RL, Kromhout H, Savitz DA. Organization and classification of work history data in industry-wide studies: an application to the electric power industry. *Am J Ind Med* 1994;26:413-25.
156. Koontz MD, Dietrich FM. Variability and predictability of children's exposure to magnetic fields. *J. Expo. Anal. Environ. Epidemiol.* 1994;4:287-307.
157. Kaune WT, Zaffanella LE. Assessing historical exposures of children to power-frequency magnetic fields. *J Expo Anal Environ Epidemiol* 1994;4:149-70.
158. Grota LJ, Reiter RJ, Keng P, Michaelson S. Electric field exposure alters serum melatonin but not pineal melatonin synthesis in male rats. *Bioelectromagnetics* 1994;15:427-37.
159. McCann J, Dietrich F, Rafferty C, Martin AO. A critical review of the genotoxic potential of electric and magnetic fields. *Mutat Res* 1993;297:61-95.
160. Matanoski GM, Elliott EA, Breyse PN, Lynberg MC. Leukemia in telephone linemen. *Am J Epidemiol* 1993;137:609-19.
161. Weaver JC. Electromagnetic field dosimetry: issues relating to background, noise, and interaction mechanisms. *Bioelectromagnetics* 1992;Suppl:115-7.

162. Weaver JC, Astumian RD. Estimates for ELF effects: noise-based thresholds and the number of experimental conditions required for empirical searches. *Bioelectromagnetics* 1992;Suppl:119-38.
163. Wachtel H. Bioelectric background fields and their implications for ELF dosimetry. *Bioelectromagnetics* 1992;Suppl:139-45.
164. Wachtel H. Methodological approaches to EMF microdosimetry. *Bioelectromagnetics* 1992;Suppl:159-60.
165. Tenforde TS. Microscopic dosimetry of extremely-low-frequency electric and magnetic fields. *Bioelectromagnetics* 1992;Suppl:61-6.
166. Stuchly MA, Esselle KP. Factors affecting neural stimulation with magnetic fields. *Bioelectromagnetics* 1992;Suppl:191-204.
167. Stein GS, Lian JB. Regulation of cell cycle and growth control. *Bioelectromagnetics* 1992;Suppl:247-65.
168. Rafferty CN, Phillips RD, Guy AW. Dosimetry Workshop: extremely-low-frequency electric and magnetic fields. *Bioelectromagnetics* 1992;Suppl:1-10.
169. Polk C. Dosimetric extrapolations of extremely-low-frequency electric and magnetic fields across biological systems. *Bioelectromagnetics* 1992;Suppl:205-8.
170. Polk C. Dosimetry of extremely-low-frequency magnetic fields. *Bioelectromagnetics* 1992;Suppl:209-35.
171. Nuccitelli R. Endogenous ionic currents and DC electric fields in multicellular animal tissues. *Bioelectromagnetics* 1992;Suppl:147-57.
172. McLeod KJ. Microelectrode measurements of low frequency electric field effects in cells and tissues. *Bioelectromagnetics* 1992;Suppl:161-78.
173. Loew LM. Voltage-sensitive dyes: measurement of membrane potentials induced by DC and AC electric fields. *Bioelectromagnetics* 1992;Suppl:179-89.
174. Litovitz TA, Montrose CJ, Wang W. Dose-response implications of the transient nature of electromagnetic- field-induced bioeffects: theoretical hypotheses and predictions. *Bioelectromagnetics* 1992;Suppl:237-46.
175. Kirschvink JL. Uniform magnetic fields and double-wrapped coil systems: Improved techniques for the design of bioelectromagnetic experiments. *Bioelectromagnetics* 1992;13:401-11.
176. Kirschvink JL, Kobayashi-Kirschvink A, Diaz-Ricci JC, Kirschvink SJ. Magnetite in human tissues: a mechanism for the biological effects of weak ELF magnetic fields. *Bioelectromagnetics* 1992;Suppl:101-13.
177. Kaune WT. Macroscopic dosimetry of power-frequency electric and magnetic fields. *Bioelectromagnetics* 1992;Suppl:11-4.
178. Hart FX. Numerical and analytical methods to determine the current density distributions produced in human and rat models by electric and magnetic fields. *Bioelectromagnetics* 1992;Suppl:27-42.

179. Gandhi OP, Chen JY. Numerical dosimetry at power-line frequencies using anatomically based models. *Bioelectromagnetics* 1992;Suppl:43-60.
180. Fishman HM. Assessment of conduction properties and thermal noise in cell membranes by admittance spectroscopy. *Bioelectromagnetics* 1992;Suppl:87-100.
181. Bracken TD. Experimental macroscopic dosimetry for extremely-low-frequency electric and magnetic fields. *Bioelectromagnetics* 1992;Suppl:15-26.
182. Barnes FS. Some engineering models for interactions of electric and magnetic fields with biological systems. *Bioelectromagnetics* 1992;Suppl:67-85.
183. Dosimetry workshop: extremely-low-frequency electric and magnetic fields. Carmel, California, March 20-22, 1991. *Bioelectromagnetics* 1992;Suppl:1-265.
184. London SJ, Thomas DC, Bowman JD, Sobel E, Cheng TC, Peters JM. Exposure to residential electric and magnetic fields and risk of childhood leukemia. *Am J Epidemiol* 1991;134:923-37.
185. Flynn MR, West S, Kaune WT, Savitz DA, Chen C-C, Loomis DP. Validation of expert judgment in assessing occupational exposure to magnetic fields in the utility industry. *Appl. Occup. Ind. Hyg.* 1991;6:141-145.
186. Rommereim DN, Rommereim RL, Sikov MR, Buschbom RL, Anderson LE. Reproduction, growth, and development of rats during chronic exposure to multiple field strengths of 60-Hz electric fields. *Fundam Appl Toxicol* 1990;14:608-21.
187. Rommereim DN, Kaune WT, Anderson LE, Sikov MR. Rats reproduce and rear litters during chronic exposure to 150-kV/m, 60-Hz electric fields. *Bioelectromagnetics* 1989;10:385-9.
188. Sikov MR, Rommereim DN, Beamer JL, Buschbom RL, Kaune WT, Phillips RD. Developmental studies of Hanford miniature swine exposed to 60-Hz electric fields. *Bioelectromagnetics* 1987;8:229-42.
189. Rommereim DN, Kaune WT, Buschbom RL, Phillips RD, Sikov MR. Reproduction and development in rats chronologically exposed to 60-Hz electric fields. *Bioelectromagnetics* 1987;8:243-58.
190. Hjerresen DL, Miller MC, Kaune WT, Phillips RD. A behavioral response of swine to a 60-Hz electric field. *Bioelectromagnetics* 1982;3:443-51.
191. Kaune WT, Phillips RD. Comparison of the coupling of grounded humans, swine and rats to vertical, 60-Hz electric fields. *Bioelectromagnetics* 1980;1:117-29.
192. Schüz J, Svendsen AL, Linet MS, McBride ML, Roman E, Feychting M, Kheifets L, Lightfoot T, Mezei G, Simpson J, Ahlbom A. Nighttime exposure to electromagnetic fields and childhood leukemia: an extended pooled analysis. *Am J Epidemiol* advance online publication, 7 May 2007; doi:10.1093/aje/kwm080.
193. Li CY, Mezei G, Sung FC, Silva M, Lee PC, Chen PC, Chen LM. Assessment of non-response bias in a survey of residential magnetic field exposure in Taiwan. *Bioelectromagnetics* advance online publication, 16 Apr 2007; doi: 10.1002/bem.20306.

194. Li CY, Sung FC, Chen FL, Lee PC, Silva M, Mezei G. Extremely-low-frequency magnetic field exposure of children at schools near high voltage transmission lines. *Sci Total Environ* 2007;376:151-9.
195. Li CY, Mezei G, Sung FC, Silva M, Chen PC, Lee PC, Chen LM. Survey of residential extremely-low-frequency magnetic field exposure among children in Taiwan. *Environ Int* 2007;33:233-8.
196. Foliart DE, Mezei G, Iriye R, Silva JM, Ebi KL, Kheifets L, Link MP, Kavet R, Pollock BH. Magnetic field exposure and prognostic factors in childhood leukemia. *Bioelectromagnetics* 2007;28:69-71.
197. Mezei G, Benyi M, Muller A. Mobile phone ownership and use among school children in three Hungarian cities. *Bioelectromagnetics* 2007; 28:309-15.
198. Bowman J, Niple J, Kavet R. Pilot measurements of ELF contact currents in some electric utility occupations. *J Occup Environ Hyg* 2006;3:323-33.
199. Kavet R, Daigle JP, Zaffanella LE. Residential magnetic fields, contact voltage and their relationship: the effects of distribution unbalance and residential proximity to a transmission line. *Health Phys* 2006;91:592-607.
200. Mezei G, Borugian MJ, Spinelli JJ, Wilkins R, Abanto Z, McBride ML. Socioeconomic status and childhood solid tumor and lymphoma incidence in Canada. *Am J Epidemiol* 2006;164:170-5.
201. Mezei G, Bracken TD, Senior R, Kavet R. Analyses of magnetic-field peak-exposure summary measures. *J Expo Sci Environ Epidemiol* 2006;16:477-85.
202. Mezei G, Kheifets L. Selection bias and its implications for case-control studies: a case study of magnetic field exposure and childhood leukaemia. *Int J Epidemiol* 2006;35:397-406.
203. Poole C, Greenland S, Luetters C, Kelsey JL, Mezei G. Socioeconomic status and childhood leukaemia: a review. *Int J Epidemiol* 2006;35:370-84.
204. Szabo J, Mezei K, Thuroczy G, Mezei G. Occupational 50 Hz magnetic field exposure measurements among female sewing machine operators in Hungary. *Bioelectromagnetics* 2006;27:451-7.
205. Savitz DA, Herring AH, Mezei G, Evenson K, Terry J, Kavet R. Physical activity and magnetic field exposure in pregnancy. *Epidemiology* 2006;17:222-5.
206. Foliart DE, Pollock BH, Mezei G, Iriye R, Silva JM, Ebi KL, Kheifets L, Link MP, Kavet R. Magnetic field exposure and long-term survival among children with leukaemia. *Br J Cancer* 2006;94:161-4.
207. Peck SC, Kavet R. Research strategies for magnetic fields and cancer. *Risk Anal* 2005;25:179-88.
208. Patterson RM, Bracken TD, Alldredge JR. Assessing compliance with 60-Hertz magnetic-field exposure guidelines. *J Occup Environ Hyg* 2005;2:77-85.

209. Stuchly MA, Kavet R. Numerical modeling of pacemaker interference in the electric utility environment. *IEEE Trans Device Mater Reliab* 2005;5:481-487.
210. Niple JC, Sahl JD, Kelsh MA, Kavet R. Equipment grounding affects contact current exposure: a case study of sewing machines. *Ann Occup Hyg* 2005;49:673-82.
211. Mezei G, Cher D, Kelsh M, Edinboro C, Chapman P, Kavet R. Occupational magnetic field exposure, cardiovascular disease mortality, and potential confounding by smoking. *Ann Epidemiol* 2005;15:622-9.
212. Kheifets L, Sahl JD, Shimkhada R, Repacholi MH. Developing policy in the face of scientific uncertainty: Interpreting 0.3 mT or 0.4 mT cutpoints from EMF epidemiologic studies. *Risk Anal* 2005;25:927-35.
213. Kavet R. Contact current hypothesis: Summary of results to date. *Bioelectromagnetics* 2005;26:S75-S85.
214. Bracken TD. 60-Hertz electric-field exposures in transmission line towers. *J Occup Environ Hyg* 2005;2:444-455.
215. Bracken TD, Senior RS, Bailey WH. DC electric fields from corona-generated space charge near AC transmission lines. *IEEE Trans Power Delivery* 2005;20:1692-1702.
216. Borugian MJ, Spinelli JJ, Mezei G, Wilkins R, Abanto Z, McBride ML. Childhood leukemia and socioeconomic status in Canada. *Epidemiology* 2005;16:526-31.
217. Bailey WH, Nyenhuis JA. Thresholds for 60 Hz magnetic field stimulation of peripheral nerves in human subjects. *Bioelectromagnetics* 2005;26:462-8.
218. Niple JC, Daigle JP, Zaffanella LE, Sullivan T, Kavet R. A portable meter for measuring low frequency currents in the human body. *Bioelectromagnetics* 2004;25:369-73.
219. Mezei G, Papp C, Toth-Pal E, Beke A, Papp Z. Factors influencing parental decision making in prenatal diagnosis of sex chromosome aneuploidy. *Obstet Gynecol* 2004;104:94-101.
220. McCormick DL, Kavet R. Animal models for the study of childhood leukemia: considerations for model identification and optimization to identify potential risk factors. *Int J Toxicol* 2004;23:149-61.
221. Kavet R, Zaffanella LE, Pearson RL, Dallapiazza J. Association of residential magnetic fields with contact voltage. *Bioelectromagnetics* 2004;25:530-6.
222. Forssen UM, Mezei G, Nise G, Feychting M. Occupational magnetic field exposure among women in Stockholm County, Sweden. *Occup Environ Med* 2004;61:594-602.
223. Dawson TW, Stuchly MA, Kavet R. Electric fields in the human body due to electrostatic discharges. *IEEE Trans Biomed Eng* 2004;51:1460-8.
224. Dawson TW, Stuchly MA, Kavet R. Evaluation of interactions of electric fields due to electrostatic discharge with human tissue. *IEEE Trans Biomed Eng*

2004;51:2194-8.

225. Kelsh MA, Bracken TD, Sahl JD, Shum M, Ebi KL. Occupational magnetic field exposures of garment workers: results of personal and survey measurements. *Bioelectromagnetics* 2003;24:316-26.
226. Dawson TW, Caputa K, Stuchly MA, Kavet R. Comparison of electric fields induced in humans and rodents by 60-Hz contact currents. *IEEE Trans Biomed Eng* 2003;50:744-53.
227. Brain JD, Kavet R, McCormick DL, Poole C, Silverman LB, Smith TJ, Valberg PA, Van Etten RA, Weaver JC. Childhood leukemia: electric and magnetic fields as possible risk factors. *Environ Health Perspect* 2003;111:962-70.
228. Yamaguchi DT, Huang J, Ma D, Wang PK. Inhibition of gap junction intercellular communication by extremely low- frequency electromagnetic fields in osteoblast-like models is dependent on cell differentiation. *J Cell Physiol* 2002;190:180-8.
229. Swanson J. A transmission utility's experience of applying EMF exposure standards. *Health Phys* 2002;83:417-25.
230. Stuchly MA, Dawson TW. Human body exposure to power lines: relation of induced quantities to external magnetic fields. *Health Phys* 2002;83:333-40.
231. Sheppard AR, Kavet R, Renew DC. Exposure guidelines for low-frequency electric and magnetic fields: report from the Brussels workshop. *Health Phys* 2002;83:324-32.
232. Saunders RD, Jefferys JG. Weak electric field interactions in the central nervous system. *Health Phys* 2002;83:366-75.
233. Sastre A, Kavet R. Candidate sites of action for microdosimetry associated with exposure to extremely-low-frequency magnetic fields, electric fields and contact currents. *Health Phys* 2002;83:387-94.
234. Sahl J, Mezei G, Kavet R, McMillan A, Silvers A, Sastre A, Kheifets L. Occupational magnetic field exposure and cardiovascular mortality in a cohort of electric utility workers. *Am J Epidemiol*. 2002;156:913-918.
235. Renew DC, Glover ID. Basic restrictions in EMF exposure guidelines. *Health Phys* 2002;83:395-401.
236. Reilly JP, Diamant AM. Neuroelectric mechanisms applied to low frequency electric and magnetic field exposure guidelines--part II: non sinusoidal waveforms. *Health Phys* 2002;83:356-65.
237. Reilly JP. Neuroelectric mechanisms applied to low frequency electric and magnetic field exposure guidelines--part I: sinusoidal waveforms. *Health Phys* 2002;83:341-55.
238. Rankin RF, Dan Bracken T, Senior RS, Kavet R, Montgomery JH. Results of a multisite study of U.S. residential magnetic fields. *J Expo Anal Environ Epidemiol* 2002;12:9-20.
239. Mezei G, Kheifets LI. Clues to the possible viral etiology of childhood leukemia.

Technology 2002;9:3-14.

240. Kavet R, Zaffanella LE. Contact voltage measured in residences: implications to the association between magnetic fields and childhood leukemia. *Bioelectromagnetics* 2002;23:464-474.
241. Kaune WT, Dovan T, Kavet RI, Savitz DA, Neutra RR. Study of high- and low-current-configuration homes from the 1988 Denver childhood cancer study. *Bioelectromagnetics* 2002;23:177-88.
242. Johnson KC, Goodman M, Kelsh M, Iannuzzi J, Ebi K, Langholz B. Passive and active smoking as possible confounders in studies of breast cancer risk. *Epidemiology* 2002;13:610; discussion 610-1.
243. Goodman M, Kelsh M, Ebi K, Iannuzzi J, Langholz B. Evaluation of potential confounders in planning a study of occupational magnetic field exposure and female breast cancer. *Epidemiology* 2002;13:50-8.
244. Foliat DE, Iriye RN, Silva JM, Mezei G, Tarr KJ, Ebi KL. Correlation of year-to-year magnetic field exposure metrics among children in a leukemia survival study. *J Expo Anal Environ Epidemiol* 2002;12:441-7.
245. Dawson TW, Caputa K, Stuchly MA, Shepard RB, Kavet R, Sastre A. Pacemaker interference by magnetic fields at power line frequencies. *IEEE Trans Biomed Eng* 2002;49:254-62.
246. Dawson TW, Caputa K, Stuchly MA, Kavet R. Pacemaker interference by 60-Hz contact currents. *IEEE Trans Biomed Eng* 2002;49:878-886.
247. Dawson TW, Caputa K, Stuchly MA. Magnetic field exposures for UK live-line workers. *Phys Med Biol* 2002;47:995-1012.
248. Dawson TW, Caputa K, Stuchly MA. Electric fields induced in humans and rodents by 60 Hz magnetic fields. *Phys Med Biol* 2002;47:2561-8.
249. Bracken TD. Assessing compliance with power-frequency magnetic-field guidelines. *Health Phys* 2002;83:409-16.
250. Bailey WH. Dealing with uncertainty in formulating occupational and public exposure limits. *Health Phys* 2002;83:402-8.
251. Bailey WH. Health effects relevant to the setting of EMF exposure limits. *Health Phys* 2002;83:376-86.
252. van Wijngaarden E, Savitz DA, Kleckner RC, Kavet R, Loomis D. Mortality patterns by occupation in a cohort of electric utility workers. *Am J Ind Med* 2001;40:667-73.
253. Mezei G, Kheifets LI, Nelson LM, Mills KM, Iriye R, Kelsey JL. Household appliance use and residential exposure to 60-hz magnetic fields. *J Expo Anal Environ Epidemiol* 2001;11:41-9.
254. Kheifets LI. Electric and magnetic field exposure and brain cancer: a review. *Bioelectromagnetics* 2001;Suppl:S120-31.
255. Kheifets LI, Greenberg RS, Neutra RR, Hester GL, Poole CL, Rall DP, Lundell G.

- Electric and magnetic fields and cancer: case study. *Am J Epidemiol* 2001;154:S50-9.
256. Kavet R, Stuchly MA, Bailey WH, Bracken TD. Evaluation of biological effects, dosimetric models, and exposure assessment related to ELF electric- and magnetic-field guidelines. *Appl Occup Environ Hyg* 2001;16:1118-38.
257. Kaune WT, Davis S, Stevens RG, Mirick DK, Kheifets L. Measuring temporal variability in residential magnetic field exposures. *Bioelectromagnetics* 2001;22:232-45.
258. Hefeneider SH, McCoy SL, Hausman FA, Christensen HL, Takahashi D, Perrin N, Bracken TD, Shin KY, Hall AS. Long-term effects of 60-Hz electric vs. magnetic fields on IL-1 and IL-2 activity in sheep. *Bioelectromagnetics* 2001;22:170-7.
259. Guttman JL, Niple J, Kavet R, Johnson GB. Measurement instrumentation for transient magnetic fields and currents. *Proc IEEE EMC Int Symp* 2001;1:419-424.
260. Guttman JL, Kavet R, Johnson GB. Transient magnetic fields and currents in residences. *Proc IEEE EMC Int Symp*. Montreal, Canada, 2001;227-232.
261. Foliat DE, Iriye RN, Tarr KJ, Silva JM, Kavet R, Ebi KL. Alternative magnetic field exposure metrics: relationship to TWA, appliance use, and demographic characteristics of children in a leukemia survival study. *Bioelectromagnetics* 2001;22:574-580.
262. Dawson TW, Caputa K, Stuchly MA, Kavet R. Electric fields in the human body resulting from 60-Hz contact currents. *IEEE Trans Biomed Eng* 2001;48:1020-1026.
263. Davis S, Kaune WT, Mirick DK, Chen C, Stevens RG. Residential magnetic fields, light-at-night, and nocturnal urinary 6- sulfatoxymelatonin concentration in women. *Am J Epidemiol* 2001;154:591-600.
264. Bracken TD, Rankin RF, Senior RS, Kavet R, Geissinger LG. Magnetic-field exposures of cable splicers in electrical network distribution vaults. *Appl Occup Environ Hyg* 2001;16:369-79.
265. Anderson LE, Morris JE, Miller DL, Rafferty CN, Ebi KL, Sasser LB. Large granular lymphocytic (LGL) leukemia in rats exposed to intermittent 60 Hz magnetic fields. *Bioelectromagnetics* 2001;22:185-93.
266. van Wijngaarden E, Savitz DA. Occupational sunlight exposure in relation to suicide among electric utility workers. *Am J Ind Med* 2000;38:149-54.
267. van Wijngaarden E, Savitz DA, Kleckner RC, Cai J, Loomis D. Exposure to electromagnetic fields and suicide among electric utility workers: a nested case-control study. *West J Med* 2000;173:94-100.
268. Stevens RG, Davis S, Mirick DK, Kheifets L, Kaune W. Alcohol consumption and urinary concentration of 6-sulfatoxymelatonin in healthy women. *Epidemiology* 2000;11:660-5.
269. Savitz DA, Cai J, van Wijngaarden E, Loomis D, Mihlan G, Dufort V, Kleckner RC, Nylander-French L, Kromhout H, Zhou H. Case-cohort analysis of brain cancer

- and leukemia in electric utility workers using a refined magnetic field job-exposure matrix. *Am J Ind Med* 2000;38:417–25.
270. Mills KM, Kheifets LI, Nelson LM, Bloch DA, Takemoto-Hambleton R, Kelsey JL. Reliability of proxy-reported and self-reported household appliance use. *Epidemiology* 2000;11:581–8.
271. McCann J, Kavet R, Rafferty CN. Assessing the potential carcinogenic activity of magnetic fields using animal models. *Environ Health Perspect* 2000;108 Suppl 1:79–100.
272. Kavet R, Zaffanella LE, Daigle JP, Ebi KL. The possible role of contact current in cancer risk associated with residential magnetic fields. *Bioelectromagnetics* 2000;21:538–53.
273. Kaune WT, Bracken TD, Senior RS, Rankin RF, Niple JC, Kavet R. Rate of occurrence of transient magnetic field events in U.S. residences. *Bioelectromagnetics* 2000;21:197–213.
274. Graham C, Sastre A, Cook MR, Kavet R. Heart rate variability and physiological arousal in men exposed to 60 Hz magnetic fields. *Bioelectromagnetics* 2000;21:480–2.
275. Graham C, Sastre A, Cook MR, Kavet R, Gerkovich MM, Riffle DW. Exposure to strong ELF magnetic fields does not alter cardiac autonomic control mechanisms. *Bioelectromagnetics* 2000;21:413–21.
276. Graham C, Cook MR, Sastre A, Gerkovich MM, Kavet R. Cardiac autonomic control mechanisms in power-frequency magnetic fields: a multistudy analysis. *Environ Health Perspect* 2000;108:737–742.
277. Ebi KL, Kheifets LI, Pearson RL, Wachtel H. Description of a new computer wire coding method and its application to evaluate potential control selection bias in the Savitz et al. childhood cancer study. *Bioelectromagnetics* 2000;21:346–53.
278. Dawson TW, Stuchly MA, Caputa K, Sastre A, Shepard RB, Kavet R. Pacemaker interference and low-frequency electric induction in humans by external fields and electrodes. *IEEE Trans Biomed Eng* 2000;47:1211–1218.
279. Cook MR, Graham C, Kavet R, Stevens RG, Davis S, Kheifets L. Morning urinary assessment of nocturnal melatonin secretion in older women. *J Pineal Res* 2000;28:41–7.
280. Chen G, Upham BL, Sun W, Chang CC, Rothwell EJ, Chen KM, Yamasaki H, Trosko JE. Effect of electromagnetic field exposure on chemically induced differentiation of friend erythroleukemia cells. *Environ Health Perspect* 2000;108:967–72.
281. Boorman GA, Rafferty CN, Ward JM, Sills RC. Leukemia and lymphoma incidence in rodents exposed to low-frequency magnetic fields. *Radiat Res* 2000;153:627–36.
282. Babbitt JT, Kharazi AI, Taylor JM, Bonds CB, Mirell SG, Frumkin E, Zhuang D, Hahn TJ. Hematopoietic neoplasia in C57BL/6 mice exposed to split-dose ionizing

- radiation and circularly polarized 60 Hz magnetic fields. *Carcinogenesis* 2000;21:1379-89.
283. Williams JR, Zhang Y, Zhou H, Osman M, Cha D, Kavet R, Cuccinotta F, Dicello JF, Dillehay LE. Predicting cancer rates in astronauts from animal carcinogenesis studies and cellular markers. *Mutat Res* 1999;430:255-69.
284. van Wijngaarden E, Savitz DA, Kleckner RC, Mihlan G, Nylander-French LA, Dufort V, Cai J, Loomis D, Kromhout H. Refinements in magnetic field exposure assignment for a case-cohort study of electrical utility workers. *Ann Occup Hyg* 1999;43:485-92.
285. Savitz DA, Liao D, Sastre A, Kleckner RC, Kavet R. Magnetic field exposure and cardiovascular disease mortality among electric utility workers [see comments]. *Am J Epidemiol* 1999;149:135-42.
286. Savitz DA, Liao D, Sastre A, Kleckner RC, Kavet R. Magnetic field exposure and cardiovascular disease mortality among electric utility workers. *Am J Epidemiol* 1999;149:135-42.
287. Morris JE, Sasser LB, Miller DL, Dagle GE, Rafferty CN, Ebi KL, Anderson LE. Clinical progression of transplanted large granular lymphocytic leukemia in Fischer 344 rats exposed to 60 Hz magnetic fields. *Bioelectromagnetics* 1999;20:48-56.
288. McBride ML, Gallagher RP, Theriault G, Armstrong BG, Tamaro S, Spinelli JJ, Deadman JE, Fincham S, Robson D, Choi W. Power-frequency electric and magnetic fields and risk of childhood leukemia in Canada. *Am J Epidemiol* 1999;149:831-42.
289. Loomis D, Dufort V, Kleckner RC, Savitz DA. Fatal occupational injuries among electric power company workers. *Am J Ind Med* 1999;35:302-9.
290. Kheifets L. Occupational exposure assessment in epidemiological studies of EMF. *Radiat. Prot. Dosimetry* 1999;83:61-69.
291. Kheifets LI, Sussman SS, Preston-Martin S. Childhood brain tumors and residential electromagnetic fields (EMF). *Rev Environ Contam Toxicol* 1999;159:111-29.
292. Kheifets LI, Matkin CC. Industrialization, electromagnetic fields, and breast cancer risk. *Environ Health Perspect* 1999;107 Suppl 1:145-54.
293. Kheifets LI, Gilbert ES, Sussman SS, Guenel P, Sahl JD, Savitz DA, Theriault G. Comparative analyses of the studies of magnetic fields and cancer in electric utility workers: studies from France, Canada, and the United States. *Occup Environ Med* 1999;56:567-74.
294. Kavet R, Ulrich RM, Kaune WT, Johnson GB, Powers T. Determinants of power-frequency magnetic fields in residences located away from overhead power lines. *Bioelectromagnetics* 1999;20:306-18.
295. Kavet R. ELF magnetic fields, transients and TWA metrics. *Radiat. Prot. Dosimetry* 1999;83:29-40.

296. Ebi KL. Developments in the generation and interpretation of wire codes. *Radiat. Prot. Dosimetry* 1999;83:71–78.
297. Ebi KL, Zaffanella LE, Greenland S. Application of the case-specular method to two studies of wire codes and childhood cancers. *Epidemiology* 1999;10:398–404.
298. DiGiovanni J, Johnston DA, Rupp T, Sasser LB, Anderson LE, Morris JE, Miller DL, Kavet R, Walborg EF, Jr. Lack of effect of a 60 Hz magnetic field on biomarkers of tumor promotion in the skin of SENCAR mice. *Carcinogenesis* 1999;20:685–9.
299. Dawson TW, Caputa K, Stuchly MA. Magnetic induction at 60 Hz in the human heart: a comparison between the in situ and isolated scenarios. *Bioelectromagnetics* 1999;20:233–43.
300. Dawson TW, Caputa K, Stuchly MA. Numerical evaluation of 60 Hz magnetic induction in the human body in complex occupational environments. *Phys Med Biol* 1999;44:1025–40.
301. Brainard GC, Kavet R, Kheifets LI. The relationship between electromagnetic field and light exposures to melatonin and breast cancer risk: a review of the relevant literature. *J Pineal Res* 1999;26:65–100.
302. Bailey WH, Su SH, Dan Bracken T. Probabilistic approach to ranking sources of uncertainty in ELF magnetic field exposure limits. *Health Phys* 1999;77:282–90.
303. Zaffanella LE, Savitz DA, Greenland S, Ebi KL. The residential case-specular method to study wire codes, magnetic fields, and disease. *Epidemiology* 1998;9:16–20.
304. Savitz DA, Checkoway H, Loomis DP. Magnetic field exposure and neurodegenerative disease mortality among electric utility workers. *Epidemiology* 1998;9:398–404.
305. Sasser LB, Anderson LE, Morris JE, Miller DL, Walborg EF, Jr., Kavet R, Johnston DA, DiGiovanni J. Lack of a co-promoting effect of a 60 Hz magnetic field on skin tumorigenesis in SENCAR mice. *Carcinogenesis* 1998;19:1617–21.
306. Reiter RJ, Tan DX, Poeggeler B, Kavet R. Inconsistent suppression of nocturnal pineal melatonin synthesis and serum melatonin levels in rats exposed to pulsed DC magnetic fields. *Bioelectromagnetics* 1998;19:318–29.
307. McCann J. Cancer risk assessment of extremely low frequency electric and magnetic fields: a critical review of methodology. *Environ Health Perspect* 1998;106:701–17.
308. McCann J, Dietrich F, Rafferty C. The genotoxic potential of electric and magnetic fields: an update. *Mutat Res* 1998;411:45–86.
309. Loomis A, Kromhout H, Kleckner RC, Savitz DA. Effects of the analytical treatment of exposure data on associations of cancer and occupational magnetic field exposure. *Am J Ind Med* 1998;34:49–56.
310. Graham C, Cook MR, Kavet R, Sastre A, Smith DK. Prediction of nocturnal plasma melatonin from morning urinary measures [published erratum appears in J

- Pineal Res 1999 Mar;26(2):128]. J Pineal Res 1998;24:230-8.
311. Bracken MB, Belanger K, Hellenbrand K, Addesso K, Patel S, Triche E, Leaderer BP. Correlates of residential wiring code used in studies of health effects of residential electromagnetic fields. *Am J Epidemiol* 1998;148:467-74.
312. Belanger K, Leaderer B, Hellenbrand K, Holford TR, McSharry J, Power ME, Bracken MB. Spontaneous abortion and exposure to electric blankets and heated water beds. *Epidemiology* 1998;9:36-42.
313. Zaffanella LE, Kavet R, Pappa JR, Sullivan TP. Modeling magnetic fields in residences: validation of the resicalc program. *J Expo Anal Environ Epidemiol* 1997;7:241-59.
314. Valberg PA, Kavet R, Rafferty CN. Can low-level 50/60 Hz electric and magnetic fields cause biological effects? [see comments] [published erratum appears in *Radiat Res* 1997 Nov;148(5):528]. *Radiat Res* 1997;148:2-21.
315. Valberg PA, Kavet R, Rafferty CN. Can low-level 50/60 Hz electric and magnetic fields cause biological effects? *Radiat Res* 1997;148:2-21.
316. Schroeder JC, Savitz DA. Lymphoma and multiple myeloma mortality in relation to magnetic field exposure among electric utility workers. *Am J Ind Med* 1997;32:392-402.
317. Savitz DA, Dufort V, Armstrong B, Theriault G. Lung cancer in relation to employment in the electrical utility industry and exposure to magnetic fields. *Occup Environ Med* 1997;54:396-402.
318. McCann J, Kavet R, Rafferty CN. Testing electromagnetic fields for potential carcinogenic activity: a critical review of animal models. *Environ Health Perspect* 1997;105 Suppl 1:81-103.
319. Loomis D, Browning SR, Schenck AP, Gregory E, Savitz DA. Cancer mortality among electric utility workers exposed to polychlorinated biphenyls. *Occup Environ Med* 1997;54:720-8.
320. Kromhout H, Loomis DP, Kleckner RC, Savitz DA. Sensitivity of the relation between cumulative magnetic field exposure and brain cancer mortality to choice of monitoring data grouping scheme. *Epidemiology* 1997;8:442-5.
321. Kheifets LI, Kavet R, Sussman SS. Wire codes, magnetic fields, and childhood cancer. *Bioelectromagnetics* 1997;18:99-110.
322. Kheifets LI, Afifi AA, Buffler PA, Zhang ZW, Matkin CC. Occupational electric and magnetic field exposure and leukemia. A meta-analysis. *J Occup Environ Med* 1997;39:1074-91.
323. Kheifets LI, London SJ, Peters JM. Leukemia risk and occupational electric field exposure in Los Angeles County, California. *Am J Epidemiol* 1997;146:87-90.
324. Kaune WT, Guttman JL, Kavet R. Comparison of coupling of humans to electric and magnetic fields with frequencies between 100 Hz and 100 kHz. *Bioelectromagnetics* 1997;18:67-76.

325. Graham C, Cook MR, Riffle DW. Human melatonin during continuous magnetic field exposure. *Bioelectromagnetics* 1997;18:166-71.
326. Bracken TD, Senior RS, Rankin RF, Bailey WH, Kavet R. Magnetic field exposures in the electric utility industry relevant to occupational guideline levels. *Appl. Occup. Environ. Hyg.* 1997;12:756-768.
327. Bailey WH, Su SH, Bracken TD, Kavet R. Summary and evaluation of guidelines for occupational exposure to power frequency electric and magnetic fields. *Health Phys* 1997;73:433-53.
328. Sussman SS, Kheifets LI. Re: "Adult leukemia risk and personal appliance use: a preliminary study". *Am J Epidemiol* 1996;143:743-4.
329. Sasser LB, Morris JE, Miller DL, Rafferty CN, Ebi KL, Anderson LE. Exposure to 60 Hz magnetic fields does not alter clinical progression of LGL leukemia in Fischer rats. *Carcinogenesis* 1996;17:2681-7.
330. Kavet R. EMF and current cancer concepts. *Bioelectromagnetics* 1996;17:339-57.
331. Graham C, Cook MR, Riffle DW, Gerkovich MM, Cohen HD. Nocturnal melatonin levels in human volunteers exposed to intermittent 60 Hz magnetic fields. *Bioelectromagnetics* 1996;17:263-73.
332. Savitz DA, Loomis DP. Magnetic field exposure in relation to leukemia and brain cancer mortality among electric utility workers. *Am J Epidemiol* 1995;141:123-34.
333. Kromhout H, Loomis DP, Mihlan GJ, Peipins LA, Kleckner RC, Iriye R, Savitz DA. Assessment and grouping of occupational magnetic field exposure in five electric utility companies. *Scand J Work Environ Health* 1995;21:43-50.
334. Kheifets LI, Afifi AA, Buffler PA, Zhang ZW. Occupational electric and magnetic field exposure and brain cancer: a meta-analysis. *J Occup Environ Med* 1995;37:1327-41.
335. Kavet R. Magnetic field exposure assessment. In: Blank M, ed. *Electromagnetic Fields: Biological Interactions and Mechanisms*. Washington, DC : American Chemical Society, 1995;191-223.
336. Savitz DA, Ohya T, Loomis DP, Senior RS, Bracken TD, Howard RL. Correlations among indices of electric and magnetic field exposure in electric utility workers. *Bioelectromagnetics* 1994;15:193-204.
337. Loomis DP, Kromhout H, Peipins LA, Kleckner RC, Iriye R, Savitz DA. Sampling design and field methods of a large, randomized, multisite survey of occupational magnetic field exposure. *Appl. Occup. Ind. Hyg.* 1994;9:49-52.
338. Loomis DP, Peipins LA, Browning SR, Howard RL, Kromhout H, Savitz DA. Organization and classification of work history data in industry-wide studies: an application to the electric power industry. *Am J Ind Med* 1994;26:413-25.
339. Koontz MD, Dietrich FM. Variability and predictability of children's exposure to magnetic fields. *J. Expo. Anal. Environ. Epidemiol.* 1994;4:287-307.

340. Kaune WT, Zaffanella LE. Assessing historical exposures of children to power-frequency magnetic fields. *J Expo Anal Environ Epidemiol* 1994;4:149-70.
341. Grota LJ, Reiter RJ, Keng P, Michaelson S. Electric field exposure alters serum melatonin but not pineal melatonin synthesis in male rats. *Bioelectromagnetics* 1994;15:427-37.
342. McCann J, Dietrich F, Rafferty C, Martin AO. A critical review of the genotoxic potential of electric and magnetic fields. *Mutat Res* 1993;297:61-95.
343. Matanoski GM, Elliott EA, Breyse PN, Lynberg MC. Leukemia in telephone linemen. *Am J Epidemiol* 1993;137:609-19.
344. Weaver JC. Electromagnetic field dosimetry: issues relating to background, noise, and interaction mechanisms. *Bioelectromagnetics* 1992;Suppl:115-7.
345. Weaver JC, Astumian RD. Estimates for ELF effects: noise-based thresholds and the number of experimental conditions required for empirical searches. *Bioelectromagnetics* 1992;Suppl:119-38.
346. Wachtel H. Bioelectric background fields and their implications for ELF dosimetry. *Bioelectromagnetics* 1992;Suppl:139-45.
347. Wachtel H. Methodological approaches to EMF microdosimetry. *Bioelectromagnetics* 1992;Suppl:159-60.
348. Tenforde TS. Microscopic dosimetry of extremely-low-frequency electric and magnetic fields. *Bioelectromagnetics* 1992;Suppl:61-6.
349. Stuchly MA, Esselle KP. Factors affecting neural stimulation with magnetic fields. *Bioelectromagnetics* 1992;Suppl:191-204.
350. Stein GS, Lian JB. Regulation of cell cycle and growth control. *Bioelectromagnetics* 1992;Suppl:247-65.
351. Rafferty CN, Phillips RD, Guy AW. Dosimetry Workshop: extremely-low-frequency electric and magnetic fields. *Bioelectromagnetics* 1992;Suppl:1-10.
352. Polk C. Dosimetric extrapolations of extremely-low-frequency electric and magnetic fields across biological systems. *Bioelectromagnetics* 1992;Suppl:205-8.
353. Polk C. Dosimetry of extremely-low-frequency magnetic fields. *Bioelectromagnetics* 1992;Suppl:209-35.
354. Nuccitelli R. Endogenous ionic currents and DC electric fields in multicellular animal tissues. *Bioelectromagnetics* 1992;Suppl:147-57.
355. McLeod KJ. Microelectrode measurements of low frequency electric field effects in cells and tissues. *Bioelectromagnetics* 1992;Suppl:161-78.
356. Loew LM. Voltage-sensitive dyes: measurement of membrane potentials induced by DC and AC electric fields. *Bioelectromagnetics* 1992;Suppl:179-89.
357. Litovitz TA, Montrose CJ, Wang W. Dose-response implications of the transient nature of electromagnetic-field-induced bioeffects: theoretical hypotheses and predictions. *Bioelectromagnetics* 1992;Suppl:237-46.

358. Kirschvink JL. Uniform magnetic fields and double-wrapped coil systems: improved techniques for the design of bioelectromagnetic experiments. *Bioelectromagnetics* 1992;13:401-11.
359. Kirschvink JL, Kobayashi-Kirschvink A, Diaz-Ricci JC, Kirschvink SJ. Magnetite in human tissues: a mechanism for the biological effects of weak ELF magnetic fields. *Bioelectromagnetics* 1992;Suppl:101-13.
360. Kaune WT. Macroscopic dosimetry of power-frequency electric and magnetic fields. *Bioelectromagnetics* 1992;Suppl:11-4.
361. Hart FX. Numerical and analytical methods to determine the current density distributions produced in human and rat models by electric and magnetic fields. *Bioelectromagnetics* 1992;Suppl:27-42.
362. Gandhi OP, Chen JY. Numerical dosimetry at power-line frequencies using anatomically based models. *Bioelectromagnetics* 1992;Suppl:43-60.
363. Fishman HM. Assessment of conduction properties and thermal noise in cell membranes by admittance spectroscopy. *Bioelectromagnetics* 1992;Suppl:87-100.
364. Bracken TD. Experimental macroscopic dosimetry for extremely-low-frequency electric and magnetic fields. *Bioelectromagnetics* 1992;Suppl:15-26.
365. Barnes FS. Some engineering models for interactions of electric and magnetic fields with biological systems. *Bioelectromagnetics* 1992;Suppl:67-85.
366. Dosimetry workshop: extremely-low-frequency electric and magnetic fields. Carmel, California, March 20-22, 1991. *Bioelectromagnetics* 1992;Suppl:1-265.
367. London SJ, Thomas DC, Bowman JD, Sobel E, Cheng TC, Peters JM. Exposure to residential electric and magnetic fields and risk of childhood leukemia. *Am J Epidemiol* 1991;134:923-37.
368. Flynn MR, West S, Kaune WT, Savitz DA, Chen C-C, Loomis DP. Validation of expert judgment in assessing occupational exposure to magnetic fields in the utility industry. *Appl. Occup. Ind. Hyg.* 1991;6:141-145.
369. Rommereim DN, Rommereim RL, Sikov MR, Buschbom RL, Anderson LE. Reproduction, growth, and development of rats during chronic exposure to multiple field strengths of 60-Hz electric fields. *Fundam Appl Toxicol* 1990;14:608-21.
370. Rommereim DN, Kaune WT, Anderson LE, Sikov MR. Rats reproduce and rear litters during chronic exposure to 150-kV/m, 60-Hz electric fields. *Bioelectromagnetics* 1989;10:385-9.
371. Sikov MR, Rommereim DN, Beamer JL, Buschbom RL, Kaune WT, Phillips RD. Developmental studies of Hanford miniature swine exposed to 60-Hz electric fields. *Bioelectromagnetics* 1987;8:229-42.
372. Rommereim DN, Kaune WT, Buschbom RL, Phillips RD, Sikov MR. Reproduction and development in rats chronologically exposed to 60-Hz electric fields. *Bioelectromagnetics* 1987;8:243-58.
373. Hjerlesen DL, Miller MC, Kaune WT, Phillips RD. A behavioral response of swine

to a 60-Hz electric field, Bioelectromagnetics 1982;3:443-51.

374. Kaune WT, Phillips RD. Comparison of the coupling of grounded humans, swine and rats to vertical, 60-Hz electric fields. Bioelectromagnetics 1980;1:117-29.

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* * * * *

Respectfully submitted,

M. ALEX ROWADY, ESQ.
Blair & Rowady, P.S.C.
212 South Maple Street
Winchester, Kentucky 40391
(859) 744-3251
ATTORNEY FOR COMPLAINANTS

This is to certify that the original and eight true copies of the foregoing was hand-delivered to Kentucky Public Service Commission, P.O. Box 615, Frankfort, Kentucky 40602-0615 and a true copy was sent by first-class mail to David S. Samford, Esq., Gross Samford, PLLC, 2365 Harrodsburg Road, Suite B235, Lexington, Kentucky 40504, this 12th day of May, 2014.

M. ALEX ROWADY, ESQ.

6. Refer to Response 5, page 12 of the Barkers' testimony . Please provide a copy of all surveys of the Barker Property undertaken for the purpose of ascertaining the precise area of the additional right of way easement.

ANSWER BY: The Barkers

Enclosed is the amended verified petition signed Dec.19 2006, accounting for the .03 acres of additional right of way. The attached amended exhibit (A) map on the following page mistakenly identifies the EKPC's electric transmission line as crossing the lands of Fred J. Farris. Whereas actually the land in exhibit (A) is the Barkers property and the KSPSZC numbers in the description are not consistent with the numbers on the map. Also attached on the following page is an e-mail from Mary Jane Warner verifying the amended verified petition to include the anchors and guy wires in the additional easement.

M. Alex Rowady

From: Mary Jane Warner [maryjane.warner@ekpc.coop]
Sent: Friday, November 10, 2006 3:27 PM
To: M. Alex Rowady
Cc: Roger Cowden; Bill Sharp; Sherman Goodpaster
Subject: RE: Harold and Ann Barker

Hi Alex -

Thank you for your quick response.

Issue #1

We will amend the Verified Petition to include the anchor and guy areas in the easement and will modify Exhibit #1 to the Verified Petition to show the offset in the easement for the guys and anchors. (P.S. - Roger looked over the case and you two may wish to discuss further for future reference, but we are willing to make this agreement regardless.)

Issue #2

We have had very limited success in assuming the responsibility for buying and planting trees to the satisfaction of property owners. We will pay the Barkers \$3000 for them to use in planting whatever they desire to replace the front yard trees, subject to the rights acquired by EKPC for the transmission line. This sum will be separate and apart from any settlement or jury verdict resulting from the transmission line easement itself, but will be the final settlement on the issue of the front yard trees only. It is very important that the Barkers understand that, consistent with the rights EKPC is acquiring, any trees planted in or around the easement area are subject to trimming or cutting should they grow to a height which would create a problem with electrical clearance or could, when in falling, contact the conductors. In the alternative, the Barkers could either use the \$3000 to plant trees away from the easement area so as not to risk the future problem, or choose trees from a list approved by EKPC. It must be understood that any tree that is deemed a danger to the line per the rights acquired by EKPC will be cut or trimmed.

Issue #3

I do not know the status of the felled trees on this property, but I will discuss with our inspector. Generally, we have no claim to the cleared trees and, pending my check and report back to you on the current status, we will leave them in place for the Barkers use.

Please respond to the Barkers as soon as you can and Roger or I will contact you on Monday to finalize this agreement.

Thank you very much for your attention to this matter.

Mary Jane

*Mary Jane Warner, P.E.
Manager, Power Delivery Expansion
East Kentucky Power Cooperative
859-745-9344
FAX 859-744-6008*

Please note my e-mail address change - maryjane.warner@ekpc.coop

-----Original Message-----

From: M. Alex Rowady [mailto:alex@blairrowadylaw.com]

Sent: Friday, November 10, 2006 2:30 PM

To: Mary Jane Warner

Subject: Harold and Ann Barker

Mary Jane: The only two issues we need to resolve are the guy wires and the trees. As for the former, there needs to be an "extention" of the easement to cover the air space between the poles and the ground and, of course, for the ground where the guy wires are anchored. As for the trees, the Barkers want EKPC to replace (at its expense) the front yard trees it intends to remove with a shorter species of the Barkers choosing. Also, the Barkers want to take possession of all trees felled (at any location on their farm) whether the wood is "merchantable" or not. Hopefully, this will clarify my clients' position for you. Thanks, Alex

11/10/2006

COMMONWEALTH OF KENTUCKY
BEFORE THE PUBLIC SERVICE COMMISSION

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PUBLIC SERVICE
COMMISSION

IN THE MATTER OF:

HAROLD BARKER; ANN BARKER
AND BROOKS BARKER

COMPLAINANTS

V.

EAST KENTUCKY POWER
COOPERATIVE, INC.

DEFENDANT

Case No. 2013-00291

DIRECT TESTIMONY OF MARY JANE WARNER, P.E.
ON BEHALF OF EAST KENTUCKY POWER COOPERATIVE, INC.

Filed: June 2, 2014

COMMONWEALTH OF KENTUCKY
CLARK CIRCUIT COURT
CIVIL ACTION NO. 06-CI-00419
DIVISION II

ENTERED 11-17-06
DAVID N. HUNT
CLARK CIRCUIT/DISTRICT
COURT
BY S.A.C. D.C.

EAST KENTUCKY POWER COOPERATIVE, INC.,
A KENTUCKY CORPORATION

PLAINTIFF

VS: AGREED INTERLOCUTORY JUDGMENT

HAROLD BARKER, et al

DEFENDANTS

Upon examining the record herein, the Court finds:

1. That all the necessary parties hereto have been duly served with summonses and/or are before the Court; that the Defendants have not questioned the right of the Plaintiff to condemn the property or the use and occupation thereof.

2. That the Report of the Commissioners conforms to the provisions of KRS 416.580 and other applicable law.

3. IT IS, THEREFORE, ORDERED AND ADJUDGED that the Plaintiff under the provisions of KRS 279.110 and KRS 416.540 through 416.680 (the Eminent Domain Act of Kentucky) has the right and is entitled to condemn the lands and materials hereinafter described, and that the Plaintiff may take possession of said lands and materials for the purpose set forth in the petition upon the payment of the amount awarded by the Commissioners, which is \$12,000.00 to the Clerk of this Court.

4. It is further ordered and adjudged that upon final determination of exceptions, or if no exceptions are taken within thirty (30) days from the entry of this Interlocutory Judgment, this Court shall enter a Final Judgment, and the Master Commissioner is appointed Special Commissioner of this Court for the sole purpose of conveying the title to the Plaintiff from the following lands and materials and for the following uses and purposes:

EXHIBIT

MJW-4

a. A certain tract of real property consisting of approximately 200 acres located approximately 5 miles east of the town of Winchester, lying on the north side of Mount Sterling Road, in Clark County, Kentucky and is more particularly described as follows:

Property #1

Beginning in the center of said Pike, corner to tract allotted to George Lewis; thence along same North 03°30' East 2123 feet to a post, corner to same; thence North 73° 00' East 98 feet to a post, corner to Ratliff; thence South 07° 14' East 18.5 feet to a fence post; thence North 72° 45' East 766.26 feet to corner to Ratliff; thence South 03° East 2455 feet to center of Mt. Sterling Pike, corner to Ratliff; thence along the center of said Pike North 84° 30' West 400 feet; thence North 87° 30' West 230 feet; thence North 84° 35' West 451.5 feet to the place of beginning, containing 50 acres, more or less.

Subject to any and all easements now of record including the existing Winchester-Mt. Sterling Road, U.S. Route 60, and applicable zoning restrictions.

Being the same property conveyed from Brooks Barnes and Elizabeth Barnes, husband and wife, to Ann Brooks Barnes Barker, a two-thirds (2/3) undivided interest, by deed dated December 28, 1973, recorded in Deed Book 212, at page 133, and of record in the Clark County Clerk's office; and being a part of the same property which Brooks Barnes and Elizabeth Barnes, his wife, conveyed an undivided one-third (1/3) interest to Ann Brooks Barnes Barker, by deed dated August 7, 1970 and of record in Deed Book 195, at page 530, also of record in the Clark County Clerk's office.

Property #2

A certain tract of land located on the north side of the Winchester-Mt. Sterling Turnpike, in Clark County, Kentucky, bounded and described as follows: Beginning at figure 11 on the map, a point in the middle of said turnpike a corner to the land sold by John Judy's heirs to George O. Graves (Williams land); thence with the middle of the pike S 88 49 E 58 poles to 12, a point in the middle of the road corner to Lot #3 in the line of Etta Clark's heirs, a stone on the north side of the road, a pointer; thence with the line of Lot #3 N 10 52 E 161.7 poles to 13 corner to Lot #3 and W. O. Brock; thence with the Brock line N 3 E 79.84 poles to 14 a stone corner on the south side of the stone fence; thence N 85 52 W 98.14 poles to the

beginning of the 85 1/2 acre tract of land conveyed by John D. Gay and wife to H. F. Judy on the east side of Cabin Creek and corner to W. O. Brock and Henry Besuden; thence with the Besuden line S 43 3 W 73.92 poles to 16 a stone corner to Mrs. Laura Williams; thence with her line S 1 E 54.32 poles to 17; thence N 73 5 E 46.44 poles to 18 a corner to Williams land; thence S 3 37 E 149.1 poles to the beginning, containing 150 acres of land, subject to all legal highways, easements and applicable zoning restrictions.

Being the same property conveyed to Brooks Barnes and Elizabeth Barnes, his wife, by Rodney Haggard, an unmarried man by deed dated January 13, 1951, and of record in Deed Book 140, page 539; of which the same property was conveyed by Brooks Barnes, et ux, an undivided 1/3 interest in same to Ann Brooks Barnes Barker, by deed dated August 7, 1970 and of record in Deed Book 195, page 530. The undivided 1/3 interest was further conveyed from Ann Brooks Barnes Barker and Harold F. Barker, her husband, back to Brooks Barnes and Elizabeth Barnes by deed dated December 28, 1973 and of record in Deed Book 212, page 130. Upon the death of Brooks Barnes and Elizabeth Barnes, the said property was then acquired by Ann Brooks Barnes Barker by virtue of the Last Will and Testament of Brooks Barnes dated June 13, 1975 and of record in Will Book 12, page 557 and the Last Will and Testament of Elizabeth Barnes dated October 26, 1993 and of record in Will Book 28, page 472; all of record in the Clark County Clerk's office.

b. It is further ordered and adjudged that Plaintiff, its successors and assigns, acquire the right to enter upon said property of the Defendant to construct, inspect, operate, repair, rebuild and maintain its electric transmission line and related facilities, including OPGW (optical ground wire) for electric utility purposes, along and upon the right-of-way herein described, together with the right of ingress and egress over said property of the Defendant while in the exercise of the rights and privileges granted herein, provided, however, that in exercising such right of ingress and egress the Plaintiff will, if reasonably accessible, confine said right of ingress and egress to the easement itself, and if not then whenever practicable to do so, use regularly established highways or farm roads.

c. Plaintiff shall also include the right to cut, fell, or otherwise control any and all trees and other vegetation and remove any structures or other obstructions, except gates and fences, located upon said easement, or any and all trees which are of such height that, in the

opinion of the Plaintiff, might come in contact with said line or system; and it is understood that all merchantable wood shall remain the property of the Defendant and will be cut in lengths specified in writing by the Defendant, except that none shall be cut shorter than eight and one-half (8-1/2) feet, with said timber and any other cuttings to be left on or alongside said easement for the use of the Defendants; however if not specified as to length as provided above, then it is to be cut in lengths determined by the Plaintiff.

d. Plaintiff shall acquire the duty to restore and repair the area affected by said easement to a reasonable condition and within a reasonable time after final completion of said construction.

e. The Plaintiff shall pay the Defendants for any and all damages that may be caused to fences, gates, crops, animals and other property, including the land not actually occupied by the poles and anchors as a result of it constructing, inspecting, repairing, operating, or rebuilding said line and related facilities, except that it is specifically understood that the Plaintiff shall not be liable for cutting or trimming trees, or otherwise controlling trees and other vegetation and removing any structures or other obstructions in the manner and to the extent hereinabove specified; and Plaintiff shall also remain liable for any damages sustained because of its negligence in the operation and maintenance of said line and related facilities.

f. The Defendants, their successors, heirs, or assigns, are free to use and enjoy the property crossed by said easement, except, however, that such use shall not conflict with any rights or privileges herein granted to the Plaintiff, and that it is specifically understood that no buildings, signs, towers, antennas, swimming pools, or any other structures, except gates and fences shall be erected, maintained or moved upon the right of way described herein, nor shall any changes in the grade be made to the lands crossed by this easement without written permission from the Cooperative; and it is further understood that all poles, wires, and other related facilities installed on the herein described property at the Cooperative's expense, shall remain the property of the Cooperative and removable at the sole option of the Plaintiff.

5. It is further ordered and adjudged that Plaintiff takes and acquires hereby a transmission line easement across the above-described property and that said transmission line and related facilities are to be constructed and located according to the plat, marked "Verified Petition Appendix B," showing the centerline of survey, distance and bearings of said line and the location and number of poles and anchors thereon, and that said plat is made by reference a part hereof to the same extent as if copied in full herein. Said specific easement right-of-way which is necessary that Plaintiff acquire over and upon said property of Defendants, the centerline of which being described as follows:

Beginning at a point between the subject land herein noted and the land of U.S. Highway 60 at Kentucky State Plane, South Zone Coordinate (hereinafter called KSP, SZC) N:2262200, E:2113466, and running thence N18°50'59"E, for a total distance of approximately 519 feet to a point in the line where line turns at KSP, SZC N:2262691, E:2113634, and running thence N17°48'03"E, for a total distance of approximately 2235 feet to a point in the line where line turns at KSP, SZC N:2264819, E:2114317, and running thence N14°54'29"E, for a total distance of approximately 1359 between the subject property and the land of Gerald Rogers at KSP, SZC N:2266132, E:2114667.

6. It is finally ordered and adjudged that the Sheriff of this county is hereby authorized and directed to evict or otherwise restrain Defendants if they attempt in any manner to keep Plaintiff from exercising its said rights after Plaintiff has complied with all costs and payments as noted in paragraph 3 herein; and said Defendants shall pay for all costs and expenses of said eviction or other related action and for which cost and expense execution shall issue. All other costs in this case shall be paid by Plaintiff.

Dated this the 16th day of November, 2006.


JUDGE, CLARK CIRCUIT COURT

SEEN AND AGREED TO BY:



ROGER R. COWDEN
Counsel for Plaintiff



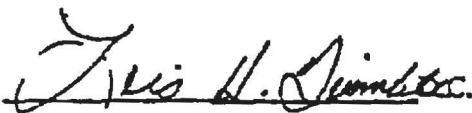
MICHAEL ALEX ROWADY
Counsel for Defendants

CIRCUIT COURT CLERK'S CERTIFICATION

 D.C.

Circuit Court Clerk, do hereby certify that a copy of this
Interlocutory Judgment was mailed to the Defendants named in this suit at the address as shown on
the subject summons on this 17th day of November 2006.

CLERK, CLARK CIRCUIT COURT

By: 

NFPA 921

Guide for Fire and Explosion Investigations

2004 Edition



NFPA, 1 Batterymarch Park, Quincy, MA 02169-7471
An International Codes and Standards Organization

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NFPA 921

Guide for

Fire and Explosion Investigations

2004 Edition

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NOTICE: An asterisk (*) following the number or letter designating a paragraph indicates that explanatory material on the paragraph can be found in Annex A.

Changes other than editorial are indicated by a vertical rule beside the paragraph, table, or figure in which the change occurred. These rules are included as an aid to the user in identifying changes from the previous edition. Where one or more complete paragraphs have been deleted, the deletion is indicated by a bullet (•) between the paragraphs that remain.

A reference in brackets [] following a section or paragraph indicates material that has been extracted from another NFPA document. As an aid to the user, Annex C lists the complete title and edition of the source documents for both mandatory and nonmandatory extracts. Editorial changes to extracted material consist of revising references to an appropriate division in this document or the inclusion of the document number with the division number when the reference is to the original document. Requests for interpretations or revisions of extracted text should be sent to the technical committee responsible for the source document.

Information on referenced publications can be found in Chapter 2 and Annex C.

Chapter 1 Administration

1.1 Scope. This document is designed to assist individuals who are charged with the responsibility of investigating and analyzing fire and explosion incidents and rendering opinions as to the origin, cause, responsibility, or prevention of such incidents.

1.2 Purpose.

1.2.1 The purpose of this document is to establish guidelines and recommendations for the safe and systematic investigation or analysis of fire and explosion incidents. Fire investigation or analysis and the accurate listing of causes is fundamental to the protection of lives and property from the threat of hostile fire or explosions. It is through an efficient and accurate determination of the cause and responsibility that future fire incidents can be avoided. This document has been developed as a model for the advancement and practice of fire and explosion investigation, fire science, technology, and methodology.

1.2.2 Proper determination of fire origin and cause is also essential for the meaningful compilation of fire statistics. Accurate statistics form part of the basis of fire prevention codes, standards, and training.

1.3 Application. This document is designed to produce a systematic, working framework or outline by which effective fire and explosion investigation and origin and cause analysis can be accomplished. It contains specific procedures to assist in the investigation of fires and explosions. These procedures represent the judgment developed from the NFPA consensus process system, that if followed can improve the probability of reaching sound conclusions. Deviations from these procedures, however, are not necessarily wrong or inferior but need to be justified.

1.3.1 The reader should note that frequently the phrase *fire investigation* is used in this document when the context indicates that the relevant text refers to the investigation of both fires and explosions.

1.3.2 As every fire and explosion incident is in some way different and unique from any other, this document is not designed to encompass all the necessary components of a complete investigation or analysis of any one case.

1.3.3 Not every portion of this document may be applicable to every fire or explosion incident. It is up to investigators (depending on their responsibility, as well as the purpose and scope of their investigation) to apply the appropriate recommended procedures in this guide to a particular incident.

1.3.4 In addition, it is recognized that time and resource limitations or existing policies may limit the degree to which the recommendations in this document will be applied in a given investigation. This document has been developed as a model for the advancement and practice of fire and explosion investigation, fire science, technology, and methodology.

1.4* Units of Measure. Metric units of measurement in this guide are in accordance with the modernized metric system known as the International System of Units (SI). The unit of liter is outside of but recognized by SI and is commonly used in international fire protection. These units are listed in Table 1.4.

Table 1.4 SI Units and Equivalent U.S. Customary Units

SI	U.S.
2.54 cm	1 in.
0.3048 m	1 ft
0.09290 m ²	1 ft ²
28.32 L	1 ft ³
0.02832 m ³	1 ft ³
3.785 L	1 U.S. gal
0.4536 kg	1 lb
28.35 g	1 oz (weight)
0.3048 m/s	1 ft/s
16.02 kg/m ³	1 lb/ft ³
0.06308 L/s	1 gpm
Pressure exerted by 760 millimeters of mercury of standard density at 0°C, 14.7 lb/in. ² (101.3 kPa).	1 atmosphere
1.055 kW	1 Btu/s
1055 J	1 Btu
0.949 Btu/s	1 kW
248.8 Pa = 0.036 psi	1 in. w.c.
1 atmosphere	27.7 in. w.c.

2004 Edition

COMMONWEALTH OF KENTUCKY
BEFORE THE PUBLIC SERVICE COMMISSION

IN THE MATTER OF:

**HAROLD BARKER; ANN BARKER
AND BROOKS BARKER**

COMPLAINANTS

V.

**EAST KENTUCKY POWER
COOPERATIVE, INC.**

DEFENDANT

Case No. 2013-00291

**DIRECT TESTIMONY OF PAUL A. DOLLOFF, Ph.D.
ON BEHALF OF EAST KENTUCKY POWER COOPERATIVE, INC.**

Filed: June 2, 2014

**EKPC
Exhibit**

7

Jurisdiction/Agency	Electric Field Standard		Magnetic Field Standard	
	On ROW	Edge of ROW	On ROW	Edge of ROW
United States	NONE	NONE	NONE	NONE
Kentucky	NONE	NONE	NONE	NONE
Rural Utilities Service	NONE	NONE	NONE	NONE
California ¹	NONE	1.6 kV/m	NONE	NONE
Florida ²	8 kV/m ^a 10 kV/m ^b	2 kV/m	NONE	150 mG ^a (max. load) 200 mG ^b (max. Load) 250 mG ^c (max. Load)
Minnesota	8 kV/m	NONE	NONE	NONE
Montana	7 kV/m ^d 2.5 to 3.5 kV/m ^{1,g}	1 kV/m ^e	NONE	NONE
New Jersey	NONE	3 kV/m	NONE	NONE
New York	11.8 kV/m 11.0 kV/m ^f 7.0 kV/m ^d	1.6 kV/m	NONE	200 mG (max. load) ^h
North Dakota ¹	NONE	9 kV/m	NONE	NONE
Oregon	9 kV/m	7 kV/m ^{1,d}	NONE	NONE
OBSERVED MEASURES ⁵	1.1 kV/m	0.9 kV/m	10.7 mG	4.2 mG
OBSERVED MEASURES	0.997 kV/m ³	0.621 kV/m ³	61.4 mG ⁴	23.6 mG ⁴
EKPC MODELED MEASURES	1.515 kV/m ³	1.167 kV/m ³	70.847 mG ⁴	30.931 mG ⁴

¹Not included in the EMF RAPID Program Booklet

²In the Florida, the standard applies to certain additional areas adjoining the ROW

³Taken during and modeled with 351.9kV on the 345kV line; 71.0kV (estimated) on the 69kV line

⁴Taken during and modeled with 868.7 amps on the 345kV line; 58.7.0 amps (estimated) on the 69kV line

⁵Measurements taken by independent consultant, Dr. Benjamin Cotts

^aFor lines of 69-230 kV

^bFor 500 kV lines

^cFor 500 kV lines on certain existing ROW

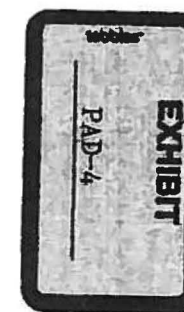
^dMaximum for highway crossings

^eMay be waived by landowner

^fMaximum for private road crossings

^gIn areas such as parking lots

^hFor lines over 125 kV and more than 1 mile in length¹



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Central Minnesota Municipal Power Agency
Dairyland Power Cooperative
Great River Energy
Minnesota Power
Minnkota Power Cooperative
Missouri River Energy Services
Otter Tail Power Company
Rochester Public Utilities
Southern Minnesota Municipal Power Agency
WPPI Energy
Xcel Energy

Electric and Magnetic Fields (EMF): the Basics

Electric charges are present in all matter, but most objects are electrically neutral because positive and negative charges are present in equal numbers. When the balance of electric charges is altered, electrical effects are experienced, such as the attraction between a comb and our hair or the drawing of sparks after walking on a synthetic rug in the wintertime. The voltage on an electrical wire is caused by electric charges that can exert forces on other nearby charges, and this force is called an 'electric field' (E). When charges move they produce an electric current that can exert forces on other electric currents, and this force between electric currents is called a 'magnetic field' (M).

EMF exists wherever electricity is produced or used, and EMF surrounds any electrical appliance or wire that is conducting electricity. Everyone is exposed to these fields at home when you turn on a lamp, e-mail a friend, or use an electric oven or microwave to cook your dinner. In all likelihood, you're surrounded by EMF from electrical equipment in your workplace, too.

The electric power we use daily is a 60-Hertz (Hz) alternating current, meaning that electric charges move back and forth 60 times a second. We use 'EMF' in this fact sheet in reference to these 60 Hz fields, called 'extremely low frequency' or 'power frequency' fields, which are distinct from the much higher frequency fields associated with radio and TV waves, and cell phone signals.

What are electric and magnetic fields?

Electric fields are created by voltage – the higher the voltage, the stronger the field. Anytime an electrical appliance is plugged in, even if it isn't on, an electric field is created in its vicinity. But these fields are easily blocked by walls, trees, and even your clothes and skin, and the farther away you move from the source of the electric field, the weaker it becomes. Moving even a few feet away from an appliance makes a big difference in the strength of the field that you're exposed to. Electric fields are measured in kilovolts per meter (kV/m).

Magnetic fields, measured in milliGauss (mG), are produced by electric current and only exist when an electric appliance is turned on – the higher the current, the greater the magnetic field. As with electric fields, the strength of a magnetic field dissipates rapidly as you move away from its source. However, unlike electric fields that are easily blocked by ordinary materi-

als, magnetic fields do not interact with and are not affected by walls and clothes and other barriers.

Research studies on the biological effects of EMF often focus on magnetic fields because they are not blocked by ordinary materials and because power line magnetic fields can create weak electric currents in the body by a process called 'induction'. Induced currents from 60 Hz EMF are weaker than the natural currents found in the body, such as those from the electrical activity generated by your brain or your heart. Such induced currents are also much weaker than the currents you might experience from a mild electric shock.

Why are you calling them electric and magnetic fields instead of electromagnetic fields? Is there a difference?

These terms are often used interchangeably, and both electric and magnetic fields from power lines and electromagnetic fields may be abbreviated as EMF. However, there are important differences between power line EMF and radio waves.

The frequency (i.e., the rate of time variation) of fields produced by the generation, transmission and use of electricity – typical of most household and office appliances and power lines – are low, and electric and magnetic fields exist separately. At higher frequencies, such as with radio or TV signals, the fields are interrelated, and are more accurately described by the term 'electromagnetic'.

Radio and TV electromagnetic waves are meant to transmit away from the antenna and carry radio frequency energy to the receiver. The EMF from power lines is too low in frequency to carry energy away, and the electric power stays on the utility lines.

Thus, the EMF from power lines should not be called radiation or emissions. More importantly, neither power line EMF nor radio electromagnetic waves should be confused with ionizing radiation, such as X-rays. Because of its dramatically higher frequency, ionizing radiation (like X-rays) has enough energy to alter chemical bonds and damage biological molecules, something that lower frequencies in the electromagnetic spectrum (power lines, radio, TV, microwaves, infrared) cannot do.

What are some of the things in my home and at work that produce EMF?

Anything that generates, distributes or uses electricity creates electric and magnetic fields. Below is a list of some appliances and machines commonly found in homes or offices and the magnetic field levels found nearby.

Figure 1. Typical 60 Hz magnetic field levels from some common home appliances

	Magnetic field 6 inches from appliance (mG)	Magnetic field 2 feet away (mG)
Electric shaver	100	-
Vacuum cleaner	300	10
Electric oven	9	-
Dishwasher	20	4
Microwave oven	200	10
Hair dryer	300	-
Computers	14	2
Fluorescent lights	40	2
Faxogram machines	6	-
Copy machines	90	7
Garbage disposals	80	2

Source: National Institute of Environmental Health Services / National Institutes of Health: EMF Associated with the Use of Electric Power

We also encounter a wide variety of EMF in other ways – natural and man-made. The earth's atmosphere creates slowly varying electric fields, and thunderstorms produce very intense electric fields that are occasionally discharged by a lightning bolt. The earth's core produces a steady magnetic field, as can easily be demonstrated with a compass needle. This magnetic field has a strength of about 550 mG, and this knowledge provides a perspective on the size of the magnetic fields produced by an electric transmission line.

Magnetic fields from the earth or from small magnets exert forces on electric currents or on other magnetic objects, as when a compass needle orients toward a magnet. Magnetic fields are common in our lives. Many children's toys contain magnets and many of us use refrigerator magnets, generating fields of about 100,000 to 500,000 mG. An increasingly common diagnostic procedure, magnetic resonance imaging (MRI), uses fields of about 20,000,000 mG. If you were to

spin a magnet at a rate of 60 times a second, you would get an alternating magnetic field like the fields produced by power lines.

How can I find out what EMF levels I'm exposed to at home and at work?

You can monitor your daily exposure to magnetic fields by wearing a personal exposure meter (called a magnetometer or gaussmeter) or by keeping one close to you. This is the most accurate way to measure your true exposure to magnetic fields during the course of your normal activities. Other meters can be put in a location – like your kitchen or home office – to measure typical EMF levels in that spot. This type of measurement isn't an accurate measure of personal exposure, however, because it doesn't take into account your distance from the source of the fields or the amount of time you might spend in that place.

Contact your local electric service provider. Most utilities offer a free measurement service to customers for their homes or businesses.

What are 'typical' residential exposures to magnetic fields?

Exposure levels vary from individual to individual and from home to home, but a study by the Electric Power Research Institute (EPRI) puts the background levels of power line magnetic fields in the typical U.S. home at between 0.5 mG and 4 mG with an average of 0.9 mG. Levels rise the closer you get to the source of the field. Most people are exposed to greater magnetic fields at work than in their homes. See Figure 1.

What EMF levels are found near transmission lines?

All transmission lines produce EMF. The fields are the strongest directly under the lines and drop dramatically the farther away you move. Contact your local utility to find out EMF information about a particular transmission line near you. See Figures 2a-c.

Figure 2a. Typical EMF Levels for a 161-kV Transmission Line

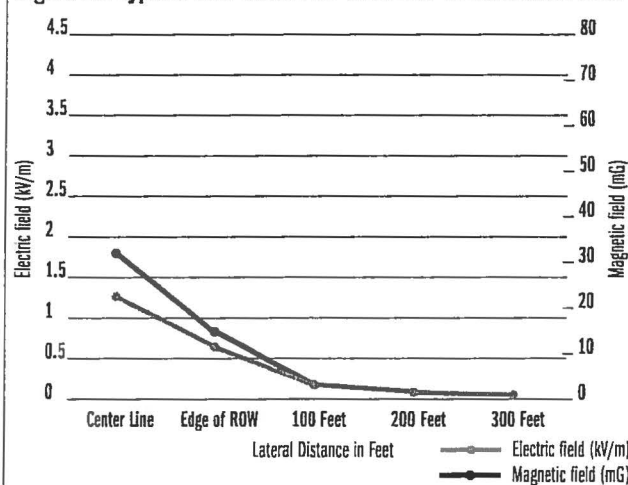


Figure 2b. Typical EMF Levels for a 230-kV Transmission Line

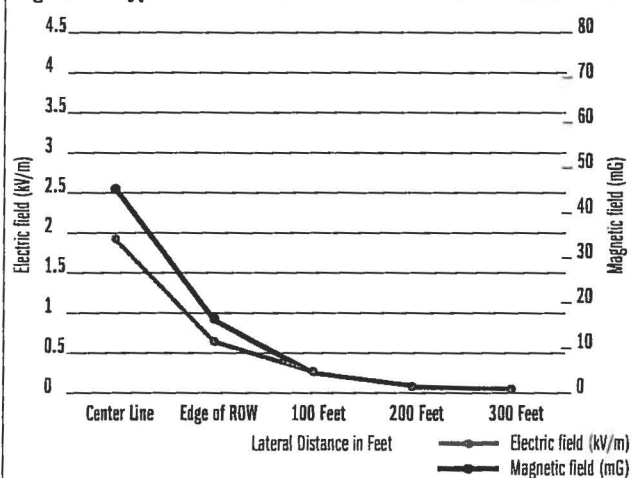
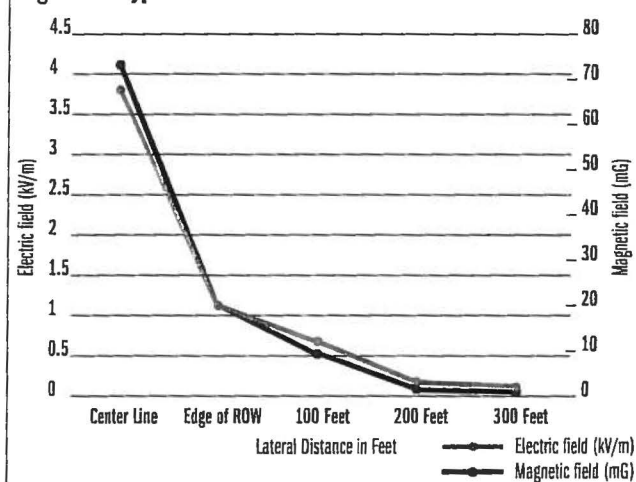


Figure 2c. Typical EMF Levels for a 345-kV Transmission Line



Source: CapX 2020 Certificate of Need application to the Minnesota Public Utilities Commission for three 345-kV transmission line projects (8/16/2007, MPUC Docket No. ET02, E-002/CN-06-1115)

Do underground lines reduce EMF levels?

Because magnetic fields are unaffected by ordinary materials, burying power lines won't keep the fields from passing through the ground. Additionally, underground lines can produce higher levels of magnetic fields directly above them at ground level because these lines are located closer to you than overhead lines, although the strength of the magnetic field from underground lines falls away more quickly with distance than from overhead lines. But, compared to overhead lines, underground lines are significantly more expensive to install, more difficult to repair and can have greater environmental impacts. Since current research results provide no conclusive connection

between EMF exposure and health effects, burying lines isn't a reasonable alternative.

Are there state or federal standards for EMF exposure?

There are no federal standards limiting residential or occupational EMF exposure. The EMF levels produced by appliances vary from manufacturer to manufacturer and model to model. The designs of many newer model appliances, in general, often produce lower fields than older models. There is no federal certification program on EMF levels so beware of advertisements on appliances making claims of federal government certification of low or zero EMF levels.

Do exposures to power line EMF affect my health?

This issue has been studied for more than 30 years by government and scientific institutions all over the world. The balance of scientific evidence indicates that exposure to EMF does not cause disease. (See the **Sources and useful links** section of this fact sheet for more information on studies about EMF and health.)

In 2002 the Minnesota Department of Health released "A White Paper on Electric and Magnetic Field Policy and Mitigation Options." Regarding the links between EMF and health effects, the report states:

"The Minnesota Department of Health concludes that the current body of evidence is insufficient to establish a cause and effect relationship between EMF and adverse health effects." (page 36)

- The entire 2002 report is available at www.capx2020.com/documents.html.

Does EMF interfere with pacemakers or other medical devices?

High levels of power line EMF can interfere with a pacemaker's ability to sense normal electrical activity in the heart. Most often, the electric circuitry in a pacemaker might detect the interference of an external field and direct the pacemaker to fire in a regular, life-preserving mode. This isn't considered hazardous and is actually a life-preserving default feature. There have been cases with dual-chamber pacemakers triggering inappropriate pacing before the life-preserving mode takes over.

The American Conference of Governmental Industrial Hygienists (ACGIH) issued guidelines for EMF exposure for workers with pacemakers or implantable defibrillators. Maximum safe exposure for workers with these medical devices at 60 Hz (the frequency of most transmission lines) is 1 G (1,000 mG) for magnetic fields and 1 kV/m for electric fields.

Nonelectronic metallic implants (artificial limbs, screws, pins, etc.) can be affected by high magnetic fields like those produced by MRI devices but are generally unaffected by the lower magnetic fields produced by most sources.

How can I reduce my exposure to EMF?

If you wish to reduce EMF levels in your vicinity you can do so by recognizing that your exposure is determined by the strength of the magnetic fields given off by things around you, your distance from the source of the field and how much time you spend in the field.

Creating distance between yourself and the sources of EMF is the easiest way to reduce exposure. Standing back – even an arm's length away – from appliances that are in use is a simple first step. Remember, EMF decreases dramatically with distance. This is more feasible with some appliances than with others, but the following simple recommendations will help you reduce your EMF exposure at home:

- Move motor-driven electric clocks or other electrical devices away from your bed.
- Be aware that electric motors change electricity into mechanical energy by using magnetic fields, so any motorized appliance (e.g., hairdryers, shavers, fans, vacuum cleaners, air conditioners) will produce magnetic fields.
- Stand away from operating appliances that use a lot of electricity.
- Sit a few feet away from the TV and at least an arm's length from the computer screen. Liquid crystal or plasma displays (LCDs), however, produce very low levels of EMF compared to the older cathode-ray tube (CRT) displays.
- Limit the time you're exposed to a magnetic field by turning appliances, like computer monitors, off when you're not using them.

Sources and useful links

The following are links to more information and studies on EMF:

- The National Institute of Environmental Health Services (NIEHS) offers information on a variety of EMF topics. In June of 2002 they prepared *EMF: Electric and Magnetic Fields Associated with the Use of Electric Power, Questions and Answers*. This booklet, along with other helpful links, can be found at www.niehs.nih.gov/health/topics/agents/emf/.
- "A White Paper on Electric and Magnetic Field Policy and Mitigation Options," prepared by the Minnesota Interagency Working Group on EMF Issues. www.capx2020.com/documents.html
- Electric and Magnetic Fields: Facts, Western Area Power Administration. www.wapa.gov/newsroom/pdf/emfbook.pdf
- "Electromagnetic fields and public health," World Health Organization fact sheet, www.who.int/mediacentre/factsheets/fs322/en/index.html. More general information on EMF can be found at www.who.int/peh-emf/en/.
- "Unproven Risks – Non-Ionizing Radiation" (2008), The American Cancer Society. www.cancer.org/docroot/NWS/content/NWS_2_1x_The_Environment_and_Cancer_Risk.asp

COMMONWEALTH OF KENTUCKY
BEFORE THE PUBLIC SERVICE COMMISSION

In the Matter of:

HAROLD BARKER, ANN BARKER, AND BROOKS BARKER)	
)	
)	
COMPLAINANTS)	
V.)	CASE NO.
)	2013-00291
EAST KENTUCKY POWER COOPERATIVE, INC.)	
)	
DEFENDANT)	

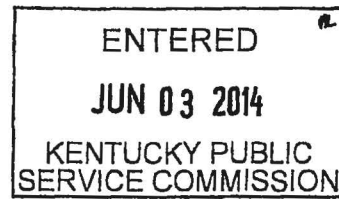
ORDER

Prior to the commencement of this action, Complainants Harold Barker, Ann Barker, and Brooks Barker ("Complainants") contacted Commission Staff regarding alleged issues with the placement of an electric transmission line, which this dispute centers on. Accordingly, on July 9, 2013, Commission Staff conducted a field visit at Complainants' property. The site visit was memorialized in a July 11, 2013 memorandum attached as an Appendix to this Order. On May 27, 2013, Defendant East Kentucky Power Cooperative, Inc. ("EKPC") submitted a letter wherein it requested information regarding the site visit as well as production of any report prepared consequent to the site visit.

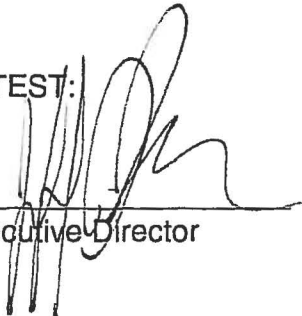
The Commission finds that EKPC's request should be granted and the July 11, 2013 site visit report should be made a part of the record in the instant proceeding.

IT IS THEREFORE ORDERED that Defendant's request to make the site visit report a part of this record is granted.

By the Commission



ATTEST:


Executive Director

Case No. 2013-00291

APPENDIX

APPENDIX TO AN ORDER OF THE KENTUCKY PUBLIC SERVICE
COMMISSION IN CASE NO. 2013-00291 DATED **JUN 03 2014**

**KENTUCKY PUBLIC SERVICE COMMISSION
INTRA-AGENCY MEMORANDUM**

TO: Jeff Derouen, Executive Director

THRU: Kyle Willard, Director of Engineering *7/12*
Eric Bowman, Elec & Comm. Engineering Branch Manager

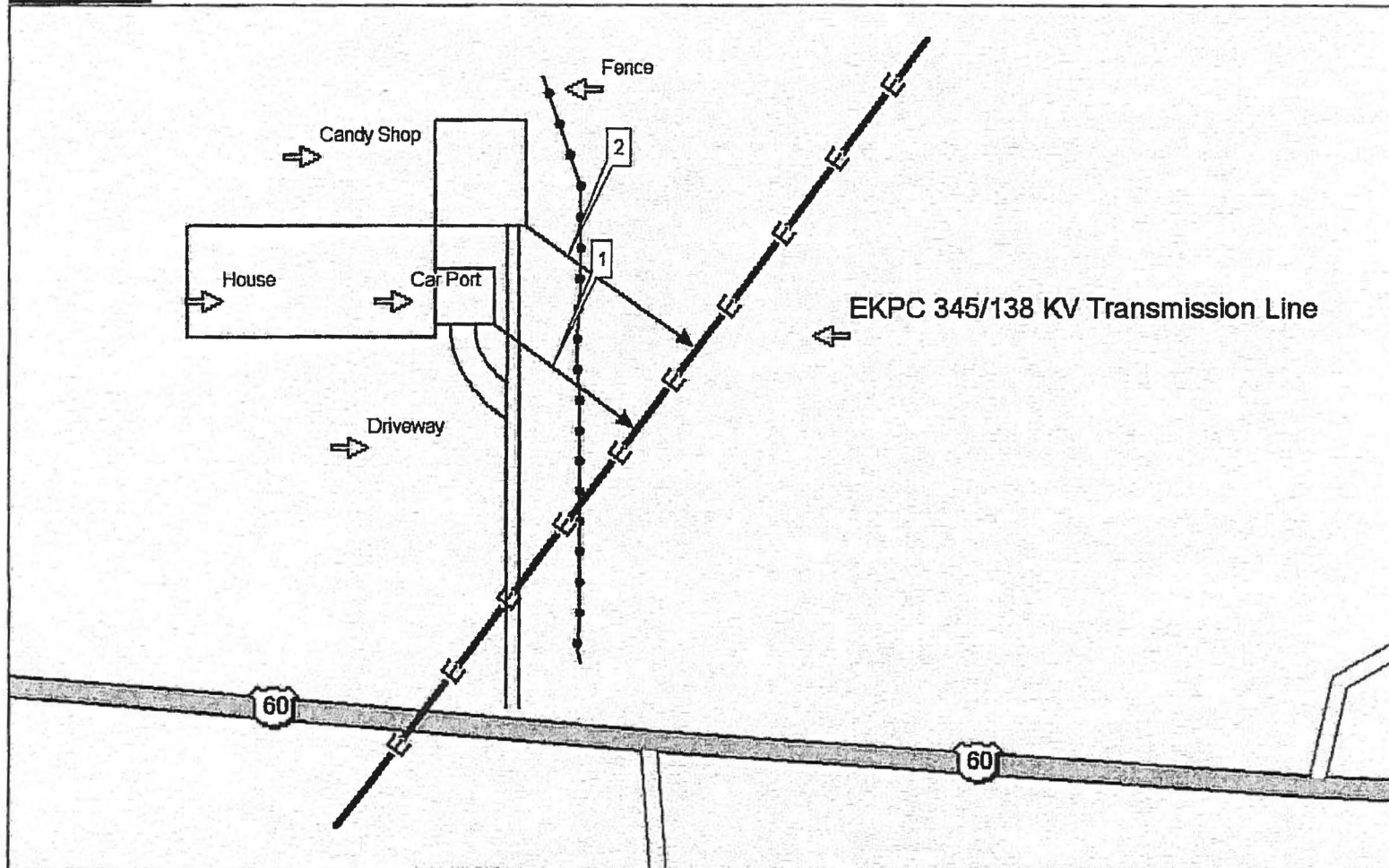
FROM: Jeff Moore, Electric Branch Investigator *JA*
James Rice, Assistant Director of Engineering *JWR*

DATE: July 11, 2013

RE: Site Visit to Winchester (Barker Property)

A site visit to the Barker's property located at 5450 Mount Sterling Road, Winchester, KY was conducted on 7/9/13. Jeff Moore, James Rice, Ann Barker, Harold Barker and Brooks Barker were present during the visit. As directed, measurements were taken from the centerline ("CL") of the existing transmission line to various points of the structures located on the Barker property. The following measurements are referenced by number on the attached map. It should be noted that the following measurements were taken via a tape measure and line of site. The measurements are approximate at best and should only be used for reference only. Also attached to this memo are pictures taken during the site visit showing the transmission line and the Barker structures. During the site visit no clearance issues were observed between the Barker structures and the transmission line.

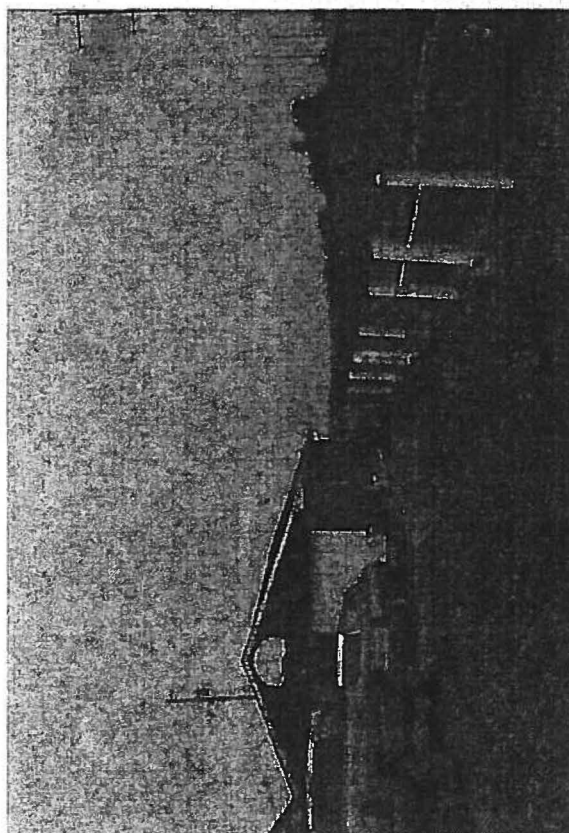
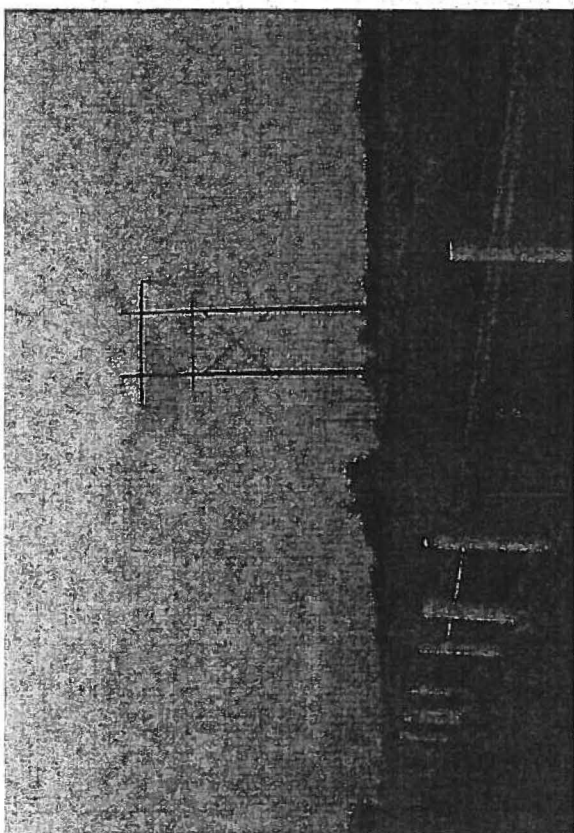
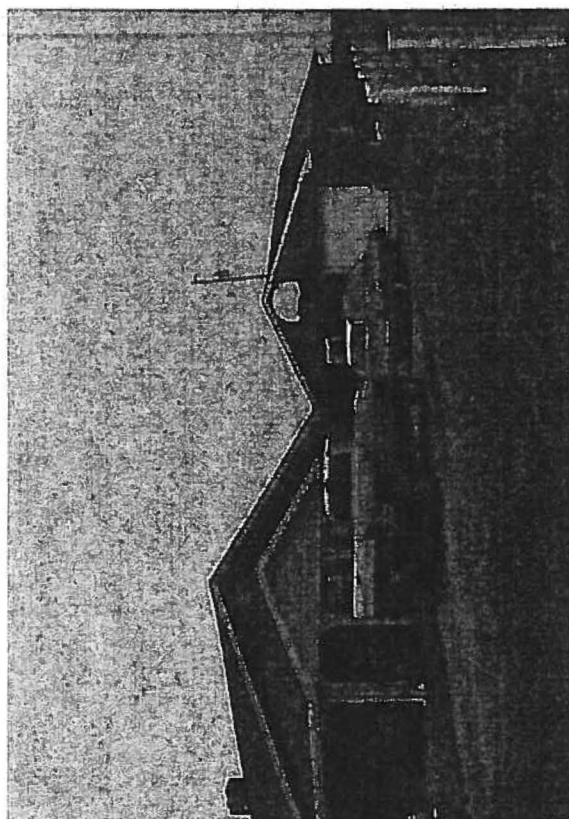
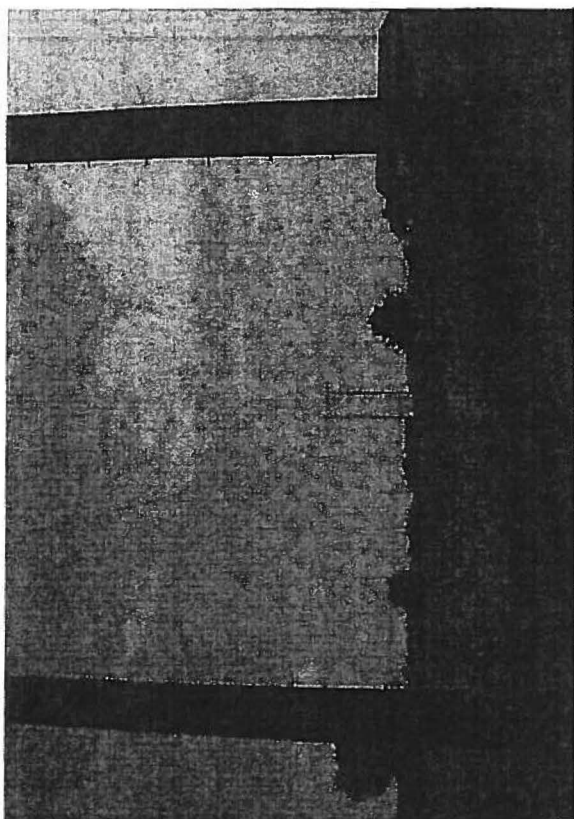
Description	Approximate Distance
1. CL to front corner of car port	75 ft.
2. CL to front corner of candy shop	77 ft.



Data use subject to license.

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Harold, Ann & Brooks Barker
5450 Mt. Sterling Road
Winchester, KENTUCKY 40391

Anthony S Campbell
President & CEO
East Kentucky Power Cooperative, Inc.
4775 Lexington Road
P. O. Box 707
Winchester, KY 40392-0707

Honorable M. Alex Rowady
Attorney at Law
Blair & Rowady P.S.C.
212 South Maple Street
Winchester, KENTUCKY 40391

David S Samford
Goss Samford, PLLC
2365 Harrodsburg Road, Suite B325
Lexington, KENTUCKY 40504

Shawn E. Abrell, WSB No. 41054, *Pro Hac Vice*
4614 SW Kelly Avenue, Suite 200, Portland, Oregon 97239
Tel.: 971.258.0333; Fax: 503.222.0693
E-Mail: shawn.e.abrell@gmail.com
Lead Counsel for Plaintiffs

Tyl W. Bakker, OSB No. 90200
621 SW Alder, Suite 621, Portland, Oregon 97205
Tel.: 503.244.4157; Fax: 503.220.1913
E-Mail: tylbakker@gmail.com
Local Counsel for Plaintiffs

United States District Court

District of Oregon

Portland Division

AHM, by and through
her Guardian *ad litem* and father,
David Mark Morrison, and
David Mark Morrison, individually,

v.

Portland Public Schools,

Defendant.

Civil Action No. 3:11-cv-00739-MO

**Amended Declaration of
Dr. David O. Carpenter, M.D.**

I, Dr. David O. Carpenter, M.D., under penalty of perjury pursuant to 28 U.S.C. § 1746,
hereby make the following declaration in support of an injunction against Portland Public Schools'
use of WI-FI:

1. I am a public health physician, educated at Harvard Medical School. My current title is Director of the Institute for Health and the Environment at the University at Albany and Professor of Environmental Health Sciences within the School of Public Health. Formerly, I was the Dean of the School of Public Health at the University of Albany and the Director of the Wadsworth Center for Laboratories and Research of the New York State Department of Health.

2. I served as the Executive Secretary to the New York State Powerlines Project in the 1980s, a program of research that showed children living in homes with elevated magnetic fields coming from powerlines suffered from an elevated risk of developing leukemia. After this I became the spokesperson on electromagnetic field (EMF) issues for the state during the time of my employment in the Department of Health. I have published several reviews on the subject and have edited two books.

3. I am a Co-Editor and a Contributing Author of the *BioInitiative: A Rationale for a Biologically-based Public Exposure Standard for Electromagnetic Fields (ELF and RF)*, www.bioinitiative.org. It documents bioeffects, adverse health effects and public health conclusions about impacts of electromagnetic radiation (electromagnetic fields including extremely-low frequency ELF-EMF and radiofrequency /microwave or RF-EMF fields). The public health chapter from this report was subsequently published in a peer-reviewed journal.

4. Additionally, I am a Co-Author of *Setting Prudent Public Health Policy for Electromagnetic Field Exposures*, *Reviews on Environmental Health*, Volume 23, No 2, 2008, attached as Addendum A-2.

5. In addition, in 2009, I was invited to present to the President's Cancer Panel on the subject of powerline and radiofrequency fields and cancer, and have testified on this issue before the United States House of Representatives.

6. In sum, I am a public health physician, professor and former public health school Dean with expertise in electrophysiology, low-frequency electromagnetic fields bioeffects, and

radiofrequency (RF) and microwave (MW) radiation bioeffects.

7. WI-FI deploys pulse-modulated (“PM”) microwave (“MW”) radiation (within the larger RF radiation spectrum) with a carrier frequency that is similar to that used by a microwave oven: about 2.45 GHz. This is the “Agent”. The 2.45 GHz frequency was chosen for the oven because of its wavelength and harmonic resonance with the water molecule, to ensure the most efficient absorption by living tissues and effective heating by way of the agitation of water at the molecular level. The pulse-modulation of a wave with lower frequencies in addition to the high-frequency carrier signal, increases the exposure complexity and in turn the bioeffects in an exposed population.

8. In the context of school development, WI-FI exposes building occupants including children and adults constantly from both computers and infrastructure antennas. Duration may be an even more potent contributing factor to RF/MW radiation bioeffects than exposure levels. Chronic, such as all-day, school exposure, is more likely than short and intermittent exposure, such as cell phone use, to produce harmful health effects, and is likely to do so at lower exposure levels.

9. Persons stationed close to school computers with WI-FI and especially those very near to any WI-FI infrastructure will receive considerably higher exposure than do others.

10. It is generally accepted within the relevant scientific community and has been established beyond any reasonable doubt that adverse human health effects occur at far lower levels of RF/MW radiation exposure than those that cause noticeable heating, particularly where the wavelength approaches body-part size and thus maximizes absorption, where the wavelength has resonance with the water molecule, where there is more complex, modulated wave, where there is chronic exposure duration, and where exposed persons lack the capacity voluntarily to remove themselves from radiation sources.

11. Some effects are shown to occur at several hundred thousand times below the FCC public exposure guidelines, which are set based on the fallacious assumption that there are no adverse health effects at exposures that do not cause easily measureable heating. FCC guidelines

also only apply to 30-minute public exposures; therefore do not even infer safety at durations >30 minutes, such as in a school setting.

12. Exposure to high-frequency RF and MW radiation and also the extreme low frequency (ELF) EM fields that accompany WI-FI exposure have been linked to a variety of adverse health outcomes. Some of the many adverse effects reported to be associated with and/or caused by ELF fields and/or RF/MW radiation include neurologic, endocrine, immune, cardiac, reproductive and other effects, including cancers.

13. Studies of isolated cells have shown that RF/MW exposures may cause changes in cell membrane function, cell communication, metabolism, activation of proto-oncogenes, and can trigger the production of stress proteins at exposure levels below FCC guidelines and also at and less than school WI-FI exposure levels and parameters. Resulting effects in cellular studies include without limitation DNA breaks and chromosome aberrations, cell death including death of brain neurons, increased free radical production, activation of the endogenous opioid system, cell stress and premature aging.

14. Human studies of comparable RF/MW radiation parameters show changes in brain function including memory loss, retarded learning, performance impairment in children, headaches and neurodegenerative conditions, melatonin suppression and sleep disorders, fatigue, hormonal imbalances, immune dysregulation such as allergic and inflammatory responses, cardiac and blood pressure problems, genotoxic effects like miscarriage, cancers such as childhood leukemia, childhood and adult brain tumors, and more.

15. There is consistent evidence for increased incidence of effects in individuals who live near to high-power short-wave, AM, FM and TV transmission towers. This is particularly relevant because, like WI-FI, radio-TV transmission towers give continuous, whole-body radiation, not just radiation to the head, constantly.

16. Since WI-FI transmitters, both infrastructural and on computers, are indoors, where children and teachers may be very close by, and since WI-FI, at 2.45 GHz, deploys a

wavelength, at ~12.2 cm or ~ 4.8 inches, more absorbable by children's and adults' bodies and brains than radio-TV wavelengths, the harmfulness of WI-FI radiation likely exceeds that of radio-TV towers.

17. Like second-hand smoke, EMF and RF/MW radiation involve complex mixtures, where different frequencies, intensities, durations of exposure(s), modulation, waveform and other factors are known to produce variable effects, often more harmful with greater complexity. Decades of scientific study have produced substantial evidence that EMF and RF/MW radiation may be considered neurotoxic, carcinogenic and genotoxic. Sources of fields and radiation, but are not limited to: power lines, navigational radar, cell phones, cordless phones [or Digitally Encoded Cordless Transmission Devices (D.E.C.T.) phones], cell towers, 'smart' meters and their grids or infrastructure, "smart" boards, meters and grids, WiMax and wireless internet (WI-FI).

18. The RF/MW radiation and low-frequency EMF science that currently exists includes tens of thousands of studies dating back to the 1920s. On the basis of this vast body of literature, many public health experts believe, myself included, that it is likely society will face epidemics of neurotoxic effects and degeneration, cancers and genotoxicity in the future, resulting from the extreme and mostly involuntary exposure to RF/MW radiation and EMFs. WI-FI radiation in schools exceeds natural background levels of microwave radiation by trillions of times. Thus, it is important that all of us restrict our use of cell phones, and be as free as possible from exposure to unnatural, background sources of MW radiation, particularly WI-FI.

19. In public health science, it is generally accepted fact that vulnerable subgroups exist within any human population. This is also recognized specifically for RF/MW radiation and fields. These groups include children, pregnant women, the elderly and those with preexisting illnesses and/or impairments. Children are more vulnerable to RF/MW radiation because of the susceptibility of their developing nervous systems. RF/MW penetration is greater relative to head size in children, who have a greater absorption of RF/MW energy in the tissues of the head at WI-FI frequencies.

Such greater absorption results because children's skulls are thinner, their brains smaller, and their brain tissue is more conductive than those of adults, and since it has a higher water content and ion concentrations. The Presidential Cancer Panel found that children 'are at special risk due to their smaller body mass and rapid physical development, both of which magnify their vulnerability to known carcinogens, including radiation.'

http://deainfo.nci.nih.gov/advisory/pcp/annualReports/pcp08-09rpt/PCP_Report_08-09_508.pdf

20. FCC public RF/MW radiation exposure guidelines are based on the height, weight and stature of a 6-foot tall man, not children or adults of smaller stature. The guidelines do not take into account the unique susceptibility of growing children to exposures. Since children are growing, their rate of cellular activity and division is more rapid, and they are at more risk for DNA damage and subsequent cancers. Growth and development of the central nervous system is still occurring well into the teenage years, such that the neurological impairments predictable by the extant science may have great impact upon development, cognition, learning, and behavior. Prenatal exposure has been identified as a risk factor for childhood leukemia, and is associated with miscarriage. Children are largely unable to remove themselves from exposures to harmful substances in their environments. Their exposure is involuntary.

21. When WI-FI is in operation in a school, children and their parents have no choice but to allow the school to expose them to trillions of times higher microwave radiation than exists naturally on Earth at the same frequencies. Children and other building users are exposed to as much as 30-40 hours per week of constant, digitally encoded WI-FI signals from each wireless device and infrastructural antenna in a school building. Based upon a review of the Mount Tabor WI-FI Floor Plan, a given child is subject to direct signals from multiple WI-FI transmitters, including rooms full of students and teachers transmitting numerous laptop and other wireless signals. There is a major legal difference between an exposure that an individual chooses to accept and one that is forced upon a person, especially a dependent, who can do nothing about it.

22. WI-FI in the Portland Schools deploys similar PM MW radiation, at 2.45 and 5 GHz, to that of cell and cordless phones and their infrastructure. There is clear and strong evidence that intensive use of cell phones increases incidence of brain cancer, tumors of the auditory nerve, and cancer of the parotid gland, the salivary gland in the cheek by the ear. Cell and cordless phone radiation closely resembles that of WI-FI radiation exposure, except that WI-FI is more hazardous by way of frequency, duration, and the involuntary nature of exposure. While a cell or cordless phone is used only intermittently and primarily voluntarily, a WI-FI radiation microenvironment is constant in duration, with unavoidable radiation exposure even when nearby students are not actively using it. Because WI-FI radiation is essentially the same as, but more hazardous than, that for cell and cordless phones, there is every reason to understand that the health effects will be the same or worse, varying in relation to the total dose of radiation, and intensified by the constancy of duration. There is evidence from Scandinavian studies of cell phone usage that children who use cell phones are about five times more likely to develop brain cancer than if their usage starts as an adult. Thus, it is especially necessary to protect children from pulse-modulated MW radiation such as both cell phones and WI-FI deploy.

23. Based on a high degree of scientific certainty, Portland Public Schools' use of WI-FI is causing and will continue to cause AHM, other students, and school staff and faculty adverse health effects, and should be discontinued immediately. Educating by way of the Internet via cabled systems only decreases MW radiation exposure and is of minimal expense.

24. Having reviewed hundreds, possibly thousands, of studies in RF/MW radiation and ELF fields, published from decades ago to the present, I would provide you the following primary evidence, without limitation. Due to the active suppression of the RF/MW literature, some researchers in public health science are less aware of these studies. However, the forefront experts specializing in these areas, RF/MW radiation and ELF fields, recognize the certainties in this large body of scientific literature, which establishes without limitation that PM MW radiation with chronic duration is quite harmful to humans, particularly children, as well as to animals and plants.

25. It is not surprising that even as of 1990, the US Environmental Protection Agency ("EPA") had determined RF/MW radiation a "probable carcinogen". Now that we have much more confirming study in the interim, the conclusion is yet more certain. And when we focus on MW radiation, particularly pulse-modulated radiation, on long, non-intermittent duration and on more vulnerable subgroups such as children, we see that the cancer outcome is very certain, indeed. Amongst the epidemiologic studies showing cancer outcomes, the following are particularly strong:

- a. Dode AC, Leao M, Tejo FdeAF, gomes ACR, Dode DC, Dode MC, Moreira CW, Condessa VA, Albinatti C and Calaffa WT. Mortality by neoplasia and cellular telephone base stations in the Belo Horizonte municipality, Minas Gerais State, Brazil. *Sci Total Environ* 409: 3649-3665:2011. This study shows higher rates of cancer in people living close to cell phone towers than for people living further away. Cell phone radiation is similar to but likely not as harmful as 2.45 GHz radiation from WI-FI. The exposure levels in this study are lower than those that Portland school building occupants receive from WI-FI.
- b. Oberfeld G. Environmental Epidemiology Study of Cancer Incidence in the Municipalities of Hausmannstatten & Vasoldsberg (Austria), 2008. This government-commissioned study found significantly increased cancer risk relative to a lower-exposure reference category, 23x higher for breast cancer and 121x higher for brain tumors, with strong exposure-effect relations.
- c. Michelozzi P, Capon A, Kirchmayer U, Forastiere F, Biggeri A, Barca A and Perucci CA. Adult and childhood leukemia near a high-power radiostation in Rome, Italy. *Am J Epidemiol.* 155: 1098-1103: 2002. The authors show that there is a significant elevation of childhood leukemia among residents living near to Vatican Radio, and that the risk declines with distance away from the transmitter. This is RF radiation in frequencies similar to that of WI-FI.

- d. Ha M, Im H, Lee M, Kim HJ, Kim BC, Gimm YM and Pack JK. Radio-frequency radiation exposure from AM radio transmitters and childhood leukemia and brain cancer. *Am J Epidemiol* 166: 270-279: 2007. Leukemia and brain cancer in children in Korea were investigated in relation to residence within 2 km of AM radio transmitters. There was a significant elevation in rates of leukemia but not of brain cancer. WI-FI radiation is more harmful than AM.
- e. Park SK, Ha M, Im HJ. Ecological study on residences in the vicinity of AM radio broadcasting towers and cancer death: preliminary observations in Korea. *Int Arch Occup Environ Health*. 2004 Aug;77(6):387-94. This study found higher mortality areas for all cancers and leukemia in some age groups in the area near the AM towers.
- f. Hallberg O. Johansson O. *Med Sci Monit* 2004 Jul;10(7):CR336-40. Malignant melanoma of the skin – not a sunshine story! Increased incidence and mortality from skin melanoma are concluded to result from continuous disturbances of cell repair mechanisms by body-resonant EMFs from FM/TV networks.
- g. Hallberg O. Johansson O. 2005. FM Broadcasting exposure time and malignant melanoma incidence, *Electromagnetic Biology and Medicine* 24;1-8. Age-specific incidence of malignant melanoma of the skin is related to FM broadcasting radiation at whole-body resonant frequencies. This is very relevant to children, since the smaller wavelengths of WI-FI are at resonant frequencies with dimensions of the human head, particularly the child's head.
- h. Dolk H, Shaddick G, Walls P, Grundy C, Thakrar B, Kleinschmidt I, Elliot P. Cancer Incidence near radio and television transmitters in Great Britain. I – Sutton-Colfield transmitter, and II. At high-power transmitters. *Am J Epidemiol* 1997; 145(1):1-9 and 10-17. In the first study, there was a statistically significant

increase in cancer; in the second, a small but significant increase in adult leukemia.

i. Hocking B, Gordon IR, Grain HL, Harfield GE. Cancer incidence and mortality and proximity to TV towers. *Medical J of Australia*. 1965;601-605. At extremely low exposure levels, there was an association between increased childhood leukemia incidence and mortality and proximity to TV towers. TV radiation, in the VHF and UHF bands, is similar to but not as harmful as WI-FI radiation at 2.45 GHz.

j. Grayson JK. Radiation exposure, socioeconomic status, and brain tumor risk in the US Air Force: A nested case-control study. *Am J Epidemiol* 1996; 143:480-6. This study found an association between exposure to ELF and RF/MW radiation and brain tumors.

k. Szmigielski S. Cancer morbidity in subjects occupationally exposed to high frequency (radiofrequency and microwave) electromagnetic radiation. *Sci Total Environ* 1996;180:9-17. This study showed huge increases in leukemia and Non-Hodgkin's lymphomas. Though exposure levels are higher in this study than they would be with school WI-FI, it is possible that certain students or teachers stationed immediately next to the WI-FI infrastructure could receive comparable levels in radiation peaks.

26. Additional studies show neurologic, immune, endocrine, reproductive and cardiac, adverse health effects from low-dose, chronic exposure to RF/MW radiation in humans:

a. Papageorgiou CC, Hountala CD, Maganioti AE, Kyprianou MA, Rabavilas AD, Papadimitriou GN, Capsalis CN. Effects of WI-FI signals on the p300 component of event-related potentials during an auditory hayling task. *J Integr Neurosci* 2011 Jun;10(2):189-202. This study concludes that WI-FI exposure may exert gender-related alterations on neural activity.

- b. Altpeter ES, Roosli M et al. Effect of Short-wave magnetic fields on sleep quality and melatonin cycle in humans: The Schwarzenburg shut-down study. *Bioelectromagnetics* 27:142-150, 2006. Sleep quality improved and melatonin excretion increased when the transmitter was shut down.
- c. Abelin T et al. Sleep disturbances in the vicinity of the short-wave braodcast transmitter Schwarzenburg. *Somnologie* 9:203-209, 2005. There is strong evidence of a causal relationship between operation of a short-wave radio transmitter and sleep disturbances in the surrounding population.
- d. Hutter HP et al. Subjective symptoms, sleeping problems, and cognitive performance in subjects living near mobile phone base stations. *Occup Environ Med* 2006;63:307-313, 2006. There was a significant relation of some symptoms, especially headaches, to measured power density, as well as effects on wellbeing and performance.
- e. Preece AW, Georgious AG, Duunn EJ, Farrow SC. *Occup Environ Med* 2007 Jun;64(6):402-8. Compared to control village, there were highly significant differences in the reporting of migraine, headache and dizziness military and cell phone antenna systems.
- f. Buchner K, Eger, H. Changes of clinically important neurotransmitters under the influence of modulated RF fields – a long-term study under real-life conditions. *Umwelt-Medizin-Gesellschaft* 24(1):44-57, 2011. There is clear evidence of health-relevant effects, including increase in adrenaline/noradrenaline, subsequent decrease in dopamine from a new MW-emitting base station. During counterregulation, trace amine PEA decreased and remained decreased. Clinically documented increases in sleep problems, cephalgia, vertigo, concentration problems and allergies followed the onset of new microwave transmissions.

- g. Eliyahu I, Luria R, Hareuveny R, Margalioth M, Neiran N and Shani G . Effects of radiofrequency radiation emitted by cellular telephones on the cognitive functions of humans. *Bioelectromagnetics* 27: 119-126: 2006. A total of 36 human subjects were exposed to PM MW and were tested on four distinct cognitive tasks. Exposure to the left side of the brain slows left-hand response time in three of the four tasks.
- h. Barth A, Winker R, Ponocny-Seliger E, Mayrhofer W, Ponocny I, Sauter C and Vana N. *Occup Environ Med* 65: 342-345: 2008. A meta-analysis for neurobehavioural effects due to electromagnetic field exposure emitted by GSM mobile phones. The authors looked at 19 studies of cognitive function in cell phone users, and found in the meta-analysis that there is evidence for a decreased reaction time, altered working memory and increased number of errors in exposed persons.
- i. Augner C, Hacker GW, Oberfeld G, Florian M, Hitzl W, Hutter J and Pauser G. Effects of exposure to base station signals on salivary cortisol, alpha-amylase and immunoglobulin A. *Biomed Environ Sci* 23: 199-207: 2010. This was a human experimental study with exposure to PM MW radiation wherein immune indicators were monitored after five 50-minute sessions. The researchers found dose-dependent changes in cortisol and alpha-amylase.
- j. Avendano C, Mata A, Sanchez Sarimiento CA and Doncel GF. Use of laptop computers connected to internet through WI-FI decreases human sperm motility and increases sperm DNA fragmentation. *Fert Steril*, 2012, In press. In this study human sperm were exposed to WI-FI from a laptop, and were found to show reduced motility after a 4-hour exposure. The results are consistent with other publications (see Agarwal et al., *Fert Steril* 89: 124-128: 2008) that reported that those who use cell phone regularly have reduced sperm count.

- k. Baste V, Riise T and Moen BE (2008) *Int J Epidemiol* 23: 369-377: 2008. Radiofrequency electromagnetic fields: male infertility and sex ratio of offspring. This is a study of Norwegian Navy personnel chronically exposed to RF fields on the job. The rates of infertility were related to level of exposure in a dose-dependent fashion.
27. Many toxicologic and other animal studies, of which the following are but a few, support conclusions of cancer, genotoxicity, neurotoxicity and other health outcomes from RF/MW radiation.
- a. Sinha R. Chronic non-thermal exposure of modulated 2450 MHz microwave radiation alters thyroid hormones and behavior of male rats. *Int. J. Radiation Biol.* 84:6:505-513, 2008. This study of 2.45 GHz at levels and durations comparable to and less than those of school WI-FI concluded that the radiation was sufficient to alter the levels of thyroid hormone as well as emotional reactivity compared to controls.
- b. Nittby H, Grafstrom G, Tian DP, Malmgren L, Brun A, Persson BRR, Salfors LG and Eberhardt J. *Bioelectromagnetics* 29: 219-232: 2008. This study showed cognitive impairment in rats after long-term exposure to PM MW radiation. This study of rats shows that after 2 hours per week for 55 weeks there was impaired memory for objects in exposed as compared to sham animals.
- c. Kimmel S et al. Electromagnetic radiation: Influences on honeybees (*Apis mellifera*). A significant difference between non-exposed and fully irradiated bees was the result of the influence of high-frequency PM RF/MW radiation.
- d. Panagopoulos DJ et al. Bioeffects of mobile telephony radiation in relation to its intensity or distance from the antenna. *Int. J Radiat Biol*, 86;(5):345-357, 2010. The PM MW radiations at 900 and 1800 MHz decreased the reproductive capacity by cell death induction, with an increased bioactivity "window" at 10

uW/cm², and still evident down to 1 uW/cm².

e. Everaert J, Bauwens D. A possible effect of electromagnetic radiation from mobile phone base stations on the number of breeding house sparrow (*passer domesticus*). *Electromagnetic Biology and Medicine*, 26:63-72, 2007. Long-term exposure to higher-level low-intensity PM MW radiation negatively affects the abundance or behavior of House Sparrows in the wild.

f. Magras I, Xenos T. RF Radiation-Induced Changes in the Prenatal Development of Mice. *Bioelectromagnetics* 18:455-461, 1997. Near almost 100 TV and FM broadcast transmitters, with exposure levels between 0.168 uW/cm² and 1.053 uW/cm², found in the more exposed groups testicular damage and decreasing size of litters to irreversible infertility.

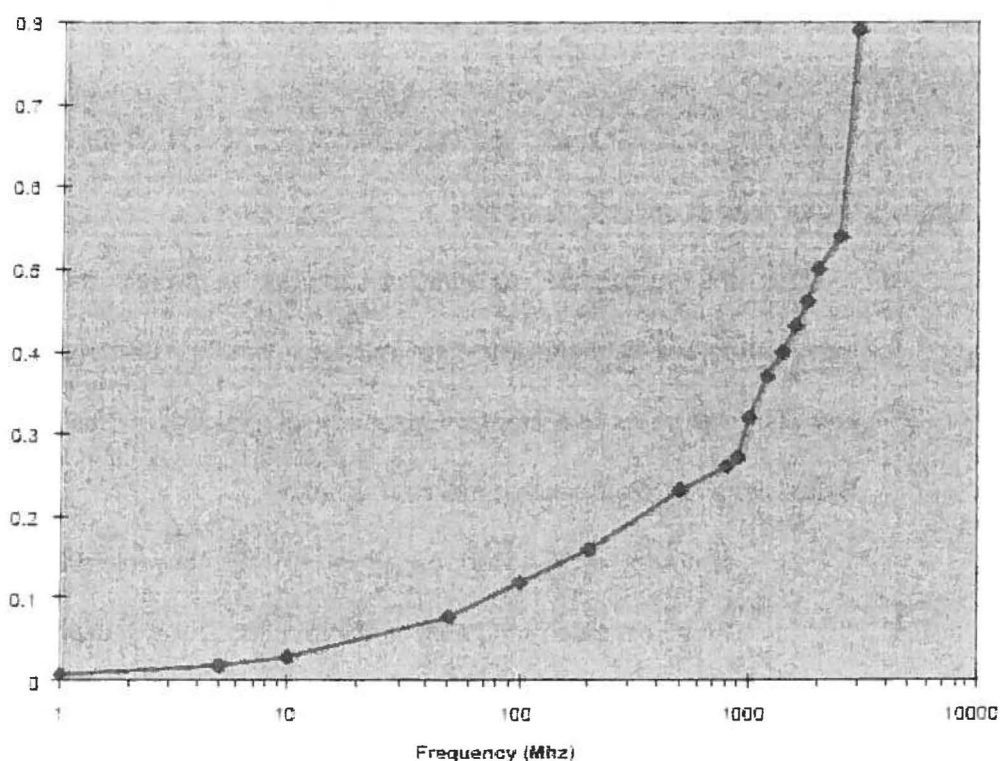
g. Balmori A. Electromagnetic pollution from phone masts. Effects on wildlife, *Pathophysiology* 2009. This large review of wildlife effects concludes, "pulsed telephony microwave radiation can produce effects on nervous, cardiovascular, immune and reproductive systems," including damage to the nervous system by altering EEG and changes to the blood-brain barrier, disruption of the circadian rhythms (sleep-wake) by interfering with the pineal gland and hormonal imbalances, changes in heart rate and blood pressure, impairment of health and immunity towards pathogens, weakness, exhaustion, growth problems, problems in building the nest or impaired fertility, embryonic development, hatching percentage, genetic and developmental problems, problems of locomotion, promotion of tumors and more.

28. Exposure thresholds for harmful effects are lowered in human populations and individuals when duration is increased. Due to the variability of thresholds for harmful effects both in the population and within the individual, there is no exposure power density that is safe. The School's WI-FI deploys arguably the worst possible frequency of 2.45 GHz, that of the

microwave oven, worst because it is most absorbable by the brain and most resonant with the water molecule, such that:

- a. absorption-per-exposure is maximized, dramatically lowering effects thresholds for population and individual effects; and
- b. water molecules in tissues and cells are highly agitated.

Microwave Absorption in Brain Tissue (Grey Matter)



Curry, Ph.D., *Wireless LANs in the schoolroom*

29. This above graph, from physicist William Curry PhD's presentation *Wireless LANs in the Schoolroom*, shows how absorption in brain tissue (grey matter) increases exponentially toward the ultra-high frequency (UHF) area of the microwave oven and WI-FI.

30. In the case of the Portland Schools, the additional, unused but still deployed carrier frequency of 5 GHz would likely increase absorption in other, smaller organs, such as the thyroid.

31. The graph also illustrates the problem with the drive of the wireless industry toward ever higher frequencies within the cm microwave band. While nearly all the lower frequency bands have already been allocated by the FCC for specific types of radio transmissions, and transmission of ever more information content on any given channel requires greater bandwidth, each new deployment undermines further the integrity of the population's health. Engineers who design these systems have no training that would qualify them to consider the effects on biologic systems, which is why public health scientists need to be called in to policymaking *prior to* contracting and deployment, not after the fact.

32. The following studies explain the mechanisms of interaction between RF/MW radiation and biologic systems at the cellular level.

- a. The cell membrane recognition process -- which includes signal transduction and 'heat-shock protein' release -- was first discerned by Litovitz and his co-workers at Catholic University of America in the mid-1990s.

Below are a few citations that make the point.

- i. Litovitz, T., C. Montrose, et al. (1994). "Superimposing spatially coherent electromagnetic noise inhibits field induced abnormalities in developing chick embryos." *Bioelectromagnetics* **15**(2): 105-113.
- ii. DiCarlo, A., J. Farrell, et al. (1998). "A simple experiment to study electromagnetic field effects: Protection induced by short term exposures to 60 Hz magnetic fields." *Bioelectromagnetics* **19**(8): 498-500.
- iii. Penafiel, L., T. Litovitz, et al. (1997). "Role of modulation on the effect of microwaves on ornithine decarboxylase activity in L929

- cells." *Bioelectromagnetics* **18**(2): 132-141.
- iv. Dicarlo, A. L., Michael T. Hargis, L. Miguel Penafiel, Theodore A. Litovitz, A. (1999). "Short-term magnetic field exposures (60Hz) induce protection against ultraviolet radiation damage." *International journal of radiation biology* **75**(12): 1541-1549.
 - v. Litovitz, T., C. Montrose, et al. (1990). "Amplitude windows and transiently augmented transcription from exposure to electromagnetic fields." *Bioelectromagnetics* **11**(4): 297-312.
 - vi. Litovitz, T., M. Penafiel, et al. (1997). "The role of temporal sensing in bioelectromagnetic effects." *Bioelectromagnetics* **18**(5): 388-395.
 - vii. Litovitz, T., L. Penafiel, et al. (1997). "Role of modulation in the effect of microwaves on ornithine decarboxylase activity in L929 cells." *Bioelectromagnetics* **18**: 132-141.]
 - viii. Litovitz, T., D. Krause, et al. (1993). "The role of coherence time in the effect of microwaves on ornithine decarboxylase activity." *Bioelectromagnetics* **14**(5): 395-403.
- b. Cell membrane reaction is lipid peroxidation.
 - i. Serban, M. and V. Ni (1994). "Lipid peroxidation and change of plasma lipids in acute ischemic stroke." *Romanian journal of internal medicine= Revue roumaine de médecine interne* **32**(1): 51.

- ii. Vileno, B., S. Jeney, et al. (2010). "Evidence of lipid peroxidation and protein phosphorylation in cells upon oxidative stress photo-generated by fullerenes." *Biophysical chemistry*.
- iii. Maaroufi, K., E. Save, et al. (2011). "Oxidative stress and prevention of the adaptive response to chronic iron overload in the brain of young adult rats exposed to a 150 kilohertz electromagnetic field." *Neuroscience*.
- iv. Nelson, S. K., S. K. Bose, et al. (1994). "The toxicity of high-dose superoxide dismutase suggests that superoxide can both initiate and terminate lipid peroxidation in the reperfused heart." *Free Radical Biology and Medicine* **16**(2): 195-200.
- v. Alvarez, J. G. and B. T. Storey (1989). "Role of glutathione peroxidase in protecting mammalian spermatozoa from loss of motility caused by spontaneous lipid peroxidation." *Gamete research* **23**(1): 77-90.
- vi. Devasagayam, T., K. Bloor, et al. (2003). "Methods for estimating lipid peroxidation: An analysis of merits and demerits." *Indian journal of biochemistry & biophysics* **40**(5): 300-308.
- c. Free-Radical Damage:
 - i. Ozgur, E., G. Güler, et al. (2010). "Mobile phone radiation-induced free radical damage in the liver is inhibited by the antioxidants n-acetyl cysteine and epigallocatechin-gallate." *International journal of radiation biology*(00): 1-11.

- ii. Gutteridge, J. and X. C. Fu (1981). "Enhancement of bleomycin-iron free radical damage to DNA by antioxidants and their inhibition of lipid peroxidation." *FEBS letters* **123**(1): 71.
- d. mRNA:
 - i. Yan, J. G., M. Agresti, et al. (2009). "Qualitative Effect on mRNAs of Injury-Associated Proteins by Cell Phone Like Radiation in Rat Facial Nerves." *Electromagnetic Biology and Medicine* **28**(4): 383-390.
 - ii. Yan, J. G., M. Agresti, et al. (2008). "Upregulation of specific mRNA levels in rat brain after cell phone exposure." *Electromagnetic Biology and Medicine* **27**(2): 147-154.
 - iii. Simbürger, E., A. Stang, et al. (1997). "Expression of connexin43 mRNA in adult rodent brain." *Histochemistry and cell biology* **107**(2): 127-137.
 - iv. Chen, J., H. C. He, et al. (2010). "Effects of Pulsed Electromagnetic Fields on the mRNA Expression of RANK and CAII in Ovariectomized Rat Osteoclast-Like Cell." *Connective Tissue Research* **51**(1): 1-7.
- e. Epigenetic changes.... environmentally induced genetic change:
 - i. Migliore, L. and F. Copped (2009). "Genetics, environmental factors and the emerging role of epigenetics in neurodegenerative diseases." *Mutation Research/Fundamental and Molecular*

Mechanisms of Mutagenesis **667**(1-2): 82-97.

- ii. Currenti, S. (2009). "Understanding and Determining the Etiology of Autism." *Cellular and Molecular Neurobiology* **30**(2): 161-171.
- f. Micronuclei formation:
 - i. Tice, R. R., G. G. Hook, et al. (2002). "Genotoxicity of radiofrequency signals. I. Investigation of DNA damage and micronuclei induction in cultured human blood cells." *Bioelectromagnetics*, **23**(2): 113-126.
 - ii. Lerchl, A. (2009). "Comments on "Radiofrequency electromagnetic fields (UMTS, 1,950 MHz) induce genotoxic effects in vitro in human fibroblasts but not in lymphocytes" by Schwarz et al. (Int Arch Occup Environ Health 2008: doi: 10.1007/s00420-008-0305-5)." *Int Arch Occup Environ Health* **82**(2): 275-278.
 - iii. Vijayalaxmi and T. J. Prihoda (2009). "Genetic damage in mammalian somatic cells exposed to extremely low frequency electro-magnetic fields: a meta-analysis of data from 87 publications (1990-2007)." *Int J Radiat Biol* **85**(3): 196-213.
 - iv. Sannino, A., M. Sarti, et al. (2009). "Induction of adaptive response in human blood lymphocytes exposed to radiofrequency radiation." *Radiat Res* **171**(6): 735-742.
- g. DNA repair disruption:
 - i. Brusick, D., R. Albertini, et al. (1998). "Genotoxicity of radiofrequency radiation. DNA/Genetox Expert Panel." *Environ*

- Mol Mutagen* **32**(1): 1-16.
- ii. Belyaev, I. Y., E. Markova, et al. (2009). "Microwaves from UMTS/GSM mobile phones induce long-lasting inhibition of 53BP1/gamma-H2AX DNA repair foci in human lymphocytes." *Bioelectromagnetics* **30**(2): 129-141.
 - iii. Sun, L. X., K. Yao, et al. (2006). "[Effect of acute exposure to microwave from mobile phone on DNA damage and repair of cultured human lens epithelial cells in vitro]." *Zhonghua Lao Dong Wei Sheng Zhi Ye Bing Za Zhi* **24**(8): 465-467.
- h. Immune response suppression:
- i. Lyle, D. B., P. Schechter, et al. (1983). "Suppression of T-lymphocyte cytotoxicity following exposure to sinusoidally amplitude-modulated fields." *Bioelectromagnetics* **4**(3): 281-292.
 - ii. Elekes, E., G. Thuroczy, et al. (1996). "Effect on the immune system of mice exposed chronically to 50 Hz amplitude-modulated 2.45 GHz microwaves." *Bioelectromagnetics* **17**(3): 246-248.
 - iii. DABALA, D., D. SURCEL, et al. (2008). "Oxidative and Immune Response in Experimental Exposure to Electromagnetic Fields." *Electromagnetic field, health and environment: proceedings of EHE'07*: 105.
 - iv. Surcel, D., D. Dabala, et al. (2009). "Free Radicals, Lipid Peroxidation and Immune Response in Experimental Exposure to Electromagnetic Fields." *Epidemiology* **20**(6): S118.

Conclusions

33. To understand the seriousness of this Agent of PM RF/MW radiation in interaction with populations and individuals, we need to consider some basic facts in addition to the many relevant and reliable studies above. For example, where shortwave, AM, FM, TV and cell phone infrastructure frequencies are demonstrated to be harmful, as they consistently are shown to be at low intensities with long duration, then, all other factors being equal, MW radiation at 2.45 GHz will likely be more harmful yet, due to its higher absorption-per-exposure and water molecule resonance. Increasing the constancy and length of exposure toward the maximum of occupational and 24-7 durations will lower the threshold for effects in populations and individuals. Complex radiation microenvironments with pulse-modulated wave and multiple sources, such as are deployed in WI-FI-equipped schools, are more harmful than a single, isolated MW radiation exposure at the same power density and duration. There are only a few of the many studies of RF/MW radiation infrastructure such as base stations that fail to show their studied effect. However, even were the reverse true, i.e., if there existed greater number than those that do show adverse effects, it is the case that positive studies (those that show adverse effects) hold more weight than negative studies (those that show no effect).

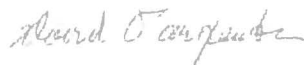
34. The FCC-appointed guideline-setting Commission, ASTM-IEEE, in 1991 referred in its conclusions to RF/MW radiation, the Agent, as a 'Hazard,' specifically setting a 'Hazard Threshold.' It has been discovered that, even amongst the 120 studies chosen by the Committee to prove the validity of its Hazard Threshold, there were 15 studies that concluded adverse effects at levels *lower* than the Hazard Threshold, thus disproving its validity. Three of these studies actually showed adverse effects at less than 10 percent of the Hazard Threshold. Thus the guidelines have no credibility.

35. The large body of scientific literature moreover redundantly proves this Agent to be a hazard. The media-promulgated notion that the relevant scientific studies are inconsistent and inconclusive is false and misleading. Chronic exposure to PM MW radiation harms every individual in a population in some ways, even if these are not always detectable by the individual or consciously attributed to the responsible RF/MW radiation sources. This Agent injures some individuals into a condition in which symptoms will be more easily retriggered with subsequent exposure. And for *a priori* susceptible individuals and those using electronic medical devices, it can respectively exacerbate the extant medical conditions and disrupt medical device operation, even to the point of death. Bassen 1997 discusses the hundreds of excess deaths, even at that time, from wireless communications radiation. See also *Radiofrequency Interference with Medical Devices*, IEEE Engineering in Medicine and Biology Magazine 17(3):111-114(1998), <http://ewh.ieee.org/soc/embs/comar/interfer.htm>.

36. For these reasons, WI-FI must be banned from school deployment.

37. I will receive no compensation for my testimony beyond out-of-pocket expenses.

Dated this 20th day of December, 2011.



DR. DAVID O. CARPENTER, M.D.
Director, Institute for Health and the Environment
University at Albany



IN THE MATTER OF

FORTISBC INC.

**CERTIFICATE OF PUBLIC CONVENIENCE AND NECESSITY
FOR THE ADVANCED METERING INFRASTRUCTURE PROJECT**

DECISION

July 23, 2013

Before:

**L.F. Kelsey, Commissioner/Panel Chair
N.E. MacMurchy, Commissioner
D.M. Morton, Commissioner**

and organizations, Dr. Blank was quick to discredit the source rather than assist the Panel to understand the differences.

For these reasons, the Panel places little weight on the written evidence and oral testimony of Dr. Blank.

4.3.3 Dr. David Carpenter

Dr. Carpenter gave evidence on behalf of CSTS. He was tendered and accepted as an expert witness qualified to provide opinion evidence as a public health specialist with expertise in electrophysiology, low frequency electromagnetic field bio-effects, and radio frequency and microwave radiation bio-effects (T10: 2069-2070).

Dr. Carpenter's education includes an M.D., Harvard Medical School, Boston, MA 1964 and a B.A., Harvard College, Cambridge, MA 1959. His curriculum vitae is found in Tab 2E of Exhibit C9-8. His experience includes research and education in Ionizing and non-ionizing radiation biology.

His written evidence is found at Tab2B of Exhibit C9-8. His written evidence also includes an article he co-authored with Cindy Sage: "Setting Prudent Health Policy for Electromagnetic Field Exposures" (Exhibit C9-8, Tab 2C). He also responded to information requests (Exhibit C9-12-3.)

FortisBC expressed concern that Dr. Carpenter had been disqualified as an expert witness by the Quebec Board [Régie de l'énergie], and had failed to disclose this (T11:2107).

Further, FortisBC submits that Dr. Carpenter's conclusions regarding the harms posed by AMI meters are made without any reference to, or regard for, the specific level of exposure from the AMI meters. Dr. Carpenter noted that he did not have expertise in exposure levels and was not qualified to comment on the exposure levels from the AMI meters. He provided no scientific reason to disagree that the AMI meters meet the Safety Code 6 limit for both average and peak pulse levels. He does not have the scientific expertise to measure the RF from AMI meters as compared to the standards of the BioInitiative Report 2007. (FBC Final Submission, pp. 174-175)

FortisBC submits that Dr. Carpenter summarizes the references he cites in a manner consistent with his own beliefs, rather than accurately reporting their findings and provides the following illustration at paragraphs 520-521 of its Final Submission:

"...Dr. Carpenter referred to a study by Volkow et al. in support of his theory that cell phone RF alters the metabolism of the brain and various clinical measures in humans at exposure levels below the intensities that cause tissue heating:

Volkow ND, Tomasi D, Wange GJ, Vaska P, Fowler JS, Teland F, et al. 2011. Effects of cell phone radiofrequency signal exposure on brain glucose metabolism. *Journal of the American Medical Association* 305:808-814.: In healthy participants and compared with no exposure, 50-minute cell phone exposure was associated with increased brain glucose metabolism in the region closest to the antenna. This shows direct effects of RF radiation on the brain with cell phone use." [underlining added by FortisBC; footnote omitted]

FortisBC submits that the full quote shows that the authors considered the findings in the study much less conclusive:

"Conclusions - In healthy participants and compared with no exposure, 50-minute cell phone exposure was associated with increased brain glucose metabolism in the region closest to the antenna. This finding is of unknown clinical significance." [underlining added by FortisBC; footnote omitted] (FortisBC Final Submission, p. 177)

The CEC submits that the evidence submitted by Dr. Carpenter is "of limited assistance in informing the issue." "Dr. Carpenter's evidence is unduly weighted in favor of a particular viewpoint and not representative of the body of scientific literature. Such actions typify those of an advocate and are not in keeping with that of an objective contributor to the proceeding. The BCUC should find Dr. Carpenter's evidence to be of limited value. Certain portions of Dr. Carpenter's evidence are potentially misleading. Dr. Carpenter is somewhat injudicious in his commentary and is at times disrespectful to organizations which have considerable stature. Several of Dr. Carpenter's statements are inflammatory and unreasonably dismissive of opinions that are not the same as his, regardless of the credentials of the statute of the decision-maker or the analysis conducted."⁵

The CEC is of the view that the references cited by Dr. Carpenter were "decidedly weighted" in favour of one viewpoint. In support of this view, the CEC provided the following analysis: "Dr. Carpenter cited a total of 59 studies of which 43 were supportive of their being a negative effect

⁵ CEC Final Submission, pp. 92-93

(73%), 14 were not supportive (24%) and 2 were inconclusive. Of the 14 that were not supportive, Dr. Carpenter cited 5 with caveats. Dr. Carpenter did not provide any caveats with respect to the 43 supportive documents."

The CEC further submits that some of the information provided as reference material without caveat by Dr. Carpenter is not necessarily well-respected and has been found to be implausible. For example, Dr. Carpenter cites reference item (g) "Mortality by neoplasia and cellular telephone base stations in the Belo Horizonte municipality, Minas Gerais state, Brazil by Dode AC et al without caveat and characterizes it as showing higher rates of death from cancer among individuals living close to cell towers than among those living further away. Rates were highest in residences less than 1 00 m, falling to near background a 1,000 m. This report has been subject to considerable critique and one of the other witnesses, Dr. Blank recognized that the results did not make sense." (T9: 1681-1685) (CEC Final Submission, pp. 92-94)

CTCS submits "the expert opinion evidence adduced by FortisBC is inferior in weight to the direct medical & scientific expert opinion evidence provided by Dr. Blank, Dr. Carpenter & Dr. Sears the former of whom has personally conducted his own independent laboratory research on the very matter in issue" (CSTS Final Submission, p. 17)

The Panel has significant concerns about Dr. Carpenter's testimony. Of particular concern is that Dr. Carpenter, in the words of FortisBC, "summarizes the references he cites in a manner consistent with his own beliefs, rather than accurately reporting their findings." (FortisBC Final Submission, p. 177; T11:2091-2099) The Panel is also concerned with Dr. Carpenter's reference to studies that suit his views and his inability to properly defend them as exhibited by the Belo Horizonte municipality study example.

In his attempt to summarize the references, Dr. Carpenter adopted a less than objective and fully informed approach. For this reason, the Panel gives little weight to his evidence.

4.3.4 Dr. Isaac Jamieson

Dr. Jamieson gave evidence on behalf of CSTS. Dr. Jamieson was tendered and accepted as an expert witness to provide opinion evidence as "as an environmental scientist with expertise in environmental health, in particular expertise in exposure to radio frequency emissions and the environmental health implications of same." A caveat was placed on his expertise noting that he

**PENNSYLVANIA
PUBLIC UTILITY COMMISSION
Harrisburg, PA 17105-3265**

Public Meeting held January 14, 2010

Commissioners Present:

James H. Cawley, Chairman, Statement
Tyrone J. Christy, Vice Chairman, Dissenting Statement
Kim Pizzingrilli
Wayne E. Gardner
Robert F. Powelson, Statement

Application of PPL Electric Utilities Corporation
Filed Pursuant to 52 Pa. Code Chapter 57,
Subchapter G, for Approval of the Siting and
Construction of the Pennsylvania Portion of
The Proposed Susquehanna-Roseland 500 kV
Transmission Line in Portions of Lackawanna,
Luzerne, Monroe, Pike and Wayne Counties,
Pennsylvania

A-2009-2082652

Petition of PPL Electric Utilities Corporation
For A Finding That A Building To Shelter
Equipment At The 500-230 kV Substation To
Be Constructed In The Borough of Blakely,
Lackawanna County, Pennsylvania is
Reasonably Necessary For the Convenience
Or Welfare Of the Public

A-2009-2082832

Application of PPL Electric Utilities Corporation
Under 15 Pa. C.S. §§1511(c) for a Finding and
Determination That The Service To Be Furnished
By The Applicant Through Its Proposed Exercise
Of The Power Of Eminent Domain To Acquire
A Right-Of-Way And Easement Over And Across
The Lands Of Chaudari Family Limited Partner-
Ship, David Murphy, and Marguerite T. Kranick
In South Canaan Township, Wayne County For
The Proposed Susquehanna-Roseland 500 kV
Transmission Line in Portions of Lackawanna,
Luzerne, Monroe, Pike and Wayne Counties,
Pennsylvania Is Necessary or Proper For The
Service, Accommodation, Convenience Or
Safety Of The Public

A-2009-2088297

Application of PPL Electric Utilities Corporation
Under 15 Pa. C.S. §§1511(c) for a Finding and
Determination That The Service To Be Furnished
By The Applicant Through Its Proposed Exercise
Of The Power Of Eminent Domain To Acquire
A Right-Of-Way And Easement Over And Across
The Lands Of The Property Owners Listed Below
For The Proposed Susquehanna-Roseland 500 kV
Transmission Line in Portions of Lackawanna,
Luzerne, Monroe, Pike and Wayne Counties,
Pennsylvania Is Necessary or Proper For The
Service, Accommodation, Convenience Or
Safety Of The Public:

HaRa Corporation

A-2009-2088337

Richard Coccodrilli, Jr.,
Jeffrey J. Coccodrilli,
Ryan T. Coccodrilli, and
Joseph Williams

A-2009-2088327

D&L Realty Company

A-2009-2088340

Rudolph Saporito and
Maria Saporito

A-2009-2088312

David Murphy

A-2009-2088360

evidence to support a determination that the risk of dangers to the health and safety of the Community are reasonable. SCECA Exc at 23.

In its Reply Exceptions, PPL states that the SCECA's exception regarding the safety of the S-R Line structures is without merit. PPL RExc at 20. PPL explains that tubular steel transmission structures are durable and stable because their foundations are designed by geotechnical engineers after extensive soil boring and testing. PPL St. 5-R at 3, 4; PPL RExc at 21. Further, as PPL explained in written testimony, even in the unlikely event of a tubular steel transmission line failure, the conductors would constrain the fall within the right-of-way. PPL St. 5-R at 4, 5; PPL RExc at 21.

Disposition of the Issue

We agree with the ALJ's finding that the overall siting of the entire line has been conducted according to and in compliance with the Commission's regulations and that PPL has provided substantial evidence to support a finding that it plans to use the appropriate safety measures in the construction of its facilities, consistent with NESC requirements and standard industry practice. We find PPL's explanation of the stability of the proposed tubular transmission structures and the safeguards it now takes regarding erosion caused failure, to be persuasive. Accordingly, we shall deny the Exceptions of the SCECA and shall adopt the ALJ's recommendation and rationale used to reach that determination.

5. Electric and/or Magnetic Fields (EMF)

Positions of the Parties

The OCA, the OTS and the ECC did not address this issue.

PPL maintains that there is no reasonable basis to conclude that electric and/or magnetic fields (“EMF”) from the S-R Line will represent a hazard or other interference to members of the public along the right-of-way, including in Saw Creek, PPL MB at 100. There is no reliable scientific basis to conclude that exposure to power frequency EMF from the proposed transmission line will cause or contribute to the development of cancer in children or adults along the proposed route of the line. PPL St. 15-R at 13.

PPL presented the testimony of Mark A. Israel, MD, director of the Norris Cotton Cancer Center at the Dartmouth Medical School, medical doctor, professor and cancer researcher, PPL Statement No. 15-R. Tr. 1166. Dr. Israel’s work focuses on the molecular genetics of cancer, which involve the study of cellular molecules such as genes that have a fundamental role in the development of cancer, PPL St. 15-R at 1, and his curriculum vitae includes work at the National Cancer Institute from 1975 to 1989, where he conducted research on the molecular genetics of childhood cancer, including the discovery of specific genes responsible for the cause of certain cancers in children. PPL St. 15-R at 3. He has published over 200 scientific studies on cancer and the molecular genetics of cancer in peer-reviewed scientific journals. PPL St. 15-R at 5; RD at 203.

Dr. Israel focuses on avenues for advancing knowledge of cancer causation and treatment. The many laboratory studies that have been conducted on EMF do not show this to be an area of research that is likely to aid in significantly enhancing the understanding of cancer causation. PPL St. 15-R at 5; RD at 204.

Dr. Israel conducted a review of the studies regarding the effects of EMF on genetic materials in the cell that are known to be required for a normal cell to become a cancer cell. In particular, the studies involved examination of whether cells exposed to EMF show significant, permanent damage to the structure of DNA or chromosomes that could lead to the development of cancer. PPL St. 15-R at 8. As a group, the DNA and

chromosome studies over the past 20 years do not show that EMF have a role in cancer by causing permanent damage to DNA or chromosomes. PPL St. 15-R at 9; RD at 204.

PPL also presented the testimony of Dr. Nancy C. Lee, MD, medical epidemiologist and public health specialist, PPL St. 16-R, Tr. 1174, who from 1999 to her retirement in 2004, was the Director of the Division of Cancer Prevention and Control in the National Center for Chronic Disease Prevention and Health Promotion at the Center for Disease Control, which is the division that develops public health programs and strategies for cancer prevention and control in the U.S. PPL St. 16-R at 2. Dr. Lee has published over 95 articles involving causes of cancer, as well as other epidemiology and public health research and programs in peer-reviewed scientific journals. PPL St. 16-R at 5. She co-authored a book entitled *The Cancer Atlas*, published by the American Cancer Society in 2006 as a comprehensive overview of current knowledge about cancer risk factors, the worldwide burden of cancer, and cancer prevention and control activities by nations around the globe. PPL St. 16-R at 6; RD at 204, 205.

Dr. Lee's evaluation of epidemiology research involving EMF and childhood leukemia, as well as EMF research on areas of adult health, led her to the following conclusion: Based on the lack of consistent statistically significant associations and various methodological concerns, the epidemiology studies relied upon by the SCECA's witness, Dr. Carpenter do not provide a scientific basis to conclude that exposure to magnetic fields is associated with an increased risk of childhood leukemia. PPL St. 16-R at 9; RD at 205.

The NIEHS, which is one of the National Institutes of Health, issued a report on EMF to the U.S. Congress in 1999. The report noted weak associations between EMF and childhood leukemia but no support for those associations from the

laboratory research. The conclusion was that the NIEHS would not rank EMF as an exposure reasonably anticipated to be a cause of cancer. PPL St. 16-R at 10; RD at 205.

The World Health Organization review of EMF research in 2007 concluded that current evidence does not confirm the existence of any health consequences from exposure to low level electromagnetic fields. PPL St. 16-R at 11; RD at 205.

The 2008 Kheifets meta-analysis concluded that the lack of a clear pattern of EMF exposure and outcome risk does *not* support a hypothesis that these exposures are responsible for the observed excess risk. PPL St. 16-R at 12; RD at 205.

Epidemiological studies do not establish that EMF exposure is a risk factor for neurodegenerative disease. PPL St. 16-R at 13; RD at 205. The epidemiology studies that have examined power frequency EMF and human health, along with the laboratory studies on animals and cellular systems, do not provide a reliable scientific basis to conclude that exposure to EMF would cause or contribute to childhood leukemia, other childhood and adult cancers, neurodegenerative disease, or other chronic health problems. PPL St. 16-R at 14; RD at 205.

The SCECA presented the testimony of David O. Carpenter, M.D. who is employed by the University at Albany, SUNY, as a Professor of Environmental Health Sciences as well as Biomedical Sciences, and a Director, Institute of Health and the Environment. SCECA Sts. 2 and R-2; Tr. 1083; RD at 206. Dr. Carpenter is a public health physician and deals with the health of the population rather than individuals. Tr. 1086; RD at 206. Dr. Carpenter was executive secretary of the New York Power Line Project, but he did not conduct the research. Tr. 1087; RD at 206.

Dr. Carpenter relied upon the Wertheimer Lieber study, which was not a blind study since the investigators already knew which homes had cancer victims. Tr. 1090; RD at 206. In addition, he relied upon “wire codes,” which assume that the thickness of the wire is a reliable indicator of the current flowing through it. Dr Carpenter testified that a wire code is an estimate based upon assumptions. Tr. 1093, 1094; RD at 206, 207.

Several years after the conclusion of the New York Power Lines Project, New York adopted EMF exposure limits for the edge of transmission line right-of way. Dr. Carpenter reported that they were not set on any health standard. Tr. 1102; RD at 207. In addition, Dr. Carpenter served on a committee with the Connecticut Academy of Science and Engineering which published a report in 1992 which concluded that, “after 20 years of active research and several dozens of published papers, there is still no solid evidence for a chain of biological effects that could initiate or promote cancer as a result of exposure to EMF magnetic fields at magnitudes of 500 milligauss or less.” PPL Cross Exam Ex. 6 at 37; Tr. 1105; RD at 207.

The SCECA also presented David W. Fugate, Ph.D., Consulting Engineer for Electric Research & Management, Inc. (ERM), SCECA Statement Nos. 1 and R-1, Tr. 1140, who testified that the two main categories of field effects associated with a high-voltage transmission line are power frequency electric and magnetic fields (EMF) and corona effects. SCECA St. 1 at 2; RD at 210. Based on Dr. Fugate’s testimony, the SCECA avers that the EMF levels at the edge of the existing right-of-way is already too high and that even PPL’s projected rates are not realistic. See SCECA Att. DWF-2; RD at 211.

PPL avers that the amount of EMF at the edge of its right-of-way is akin to everyday exposures to appliances and electric wiring in homes and businesses. To support this comparison, PPL Electric presented the testimony of James Michael Silva,

research engineer specializing in issues related to EMF and president of ENERTECH Consultants, PPL St. No. 14-R and JMS Exhibits 1 and 2; Tr. 1185; RD at 212.

ENERTECH Consultants performs work related to EMF in three areas. First, it conducts applied research projects involving EMF exposure assessment and has worked with researchers at the U.S. National Institute of Environmental Health Sciences, Johns Hopkins University, the University of North Carolina, the California Department of Health Services, and the U.S. National Cancer Institute. Second, it develops and manufactures high quality instrumentation for measurement of EMF and conducts a variety of measurement programs throughout the world. Third, it develops computer software for calculating EMF levels, analyzing measurement data and modeling EMF and electrical environments. ENERTECH designed the EXPOCALC software used for calculating EMF from electric power lines. PPL St. 14-R at 4; RD at 212 Fn. 58.

Finally, the SCECA states that the Saw Creek community residents expressed “significant concern and fears over the proposed S-R Line. Individuals testified that they fear tower failures and construction accidents, and cancer, childhood leukemia and other negative health impacts from the increased magnetic field levels, which will be caused by the proposed S-R Line.” SCECA MB at 27 (transcript citations omitted). The SCECA berates PPL because “PPL’s exhibits and testimony pertaining to PPL’s siting analysis do not mention, analyze, weigh, or otherwise consider the public’s fear and stress over these issues, and claims that this omission means that the Company has failed to satisfy the terms of 52 Pa. Code § 57.76(a)(4).” SCECA RB at 13-14; RD at 217.

ALJ’s Recommendation

The ALJ found that uncontroverted record evidence in this case shows that the existing transmission line was built in 1929, and that the first house in what is now

the Saw Creek Estates was not built until the 1950s. This means that each and every home buyer moved in next to or near the transmission line, which is quite visible and is not hidden from view (see site view photos of Saw Creek Estates), and would appear upon the deeds of those whose property is traversed by the right-of-way. In fact, it crosses the roads in the development in several places. Each of these home buyers has, in effect, agreed to the hazards – real or not – posed by the existing transmission line. Each one has already agreed to the existing levels of EMF and has forfeited any credible claim that the existing level is unacceptable. RD at 208.

The ALJ also found that *“it is only the difference between the existing level and the actual resulting level of EMF which is properly in controversy here.”* According to the ALJ, the SCECA did not present any evidence regarding the effect of this difference. Instead, the SCECA presented Dr. Carpenter’s largely unsubstantiated (albeit heartfelt) opinion that EMF poses a health threat at any level. RD at 208.

The ALJ found, however, that PPL presented convincing testimony that after the upgrade, the higher lines and the use of reverse phasing would actually reduce EMF on the 230 kV side of the right-of-way, and the EMF on the 500 kV side would only rise a small amount. PPL St. 14-R at 16; RD at 210.

The ALJ also found that based upon the evidence presented by PPL’s witnesses Drs. Israel, Lee, and Carpenter, there is no reliable scientific basis to conclude that exposure to power frequency EMF from the proposed S-R Line will cause or contribute to adverse health effects in children or adults along the proposed route of the line. RD at 210. The ALJ continued by noting that in its Main Brief, the SCECA repeats portions of Dr. Carpenter’s pre-filed testimony, but does not address any of the serious shortcomings in his opinions that were identified by the other experts and through cross-examination. The record evidence shows that Dr. Carpenter’s opinions were flawed and were not based on a reliable and objective review of the scientific research. By contrast,

the detailed evaluations of the research and the well-supported conclusions reached by Dr. Israel and Dr. Lee were not challenged on cross-examination. Their conclusions were also consistent with the findings of reputable public health agencies and were supported by Dr. Fugate's testimony on behalf of Saw Creek. In light of this overwhelming evidence, there is no good basis to give any weight to Dr. Carpenter's extreme views. RD at 210, Fn. 57.

The ALJ noted that there are no federal exposure limits, and there are no state exposure limits in Pennsylvania. Only two states have adopted magnetic field exposure limits for transmission lines: New York has a limit of 200 mG at the edge of the transmission line right-of-way, and Florida has a limit of 150-250 mG depending on the size of the transmission line. The International Commission on Non-Ionizing Radiation (ICNIRP) recommended in 1998 that the 60 Hz magnetic field exposures should not exceed 833 mG, and the IEEE recommended in 2003 that public exposures to 60 Hz magnetic fields should not exceed 9,000 mG. PPL St. 14-R at 18; RD at 213.

While the depth of genuine fear that was expressed by the residents of the Saw Creek Estates is not in question, this argument has no merit. The SCECA is relying upon a tortured reading of the Commission's regulation in using it to require a company to address stress and fear instead of the underlying reasons for those fears. The regulation is clearly meant to require a critical and objective review of the impact of a proposed line on the land itself. RD at 218.

The ALJ stated that although PPL has not addressed the actual *fears* of the public, it has addressed the underlying reasons for each and every one of those concerns. See, e.g., PPL Electric St. 5-R (rebuttal testimony of Jay A. Keeler, Supervising Engineer in Transmission and Distribution Design, and Electric and Magnetic Fields Issues and Manager for PPL); PPL E Sts. 3-R, 5-R, 20, 21, 15-R, 16-R, and 19-R; RD at 218.

In conclusion, the ALJ found that the SCECA has not presented sufficient evidence to counter the Company's presentation regarding the effects of this proposed transmission line. RD at 218.

Exceptions to the ALJ's Recommendation

In the SCECA's second Exception it stated that the ALJ erred by improperly rejecting evidence of the risks of diseases caused by magnetic fields. SCECA Exc at 7. The SCECA contends that the ALJ accepted the erroneous contention that the results of epidemiological studies on childhood leukemia are "inconsistent." RD FF 251-257. The SCECA states that while these results are not unanimous, they are consistent. SCECA Exc at 8.

In Reply, PPL states that the SCECA's attack on the sufficiency of the ALJ's Decision related to electronic and/or magnetic fields is without merit. PPL states that the SCECA does not identify any EMF evidence that was not duly considered by the ALJ. PPL RExc at 22. PPL also states that the ALJ considered all of the scientific evidence, and based upon a careful evaluation of that evidence and the credibility of the expert witnesses, reached a well-founded conclusion that the scientific research does not provide a reliable basis to find that exposure to EMF causes or contributes to adverse health effects in adults or children. PPL RExc at 22.

Disposition of the Issue

We agree with the ALJ regarding the testimony of the SCECA witness Dr. Carpenter. When the record is viewed in its entirety it is clear that Dr. Carpenter's testimony is his largely unsubstantiated (albeit heartfelt) opinion that EMF poses a health threat at any level. We find the evidence presented by PPL to be persuasive on this issue

and shall adopt the finding of the ALJ that *inter alia* PPL has addressed the underlying reasons for the fears expressed by the residents of the Saw Creek Community. Accordingly, the Exceptions of SCECA are denied.

6. Real Estate Values

Positions of the Parties

The SCECA presented testimony to indicate that PPL's proposed S-R Line project would have a negative effect on the real estate values in the Saw Creek Estates. The SCECA asserts that the proposed towers will significantly detract from the quality of the views in the Saw Creek Community.

The proposed towers will constitute a significant change to the existing landscape and viewshed. "The existing towers, at an average height of 83 feet, are from many points within Saw Creek completely hidden by the existing tree line. ... the [proposed] towers/lines will be at least twice as tall as the highest surrounding trees, and those towers and lines will become visible from locations which now have no view of the existing towers and lines. The visual effect will be like an elevated rail fence (or, alternatively, a music staff), running north/south across the easterly slope of the Saw Creek valley, with highly-visible conductors between towers, unlike the present lines, where conductors are barely visible from a distance. SCECA St. 3 at 12, 13; RD at 243.

To evaluate the real estate conditions regarding values with respect to Saw Creek, 15 people were interviewed concerning recent sales or attempted sales – 14 buyers and 1 seller. Tr.1928; RD at 243. Two buyers were not sure whether knowledge of the proposed line would have affected their decision to buy the property, two buyers said it

STATE OF MINNESOTA
OFFICE OF ADMINISTRATIVE HEARINGS
FOR THE PUBLIC UTILITIES COMMISSION

***In the Matter of the Route Permit Application by Great River Energy
and Xcel Energy for a 345 kV Transmission Line from Brookings
County, South Dakota to Hampton, Minnesota***

OAH Docket No. 7-2500-20283-2
MPUC Docket No. ET-2/TL-08-1474

**FINDINGS OF FACT, CONCLUSIONS
AND RECOMMENDATION**

B. Effects on Public Health and Safety

182. Minnesota high voltage transmission line routing criteria require consideration of the Project's effect on health and safety.²⁸¹

183. Applicants will ensure that all safety requirements are met during the construction and operation of the proposed transmission line and Associated Facilities.²⁸²

184. The Project will be designed and constructed according to local, State, and National Electric Safety Code (NESC) standards regarding ground clearance, crossing utilities clearance, and building clearance.²⁸³

185. The proposed transmission lines will be equipped with protective devices (breakers and relays located where transmission lines connect to substations) to safeguard the public in the event of an accident or if the structure or conductor falls to the ground.²⁸⁴

186. In addition, the Associated Facilities will be properly fenced and accessible only by authorized personnel.²⁸⁵

1. Electric and Magnetic Fields

187. Minnesota Statute § 216E.03, subd. 7 requires consideration of the effects of electric and magnetic fields resulting from the Project on public health and welfare.²⁸⁶

188. Electric and magnetic fields ("EMF") are produced by natural sources and by the voltages and currents associated with our society's use of electric power.²⁸⁷ Consequently, each of us every day encounters a wide variety of natural and man-made EMF.²⁸⁸ For example, exposure to these fields happens at home when the television, lamp or fan is on; using the computer to send e-mail; using a washer or dryer, or using an electric or microwave oven.²⁸⁹

²⁸¹ Minn. Stat. § 216E.03, subd. 7(b)(1); Minn. R. 7850.4100(B).

²⁸² Ex. 2 at p. 6-6 (Application).

²⁸³ Ex. 2 at p. 6-4 (Application).

²⁸⁴ *Id.*

²⁸⁵ Ex. 2 at p. 6-4 (Application).

²⁸⁶ Minn. Stat. § 216E.03, subd. 7.

²⁸⁷ Ex. 106 at p. 3 (Rasmussen Direct).

²⁸⁸ Ex. 108 at Schedule 2 at p. 2 (Valberg Direct).

²⁸⁹ Ex. 2 at p. 3-13 (Application); Ex. 108 at Schedule 2 at p. 2 (Valberg Direct).

189. Electric and magnetic fields also exist near wherever electricity is being generated and transmitted.²⁹⁰

190. The amount of electric charge on a metal wire, which is expressed as voltage, creates an electric field on other nearby charges.²⁹¹

191. When electric charges in the conductor are in motion, they produce an electric current, which is measured in amperes, and a wire with an electric current creates a magnetic field ("MF") that exerts forces on other electric currents.²⁹² MF levels become lower farther away from the source.²⁹³

192. The electric and magnetic fields associated with power lines are often designated as extremely-low-frequency EMF ("ELF-EMF").²⁹⁴

193. ELF-EMF are distinct from the high-frequency electric and magnetic fields associated with radio, television, and cell-phone signals.²⁹⁵ Radio and television electric and magnetic fields are meant to propagate away from an antenna and as a result carry radiofrequency energy ("RF") to the receiver.²⁹⁶ The EMF from power lines is too low in frequency to carry energy away, and the electric energy stays on the power lines.²⁹⁷ Therefore, ELF-EMF should not be called "radiation" or "emission" or confused with "ionizing radiation" such as X-rays.²⁹⁸

194. While there is no federal standard for transmission line electric fields, the Commission has imposed a maximum electric field limit of 8 kV/meter measured at one meter above the ground.²⁹⁹

195. The maximum electric field associated with Applicants' proposal, measured at one meter above the ground, is calculated to be 3.73 kV/m.³⁰⁰

²⁹⁰ Ex. 108 at Schedule 2 at p. 1 (Valberg Direct).

²⁹¹ *Id.*

²⁹² Ex. 108 at Schedule 2 at pp. 1-2 (Valberg Direct).

²⁹³ Ex. 108 at Schedule 2 at p. 2 (Valberg Direct); Carpenter Vol. 2B at p. 65.

²⁹⁴ Ex. 108 at Schedule 2 at p. 1 (Valberg Direct).

²⁹⁵ Ex. 108 at Schedule 2 at p. 2 (Valberg Direct).

²⁹⁶ Ex. 108 at Schedule 2 at pp. 2-3 (Valberg Direct).

²⁹⁷ Ex. 108 at Schedule 2 at p. 3 (Valberg Direct).

²⁹⁸ Ex. 108 at Schedule 2 at p. 3 (Valberg Direct).

²⁹⁹ *See In the Matter of the Petitions of Northern States Power Company d/b/a Xcel Energy and Dairyland Cooperative for Permits to Construct a 115 kV and 161 kV Transmission Line from Taylors Falls to Chisago County Substation*, Docket No. E-002/TL-06-1677, Environmental Assessment at p. 45 (Aug. 20, 2007); Ex. 23 at p. 6-5 (DEIS).

³⁰⁰ Ex. 2 at pp. 3-13, 3-14 (Application).

196. There is no federal standard for transmission line magnetic fields.³⁰¹ Presently, Minnesota also does not have any regulations regarding transmission line magnetic fields.³⁰² Other states that do have standards, such as Florida, Massachusetts, and New York, have established MF limits of 200 milligauss (mG) (for transmission lines 230-500 kV), 85 mG, and 200 mG, respectively, measured from the edge of transmission line rights-of-way.³⁰³

197. These established MF limits are far above the highest projected MF level of 42.28 mG at the edge of the right-of-way during peak operation that will be created by the Project.³⁰⁴

198. Applicants proffered an expert witness, Dr. Peter A. Valberg, to provide testimony on public health policy and the state of scientific research on whether exposure to ELF-EMF causes health effects.³⁰⁵

199. Dr. Valberg's background includes physics, physiology, and public health expertise. He holds graduate degrees both in physics and human physiology, and he has served on university faculties in both physics and public health.³⁰⁶ Dr. Valberg is the author of more than 80 peer-reviewed articles on environmental health and cell biology. He advises researchers in the physical phenomena associated with RF EMF, including its impacts on human biology, and epidemiology.³⁰⁷ Dr. Valberg has directed health risk assessments for municipal health departments, utilities, regulatory agencies, and industry on evaluation of potential health effects from exposure to EMF and RF.³⁰⁸

200. Dr. Valberg is of the opinion that there is scientific agreement on the issue of whether electric fields from power-lines cause health effects: "studies of electric fields have not suggested any links to health, and the reviews of public health agencies (e.g., the World Health Organization) have not identified health risk concerns relating to power-line electric field."³⁰⁹

³⁰¹ Ex. 108 at Schedule 2 at p. 16 (Valberg Direct).

³⁰² Ex. 23 at p. 6-6 (DEIS).

³⁰³ Ex. 108 at Schedule 2 at p. 17 (Valberg Direct).

³⁰⁴ Ex. 2 at p. 3-21 (Application).

³⁰⁵ Ex. 108 (Valberg Direct); Ex. 109 (Valberg Rebuttal).

³⁰⁶ Ex. 108 at pp. 1-4 (Valberg Direct).

³⁰⁷ Ex. 108 at Schedule 1 (Valberg Direct).

³⁰⁸ *Id.*

³⁰⁹ Ex. 108 at p. 5 (Valberg Direct); Ex. 108 at Schedule 2 at p. 2 (Valberg Direct).

201. Regarding MF, Dr. Valberg observed that "EMF health-effects research was triggered initially by an association reported between an index of power-line MF and statistics on whether or not a child had leukemia."³¹⁰

202. The study by Nancy Wertheimer and Ed Leeper, published in a 1979 issue of the *American Journal of Epidemiology*, started the research and interest in the associations between ELF-MF and various health outcomes.³¹¹

203. This initial study was an epidemiological study. Epidemiological studies look for "associations," which means checking to see whether the frequency of occurrence of two events are correlated.³¹² Epidemiological studies are inherently limited by issues of confounding, measurement error and selection bias. These inherent limitations restrict the value of epidemiological studies and require scientists and researchers to confirm the associations suggested by epidemiological studies with toxicological testing and supportive experimental results.³¹³

204. In light of the suggestive associations made by a few epidemiological studies, laboratory experiments were undertaken to determine "whether or not laboratory evidence does or does not support a MF health risk."³¹⁴

205. Over the more than 30 years since the first study, however, Dr. Valberg noted that "epidemiology has not yielded more definitive links to MF exposure" even as the studies improved in design and included larger populations of subjects.³¹⁵

206. Dr. Valberg noted that scientists have not been able to establish a laboratory or other model that reliably demonstrates adverse biological changes in response to typical electric-power MF fields.³¹⁶ In fact, "[a] large number of studies with laboratory animals exposed, over their lifetimes, to MF levels a thousand-fold higher than near power lines yielded 'no effect'...."³¹⁷ Furthermore, "laboratory research with isolated cells and biophysical analyses have not identified plausible mechanisms by which MF at levels encountered near transmission lines...can lead to the creation or stimulation of tumor cells."³¹⁸

³¹⁰ Ex. 108 at Schedule 2 at p. 4 (Valberg Direct).

³¹¹ Carpenter Vol. 2B at p. 76.

³¹² Ex. 108 at Schedule 2 at p. 4 (Valberg Direct).

³¹³ Ex. 109 at pp. 9-10 (Valberg Rebuttal).

³¹⁴ Ex. 108 at Schedule 2 at p. 4 (Valberg Direct).

³¹⁵ *Id.*

³¹⁶ Ex. 108 at p. 5 (Valberg Direct). Ex 108 at Schedule 2 at p. 5 (Valberg Direct).

³¹⁷ Ex. 108 at Schedule 2 at p. 4 (Valberg Direct).

³¹⁸ *Id.*

207. Dr. Valberg concluded that power line MF is an "implausible source of human health risk."³¹⁹

208. Dr. Valberg's conclusions are consistent with the EMF research conducted by reputable international and national health academics.³²⁰ Dr. Valberg's conclusions are also consistent with the Minnesota Interagency Working Group "White Paper on Electric and Magnetic Field (EMF) Policy and Mitigation Options" published in 2002 by the Minnesota Department of Health.³²¹ This white paper found that "Most researchers [have] concluded that there is insufficient evidence to prove an association between EMF and health effects"³²²

209. Other than Dr. Valberg, the only witness to provide testimony on EMF during the contested case hearing was the Johnsons' witness Dr. David Carpenter.³²³

210. Dr. Carpenter contended that exposures to EMF of greater than 4 mG was a risk factor for childhood leukemia and greater than 2 mG for amyotrophic lateral sclerosis (ALS), and Alzheimer's disease.³²⁴ The information relied upon for these conclusions was derived from a variety of studies, including metastudies, none of which established a causal relationship between EMF-ELF exposure levels and any disease. Further, Dr. Carpenter noted "that exposure to other household sources of magnetic fields also elevate the risk of childhood leukemia."³²⁵ Dr. Carpenter also noted that "the evidence of risk [of health concerns posed by magnetic fields of 2 mG or greater] is not conclusive."³²⁶ The lack of a conclusive connection between EMF-ELF exposure and any particular disease is borne out by the studies assessing the impact of occupational exposure on disease discussed by Dr. Carpenter. Varying results were obtained when studying the health history of workers in occupations requiring frequent exposure to high levels of EMF-ELF.³²⁷ There is no animal study model that demonstrates the development of cancer in response to exposure to EMFs.³²⁸

211. A number of commentators cited studies that claimed associations exist between ELF-EMF exposure and childhood leukemia, amyotrophic lateral sclerosis (ALS), and Alzheimer's disease. These studies relied upon the concept of the

³¹⁹ Ex. 108 at p. 6 (Valberg Direct).

³²⁰ Ex. 108 at Schedule 2 at pp. 19-23 (Valberg Direct).

³²¹ Ex. 147 (White Paper on EMF).

³²² *Id.*

³²³ Ex. 200 (Carpenter Direct).

³²⁴ Ex. 200 at p. 4 (Carpenter Direct).

³²⁵ Ex. 200 at p. 10 (Carpenter Direct).

³²⁶ Ex. 200 at p. 11 (Carpenter Direct).

³²⁷ Ex. 200 at p. 11 (Carpenter Direct).

³²⁸ Ex. 200 at p. 14 (Carpenter Direct); Applicants Reply, at 23-24.

Precautionary Principle to support assertions that ELF/EMF standards are underprotective in the face of the uncertainties of current science. The documented response to very low-level ELF and RF exposures was the observed production of "stress proteins" by cells. This observation is inferred to mean that "the cell recognizes ELF and RF exposures as harmful."³²⁹ There is no description of any mechanism of causation between this protein production and any of the conditions claimed as associated with ELF-EMF exposure.³³⁰

212. The Applicants pointed out that "Several of the studies relate to research on ELF-MF exposures many orders of magnitude higher than the highest peak field calculated for the Project."³³¹ The exceptionally high levels of exposure to EMF-ELF support the conclusion that the studies relied upon by Dr. Carpenter are not probative to assessing the impact of the Project's HVTL on the health and safety of persons living in the vicinity of the route.

213. The DEIS contains significant discussion of the issues of EMF-ELF exposure and a related issue, stray voltage. Regarding the impact of electric fields, the DEIS states:

For the proposed Project the highest calculated electric fields at 100 and 200 feet from transmission centerline would be 0.35 kV/m and 0.12 kV/m, respectively, with the lowest overall field strength of 0.02 kV/m at 300 feet from centerline. These electric field strengths are well within the range of electric fields generated by other common household and business sources. No adverse effects from electric fields on health are expected for persons living or working at locations along or near the proposed Project.³³²

214. As for magnetic fields, the DEIS states:

The results of the various studies conducted over the last three decades, specifically those regarding the relationship between EMF and childhood leukemia and other cancer risks, have been mixed; some have found an association while others have not.

Where there is association suggested in epidemiological studies, it is usually very near the statistical threshold of significance. However, when these studies are repeated in a laboratory, the results have not reproduced or identified a biological mechanism to support a link between

³²⁹ Jeffrey Otto Comment, January 12, 2010 (Doc. Id. 20101-46263-03)(quoting *BioInitiative Report: A Rationale for a Biologically-based Public Exposure Standard for Electromagnetic Fields (ELF and RF)*, at 17 (co-edited by Dr. Carpenter); Ex. 200 at p. 16 (Carpenter Direct).

³³⁰ Johnson Reply Brief, at 1-2.

³³¹ Applicants' Reply Brief, at 20-21.

³³² Ex. 23, DEIS Section 6.2, at 6-4 (Doc. Id. 200910-43110-09).

childhood leukemia and magnetic fields. The replication of field results in a laboratory setting is a basic test of scientific validity. Researchers continue to look at magnetic fields until more certain conclusion can be reached.³³³

215. The DEIS suggests that EMF-ELF impacts, to whatever extent such impacts exist, can be mitigated through distance from the HVTL, compaction between transmission line phases, and phase cancellation along the HVTL.³³⁴

216. The absence of any demonstrated impact by EMF-ELF exposure supports the conclusion that there is no demonstrated impact on human health and safety that is not adequately addressed by the existing State standards for such exposure. The record shows that the current exposure standard for EMF-ELF is adequately protective of human health and safety.

217. Linda Brown, John H. Sullivan and Jan Campe, Secretary of the Le Sueur Saddle Club, expressed concern over the impact of stray voltage on animals.³³⁵ The DEIS describes stray voltage as "a grounding issue that can occur on the electric service entrances to structures from distribution lines—not transmission lines." Based on the experiences arising through the interaction of dairy cattle and electricity, the DEIS proposed resolution of any such issues in the context of this HVTL route proceeding as follows:

Transmission lines do not, by themselves, create stray voltage because they do not connect to businesses or residences. However, transmission lines can induce stray voltage on a distribution circuit that is parallel to and immediately under the transmission line. Proper design and pole placement can reduce or eliminate stray voltage effects from the transmission lines. The applicants would be required to remedy any stray voltage issues as a condition of a route permit.³³⁶

218. Stray voltage that is induced by the proposed HVTL is appropriately remedied by the Applicants. Imposition of a condition by the Commission such as that noted above is supported by the record.

³³³ Ex. 23, DEIS Section 6.2, at 6-8 (Doc. Id. 200910-43110-09).

³³⁴ *Id.*

³³⁵ Sullivan Comment, January 14, 2010 (Doc. Id. 20101-46263-02); Campe Comment, January 12, 2010 (Doc. Id. 20101-46263-02).

³³⁶ Ex. 23, DEIS Section 6.2.2, at 6-9 (Doc. Id. 200910-43110-09).

FILE

IN CLERKS OFFICE

SUPREME COURT, STATE OF WASHINGTON

DATE MAR 07 2013

Madsen, C. J.
CHIEF JUSTICE

This opinion was filed for record
at 8:00 am on March 7, 2013

Ronald R. Carpenter
Supreme Court Clerk

IN THE SUPREME COURT OF THE STATE OF WASHINGTON

CATHERINE LAKEY, a single woman;)	No. 87679-7
GERTHA RICHARDS, a single woman;)	
MICHAEL HESLOP, a single man;)	En Banc
TROY FREEMAN and CAROLINA AYALA de)	
FREEMAN, husband and wife; PATRICK)	Filed <u>MAR 07 2013</u>
MCCLUSKY and MICHELLE MCCLUSKY,)	
husband and wife; SHAHNAZ BHUIYAN)	
and ANN RAHMAN; husband and wife;)	
STEVEN RYAN and NORA RYAN,)	
husband and wife; KEVIN CORBETT and)	
MARGARET CORBETT, husband and wife;)	
KATHRYN MCGIFFORD, a single woman;)	
and JACQUELYN MILLER, a single woman,)	
)	
Appellants,)	
)	
v.)	
)	
PUGET SOUND ENERGY, INC., a Washington)	
corporation; and CITY OF KIRKLAND, a)	
Washington municipal corporation,)	
)	
Respondents.)	

FAIRHURST, J.—Catherine Lakey, Gertha Richards, Michael Heslop, Troy
Freeman and Carolina Ayala de Freeman, Patrick and Michelle McClusky,
Shahnaz Bhuiyan and Ann Rahman, Steven and Nora Ryan, Kevin and Margaret

EKPC
Exhibit

14

Corbett, Kathryn McGifford, and Jacquelyn Miller (hereinafter the homeowners) own property bordering a parcel owned by Puget Sound Energy, Inc. (PSE) where an electrical substation has been located for over 50 years. The homeowners sued PSE and the city of Kirkland (City) after PSE constructed a new neighborhood power substation on PSE's property. The homeowners seek review of the trial court's decision to exclude the testimony of their expert under the rule announced in *Frye v. United States*, 54 App. D.C. 46, 293 F. 1013 (1923), and its ultimate decision to grant summary judgment to PSE on the homeowners' nuisance claim.¹ The homeowners also seek review of the trial court's decisions to apply the provisions of the Land Use Petition Act (LUPA), chapter 36.70C RCW, to their inverse condemnation claim and to grant summary judgment to the City on this claim. Although we reverse the trial court's *Frye* and LUPA rulings, we affirm its decisions disposing of the homeowners' claims.

I. FACTS AND PROCEDURAL HISTORY

The homeowners each own property near a parcel owned by PSE in the Juanita neighborhood of Kirkland, Washington. PSE bought its property in 1958 and built the original substation in 1960. For 52 years, there has been a substation on the property. In 2008, in order to satisfy growing electrical demand in Kirkland,

¹Because the trial court considered matters outside the pleadings in disposing of the homeowners' claim against PSE, we treat the trial court's order of dismissal as a grant of summary judgment to PSE.

PSE sought to replace the existing substation with a new one. The planned new substation had the added advantage of having two transformers, providing redundancy in case a transformer failed, a feature lacking at the old substation. Because the new substation was larger and did not comply with the City's zoning code, PSE applied for a variance from the applicable ordinances.²

The City's hearing examiner approved PSE's variance application after holding a public hearing. The homeowners appealed to the Kirkland City Council, but the council affirmed the variance decision. The homeowners did not appeal the council's decision with a land use petition.

PSE constructed the substation and in early 2010 it went on line. The homeowners thereafter filed suit against PSE in King County Superior Court. The homeowners alleged that the electromagnetic fields (EMFs) emanating from the substation trespassed on their property and constituted both a public and private nuisance. The homeowners claimed they reasonably feared exposure to the EMFs emitted by the substation and that this was injurious to their health and interfered with the use and enjoyment of their property.

PSE moved to dismiss with prejudice all of the homeowners' claims under CR 12(b)(6). PSE argued, among other things, that the homeowners could not

²The Kirkland Zoning Code requires public utilities located within a residential area to have 20 foot side yard setbacks, "Type A" landscape buffering, and limits buildings to 30 feet in height. Clerk's Papers at 1590. PSE sought a 13 foot setback along the property lines, with associated modifications to the required buffers, and the ability to build structures 35 feet tall.

reasonably fear the EMFs emitted by the substation because, PSE contended, the fields have no deleterious health effects. After reviewing PSE's motion, the trial court ordered the homeowners to submit scientific evidence to support their claims.

The homeowners submitted multiple declarations, including sworn statements by experts Dr. Be Kun Li and Dr. David Carpenter, to which they attached scientific studies and statements made by governmental bodies. The homeowners contend these attachments show the adverse health effects of, and therefore the reasonableness of the homeowners' fears of, EMF exposure.

PSE moved to exclude the testimony of Li and Carpenter under ER 702 and the rule announced in *Frye*.³ The trial court ordered a *Frye* hearing on the admissibility of the testimony.

In the interim between PSE's motion to dismiss and the *Frye* hearing, the homeowners moved to amend their complaint to add the City as a defendant and

³As the *Frye* court stated:

Just when a scientific principle or discovery crosses the line between the experimental and demonstrable stages is difficult to define. Somewhere in this twilight zone the evidential force of the principle must be recognized, and while courts will go a long way in admitting expert testimony deduced from a well-recognized scientific principle or discovery, the thing from which the deduction is made must be sufficiently established to have gained general acceptance in the particular field in which it belongs.

293 F. at 1014.

alleged that the City's decision to grant PSE the variance amounted to an inverse condemnation.⁴

At the three day *Frye* hearing, both sides offered expert testimony. The homeowners offered Carpenter who testified that he concluded that EMF was a possible cause of childhood and adult leukemia, Alzheimer's disease, amyotrophic lateral sclerosis, and infertility. Carpenter also testified about the methodology he employed to reach his conclusions. Carpenter explained that he performed no original research. Instead, he performed a literature review, reanalyzing data collected by others as part of peer reviewed epidemiological studies.⁵ Carpenter stated that this was a generally accepted practice used by governmental agencies to decide whether to list an agent as capable of causing human disease. Carpenter did admit, however, that he discounted studies and data that showed no EMF-disease link when reaching his conclusions, especially newer studies. He also testified that he reached his conclusions about the health effects of EMF exposure using epidemiological studies alone and without considering toxicological studies.⁶

PSE called Dr. Nancy Lee and Dr. Mark Israel. PSE offered Lee as an expert in epidemiology and she began her testimony with an overview of epidemiological

⁴The trial court apparently prompted this decision by asking the homeowners why they had not appealed the council's variance decision under LUPA.

⁵Epidemiology measures the health effects of exposure to an agent by comparing the incidence of disease in exposed and unexposed populations.

⁶Toxicological studies measure the incidence of disease in animals exposed to measured doses of an agent.

practices. Lee explained that epidemiology has protocols to ensure accurate and reliable results. Lee then testified that Carpenter had failed to comply with these protocols by failing to consider all the data relevant to a link between EMF exposure and illness and that his failure to do so violated generally accepted epidemiological practices. Specifically, Lee testified that Carpenter had selectively ignored numerous studies that contradicted his conclusions, including the most recent studies about EMF exposure. Lee also noted that Carpenter had not only selectively ignored studies that disagreed with his conclusions, but he had even selectively ignored data within studies, creating a distorted view of the effects of EMF exposure. Lee testified that this approach also violated established epidemiological protocols.

Both Lee and Israel also testified that proper epidemiological methodology required consideration of the toxicological studies, which showed no correlation between EMF exposure and illness. In their opinion, Carpenter's methodology violated established epidemiological protocols.

The trial court ruled Carpenter's testimony was inadmissible at the end of the *Frye* hearing. The trial court determined that Carpenter's theories lacked general acceptance in the scientific community and that he had failed to follow proper epidemiological methodology, rendering his conclusions unreliable. Consequently, the trial court excluded Carpenter's opinion under *Frye*. After

excluding Carpenter's testimony, the trial court granted PSE's motion "to the extent that [the homeowners] cannot bring a nuisance or trespass claim based on the presence of [EMFs]." Clerk's Papers at 1422.

After hearing the City's motion for summary judgment, the trial court ruled that the homeowners were required to appeal the City's decision to grant the variance under LUPA. Because the homeowners had failed to timely file a LUPA petition, the trial court granted the City summary judgment on the inverse condemnation claim.

The homeowners appealed, and the Court of Appeals certified the appeal to this court pursuant to RCW 2.06.030.

II. ISSUES

1. Did the trial court properly exclude Carpenter's testimony under *Frye* on the nuisance claim to PSE?
2. Did the trial court properly grant summary judgment on the nuisance claim?
3. Did the trial court properly interpret LUPA as applying to the inverse condemnation claim brought against the City?
4. Did the trial court properly grant summary judgment on the inverse condemnation claim?

III. ANALYSIS

A. The Homeowners' Nuisance Claim against PSE

The homeowners assign error to two trial court decisions regarding their nuisance claim against PSE. First, they appeal the trial court's order excluding Carpenter's testimony because they claim that his testimony did not involve novel scientific evidence. Second, they appeal the trial court's ultimate decision to grant PSE summary judgment.

1. *The trial court improperly excluded Carpenter's testimony under Frye but properly excluded it under ER 702*

The trial court must exclude expert testimony involving scientific evidence unless the testimony satisfies both *Frye* and ER 702. *State v. Copeland*, 130 Wn.2d 244, 255-56, 922 P.2d 1304 (1996). To admit evidence under *Frye*, the trial court must find that the underlying scientific theory and the “techniques, experiments, or studies utilizing that theory” are generally accepted in the relevant scientific community and capable of producing reliable results. *Anderson v. Akzo Nobel Coatings, Inc.*, 172 Wn.2d 593, 603, 260 P.3d 857 (2011) (quoting *State v. Riker*, 123 Wn.2d 351, 359, 869 P.2d 43 (1994)). To admit expert testimony under ER 702, the trial court must determine that the witness qualifies as an expert and

the testimony will assist the trier of fact.⁷ *State v. Cauthron*, 120 Wn.2d 879, 890, 846 P.2d 502 (1993). Unreliable testimony does not assist the trier of fact. *Anderson*, 172 Wn.2d at 600. *Frye* and ER 702 work together to regulate expert testimony: *Frye* excludes testimony based on novel scientific methodology until a scientific consensus decides the methodology is reliable; ER 702 excludes testimony where the expert fails to adhere to that reliable methodology. *Cauthron*, 120 Wn.2d at 889-90.

We review de novo a trial court's exclusion of evidence under *Frye*. *Anderson*, 172 Wn.2d at 600. We review a trial court's decision concerning the admissibility of expert testimony for an abuse of discretion. *State v. Yates*, 161 Wn.2d 714, 762, 168 P.3d 359 (2007). A trial court abuses its discretion by issuing manifestly unreasonable rulings or rulings based on untenable grounds, such as a ruling contrary to law. *Wash. State Physicians Ins. Exch. & Ass'n v. Fisons Corp.*, 122 Wn.2d 299, 339, 858 P.2d 1054 (1993).

PSE argues that *Frye* requires the exclusion of Carpenter's testimony because of what it views as his unreliable methodology. *Frye* is implicated only where "either the theory and technique or method of arriving at the data relied upon is so novel that it is not generally accepted by the relevant scientific

⁷ER 702 provides that "[i]f scientific, technical, or other specialized knowledge will assist the trier of fact to understand the evidence or to determine a fact in issue, a witness qualified as an expert by knowledge, skill, experience, training, or education, may testify thereto in the form of an opinion or otherwise."

community.” *Anderson*, 172 Wn.2d at 611. While *Frye* governs the admissibility of novel scientific testimony, the application of accepted techniques to reach novel conclusions does not raise *Frye* concerns.⁸ *Anderson*, 172 Wn.2d at 611; *State v. Gore*, 143 Wn.2d 288, 302, 21 P.3d 262 (2001) (declaring that *Frye* only examines whether evidence is based on novel scientific methodology), *overruled on other grounds by State v. Hughes*, 154 Wn.2d 288, 110 P.3d 192 (2005); *State v. Roberts*, 142 Wn.2d 471, 520-21, 14 P.3d 713 (2000) (stating that conclusions based on nonnovel methods of scientific proof are not susceptible to exclusion under *Frye*); *Reese v. Stroh*, 128 Wn.2d 300, 306, 907 P.2d 282 (1995); *Frye*, 293 F. at 1014 (“[T]he thing from which the deduction is made must be sufficiently established to have gained general acceptance in the particular field in which it belongs.”). In *Anderson*, we noted that using epidemiological studies to reach new conclusions about the correlation between exposure to an agent and disease by comparing the rates of disease in exposed and unexposed populations did not raise *Frye* concerns and is generally accepted. *Anderson*, 172 Wn.2d at 603-04, 611-12. Carpenter performed a literature review and used the data from peer reviewed epidemiological studies to reach his conclusions. *Frye* therefore does not apply to

⁸PSE cited *Grant v. Boccia*, 133 Wn. App. 176, 137 P.3d 20 (2006) and *Ruff v. Department of Labor & Industries*, 107 Wn. App. 289, 28 P.3d 1 (2001) in its trial court briefing. These cases required general acceptance of an expert’s conclusion about causation in order to admit the expert’s testimony. We explicitly overruled this requirement in *Anderson*, which we decided after the trial court made its decision. 172 Wn.2d at 612.

Carpenter's testimony. Any novelty came in Carpenter's conclusions, but novel conclusions do not implicate *Frye*. *Anderson*, 172 Wn.2d at 611-12.

Further, under *Frye* we only look generally at whether a theory has accepted and reliable mechanisms for implementing it. *Cauthron*, 120 Wn.2d at 888-90. Lee testified that epidemiology has controls to assure the reliable production of data. When a scientific theory has protocols for assuring reliability, an expert's errors in applying proper procedures go to the weight, not the admissibility, of the evidence, unless the error renders the evidence unreliable. *Copeland*, 130 Wn.2d at 270-71. In such cases, the trial court may use other rules, such as ER 702, to exclude the testimony. *Anderson*, 172 Wn.2d at 606; *Cauthron*, 120 Wn.2d at 890.

PSE invites us, alternatively, to affirm the exclusion of Carpenter's testimony under ER 702. The trial court's *Frye* order excluding the testimony found that Carpenter's testimony was unreliable and therefore failed the helpfulness requirement of ER 702. While the parties have framed this appeal as involving a *Frye* issue, we believe the trial court correctly understood PSE's objections to Carpenter's methods as challenging his testimony under ER 702. We affirm the trial court's decision to exclude Carpenter's testimony on these grounds.

Carpenter failed to follow proper methodology, rendering his conclusions unreliable and therefore inadmissible. Carpenter did not consider all relevant data as basic epidemiology required. Carpenter discounted entire epidemiological and

toxicological studies, especially the newer epidemiological studies. Carpenter failed to consider the later, better studies about the links between EMF and health harms, seriously tainting his conclusions because epidemiology is an iterative science relying on later studies to refine earlier studies in order to reach better and more accurate conclusions. Carpenter refused to account for the data from the toxicological studies, which epidemiological methodology requires unless the evidence for the link between exposure and disease is unequivocal and strong, which is not the case here. Carpenter also selectively sampled data within one of the studies he used, taking data indicating an EMF-illness link and ignoring the larger pool of data within the study that showed no such link. Carpenter's treatment of this data created an improper false impression about what the study actually showed.

The trial court possessed the discretion to find that Carpenter's failure to follow proper methodology rendered his epidemiological conclusions unreliable and unhelpful to the jury as a matter of law. Carpenter's admission that he selectively used data created the appearance that he attempted to reach a desired result, rather than allow the evidence to dictate his conclusions. The trial court did not act in a manifestly unreasonable manner in excluding his testimony, and we will not disturb its decision.

2. *The trial court properly granted PSE summary judgment on the nuisance claim*

CR 12(b)(6) allows a defendant to move for dismissal where the pleadings do not state a claim for which a court may grant relief. However, CR 12(b) mandates that where a trial court considers “matters outside the pleading[s]” and does not exclude them, “the motion shall be treated as one for summary judgment and disposed of as provided in rule 56.” *Right-Price Recreation, LLC v. Connells Prairie Cmty. Council*, 146 Wn.2d 370, 381, 46 P.3d 789 (2002) (quoting CR 12(b)). Where the trial court has considered matters outside the pleadings, we review a trial court’s order as a grant of summary judgment. *Stevens v. Murphy*, 69 Wn.2d 939, 943, 421 P.2d 668 (1966), *overruled on other grounds by Merrick v. Sutterlin*, 93 Wn.2d 411, 610 P.2d 891 (1980).

Here, the trial court considered matters beyond the face of the complaint before ordering the homeowners to justify the merits of their claim. The homeowners complied by providing numerous declarations with attached exhibits. The trial court considered these declarations and the record does not show that the trial court excluded any of these materials, although it did exclude the testimony of Carpenter. Consequently, the homeowners’ appeal is reviewed as one from an order of summary judgment.

We review de novo a trial court's decision to grant summary judgment. *Mohr v. Grantham*, 172 Wn.2d 844, 859, 262 P.3d 490 (2011). We perform the same inquiry as the trial court and will affirm an order of summary judgment when "there is no genuine issue of material fact and the moving party is entitled to judgment as a matter of law." *Qwest Corp. v. City of Bellevue*, 161 Wn.2d 353, 358, 166 P.3d 667 (2007). We review the evidence in the light most favorable to the nonmoving party and draw all reasonable inferences in that party's favor. *Id.*⁹

Washington's statutory definition of "nuisance" includes activities that "annoy[], injure[] or endanger[] the comfort, repose, health or safety of others." RCW 7.48.120. Where a defendant's conduct causes a reasonable fear of using property, this constitutes an injury taking the form of an interference with property. *Ferry v. City of Seattle*, 116 Wash. 648, 662-63, 203 P. 40 (1922); *Everett v. Paschall*, 61 Wash. 47, 50-53, 111 P. 879 (1910). Importantly, we have indicated that this fear need not be scientifically founded, so long as it is not unreasonable. *Everett*, 61 Wash. at 50-51. PSE contends that the homeowners could not

⁹Even if we reviewed the trial court's order as a dismissal pursuant to CR 12(b)(6), we would still affirm the trial court. Just as with an order of summary judgment, we review de novo a trial court's decision to grant a CR 12(b)(6) motion. *San Juan County v. No New Gas Tax*, 160 Wn.2d 141, 164, 157 P.3d 831 (2007). We will affirm the trial court's decision where "it appears beyond doubt that the claimant can prove no set of facts, consistent with the complaint, which would justify recovery." *Id.* We may even consider hypothetical facts to determine whether a trial court properly dismissed a claim. *Kinney v. Cook*, 159 Wn.2d 837, 842, 154 P.3d 206 (2007). Here, the homeowners did not allege that PSE acted unreasonably. PSE would have no liability without such an allegation. *Bradley v. Am. Smelting & Ref. Co.*, 104 Wn.2d 677, 689, 709 P.2d 782 (1985). As discussed below, we do not believe the homeowners could prove, consistent with the allegations of the complaint, that PSE acted unreasonably.

reasonably fear EMF exposure. But for purposes of summary judgment, we must view the record in the light most favorable to the nonmoving party. The homeowners have placed studies that indicate some risk from EMF exposure, as well as warnings by governmental bodies about avoiding such exposure, in the record. Viewed in the light most favorable to PSE, we must assume the homeowners reasonably feared EMF exposure.

However, even accepting the homeowners' fear as reasonable, we still affirm the trial court's grant of summary judgment because no material issue of fact exists as to the reasonableness of PSE's conduct. *Bradley v. Am. Smelting & Ref. Co.*, 104 Wn.2d 677, 689, 709 P.2d 782 (1985) ("In private nuisance an intentional interference with the plaintiff's use or enjoyment is not of itself a tort, and unreasonableness of the interference is necessary for liability." (quoting THE RESTATEMENT (SECOND) OF TORTS § 821D cmt. d at 102 (1979))); *Grundy v. Thurston County*, 155 Wn.2d 1, 6, 117 P.3d 1089 (2005) ("Nuisance is a substantial and unreasonable interference with the use and enjoyment of land." (internal quotation marks omitted) (quoting *Bodin v. City of Stanwood*, 79 Wn. App. 313, 318 n.2, 901 P.2d 1065 (1995))).

We determine the reasonableness of a defendant's conduct by weighing the harm to the aggrieved party against the social utility of the activity. *Highline Sch. Dist. No. 401 v. Port of Seattle*, 87 Wn.2d 6, 17 n.7, 548 P.2d 1085 (1976); *Morin*

Lakey v. Puget Sound Energy, Inc., No. 87679-7

v. Johnson, 49 Wn.2d 275, 280, 300 P.2d 569 (1956). This determination requires us to look to, among other things, the character of the neighborhood where the activity occurs and the “degree of community dependence on the particular activity.” *Highline Sch. Dist.*, 87 Wn.2d at 17 n.7; *see also Jones v. Rumford*, 64 Wn.2d 559, 562-63, 392 P.2d 808 (1964). While reasonableness is typically a question of fact, a court may resolve such questions as a matter of law where reasonable minds could come to only one conclusion. *Harvey v. Snohomish County*, 157 Wn.2d 33, 43, 134 P.3d 216 (2006). Given the record here, reasonable minds could not determine that PSE acted unreasonably.

First, and most importantly, the neighborhood, including the homeowners, depends on the substation for the trappings of modern life. The substation provides power for the neighborhood. All manner of devices used in the home require electricity supplied from outside to function. Individuals who work at home, as does at least one of the homeowners, could not earn a living without the electricity provided by PSE. Any schools or businesses in the area similarly depend on the power distributed by the substation for operation. This dependence weighs heavily against the homeowners when we examine the “degree of community dependence” factor and supports that PSE’s conduct was not unreasonable. *Highline Sch. Dist.*, 87 Wn.2d at 17 n.7.

Second, PSE has operated a substation on this property for approximately 50 years. Nuisance measures the fit between an activity and the place where the defendant engages in that activity. *Morin*, 49 Wn.2d at 281. The record does not indicate whether the homeowners came to the nuisance by purchasing their property after the establishment of the original substation.¹⁰ See *DiBlasi v. City of Seattle*, 136 Wn.2d 865, 887-88, 969 P.2d 10 (1998). However, the continuous operation of a substation on the site has changed the character of the neighborhood, making PSE's use of its property for this purpose reasonable. The homeowners do not allege any change in the neighborhood that would make PSE's use of its property to distribute power a newly unsuitable use. *Powers v. Skagit County*, 67 Wn. App. 180, 189, 835 P.2d 230 (1992) (citing *Lucas v. S.C. Coastal Council*, 505 U.S. 1003, 112 S. Ct. 2886, 120 L. Ed. 2d 798 (1992)). Given the long history of using this property for distribution of power, we cannot say that PSE's substation does not fit with the neighborhood.

We determine that no reasonable juror could find the harm to the homeowners outweighs the social utility of PSE's conduct. The dependence of the neighborhood on the power distributed from the substation, along with the long use

¹⁰When asked at oral argument, counsel stated that all the homeowners owned their properties before the construction of the new substation but did not clarify if any homeowner owned property before the construction of the original substation. Wash. Supreme Court oral argument, *Lakey v. Puget Sound Energy, Inc.*, No. 87679-7 (Oct. 18, 2012), at 9 min., 8 sec., audio recording by TVW, Washington State's Public Affairs Network, available at <http://www.tvw.org>.

of the property for the very activity the homeowners complain of, leads us to conclude that the social utility of PSE's conduct outweighs the interference with the homeowners' enjoyment of their property due to their fears. The trial court properly granted PSE summary judgment.

B. The Homeowners' Claim against the City

The homeowners also appeal the trial court's grant of summary judgment to the City. The homeowners contend that because they seek compensation rather than to challenge the City's decision to issue the variance, the trial court erred by applying the procedures of LUPA to their claim, making it time barred. We agree with the homeowners' argument concerning LUPA but nevertheless affirm the trial court's grant of summary judgment because our decision in *Phillips v. King County*, 136 Wn.2d 946, 968 P.2d 871 (1998), precludes the homeowners' suit against the City as a matter of law.

1. *The trial court improperly applied the provisions of LUPA to the homeowners' inverse condemnation claim*

The homeowners appeal the trial court's determination that LUPA governed their inverse condemnation claim. This raises questions of statutory interpretation, which we review de novo. *Tingey v. Haisch*, 159 Wn.2d 652, 657, 152 P.3d 1020 (2007).

LUPA authorizes the courts to grant relief in six instances, including cases where a land use decision violates a party's constitutional rights. *Lauer v. Pierce County*, 173 Wn.2d 242, 252, 267 P.3d 988 (2011); RCW 36.70.130(1)(f). LUPA claims must be brought within 21 days of the land use decision. RCW 36.70C.060(2)(d), .040(1)-(3). The legislature intended LUPA to be, with certain exemptions, the “exclusive means” of obtaining “judicial review of land use decisions.” *James v. Kitsap County*, 154 Wn.2d 574, 583, 115 P.3d 286 (2005) (quoting RCW 36.70C.030). One exemption is for “[c]laims provided by any law for monetary damages or compensation.” RCW 36.70C.030(c).

An inverse condemnation action seeks constitutionally mandated “compensation” for governmental takings. WASH. CONST. art. I, § 16. The homeowners are seeking compensation. They do not seek a judicial review or reversal of the height, setback, or buffer variances.

The City claims that LUPA extends to “damage claims that a plaintiff may have that arise from issuance of [a] land use decision.” Resp’t City of Kirkland’s Appeal Br. at 11. The cases the City cites all involved damage claims where the relief required a judicial determination that the land use decision was invalid or partially invalid; none involved damages claims generally.¹¹ See RCW 36.70C.140

¹¹*James* involved a challenge to Kitsap County’s impact fees by several developers. 154 Wn.2d at 583. The county conditioned the granting of building permits on the payment of these impact fees. *Id.* We held that the developers needed to challenge this under LUPA as the

(listing remedies available through LUPA, including reversal or modification of a land use decision). The cases the City cites are inapposite to the homeowners' claim, which only seeks compensation rather than a reversal or modification of a land use decision.

Further, LUPA provides for judicial review of a local jurisdiction's land use decisions. The superior court is exercising its appellate jurisdiction. Here, the homeowners are making a claim that they could not make before the hearing

condition of payment was part of the permit. *Id.* at 583-86. In other words, the plaintiffs needed to show the illegality of part of the permit to succeed on their claims. *Id.* We rejected this as an attack on a land use decision time barred by LUPA. *Id.*

Mercer Island Citizens for Fair Process v. Tent City 4 involved a challenge by a group attempting to undo the grant of a temporary use permit (TUA). 156 Wn. App. 393, 395-96, 232 P.3d 1163 (2010). The court noted that the claims for damages under 42 U.S.C. § 1983 depended on the invalidity of the permit. The failure to properly challenge the permit therefore doomed those claims:

But as the case law recognizes, claims for damages based on a LUPA claim must be dismissed if the LUPA claim fails. Because all of the group's claims challenged the validity of the TUA and were therefore subject to LUPA, the group's failure to assert them within LUPA's time limitations requires dismissal of all the claims, including those for damages.

Id. at 405 (footnote omitted).

In *Asche v. Bloomquist*, 132 Wn. App. 784, 799-802, 133 P.3d 475 (2006), the plaintiffs filed both public and private nuisance claims against their neighbors for constructing what the Asches contended was a building that exceeded the restrictions found in the county zoning code. A provision of the county code declared that any structure violating the zoning code constituted a public nuisance. *Id.* at 799. The court then reasoned that the public nuisance claim depended on a determination that the county had improperly applied the zoning code to the neighbors' property; it noted that LUPA specifically covered these types of interpretative decisions. *Id.* Thus, the public nuisance claim depended on a challenge to the validity of the permit and failed. *Id.* at 801.

Shaw v. City of Des Moines, 109 Wn. App. 896, 37 P.3d 1255 (2002) involved a claim similar to the one in *Mercer Island Citizens*. The plaintiff claimed a land use decision violated his constitutional rights. Discussing his damages claims, the court reasoned that if the city of Des Moines had acted properly, Shaw would not have damages claims. *Shaw*, 109 Wn. App. at 901-02. The claim thus required the plaintiff to prove Des Moines had issued an invalid land use decision.

examiner. See RCW 35A.63.170; RCW 36.70.970 (authorizing municipalities and counties to give hearing examiners jurisdiction over permitting activities), Kirkland Municipal Code § 3.34 (creating the office of hearing examiner and authorizing the hearing examiner to make decisions pursuant to the city zoning codes, none of which mention eminent domain or inverse condemnation). The homeowners are not invoking the superior court's appellate jurisdiction and LUPA does not govern their claim.

We hold that LUPA does not apply to the homeowners' inverse condemnation claim and therefore their claim is not time barred.

2. *The trial court properly granted summary judgment on the inverse condemnation claim*

Even though LUPA does not govern the homeowners' claim, we nonetheless affirm the trial court's decision to grant summary judgment to the City. The City argues that the homeowners failed to establish the elements of an inverse condemnation action as a matter of law, based on our decision in *Phillips*, 136 Wn.2d at 946. We agree.

Washington State Constitution article I, section 16 states that "[n]o private property shall be taken or damaged for public or private use without just compensation having been first made." A property owner may bring an inverse condemnation claim to "recover the value of property which has been

appropriated in fact, but with no formal exercise of the power of eminent domain.” *Fitzpatrick v. Okanogan County*, 169 Wn.2d 598, 605, 238 P.3d 1129 (2010) (quoting *Dickgieser v. State*, 153 Wn.2d 530, 534-35, 105 P.3d 26 (2005)). To maintain an action for inverse condemnation, a plaintiff must show ““(1) a taking or damaging (2) of private property (3) for public use (4) without just compensation being paid (5) by a governmental entity that has not instituted formal proceedings.” *Id.* at 606 (quoting *Dickgieser*, 153 Wn.2d at 535).

We rejected governmental liability for permit approval under inverse condemnation theories in *Phillips*. In *Phillips*, after a neighboring development flooded their land, two landowners sued, among others, the county, based on the county’s issuance of a permit for the development’s drainage system. We declared that permitting did not involve a taking for public use. Concerns about proximate causation and subverting our public duty doctrine undergirded our analysis. *Phillips*, 136 Wn.2d at 960-66. We reasoned that allowing governmental liability merely for granting a permit turned governmental entities into guarantors or insurers for all private development, unfairly making the taxpayers liable for the actions of third parties. We also noted that liability under the permitting theory essentially assumed a duty owed by government to each property owner near to any private development. *Id.* This ran counter to our public duty doctrine. We therefore approved the Court of Appeals decision, holding that inverse

condemnation liability would lie against governmental entities only when the entities “‘appropriat[ed] the land, restrict[ed] its use through regulation, or caus[ed] damage by constructing a public project to achieve a public purpose,’” not for permitting decisions. *Id.* at 962 (quoting *Pepper v. J.J. Welcome Constr. Co.*, 73 Wn. App. 523, 530, 871 P.2d 601 (1994), *abrogated by Phillips v. King County*, 87 Wn. App. 468, 943 P.2d 306 (1997)).

Here, just as in *Phillips*, we hold that the City has no liability as a matter of law. The City did not directly appropriate any part of the homeowners’ lands. The City did not regulate the homeowners’ use of their lands. The City did not damage the homeowners’ properties by “‘constructing a public project to achieve a public purpose.’” *Id.* (quoting *Pepper*, 73 Wn. App. at 530). It merely granted a variance to PSE to enable it to replace an electrical substation already on the property with another one, an act that by law carries no liability for the City.

The homeowners ask this court to read *Phillips* as stating that governments have no liability when they approve a permit based only on “existing law.” Appellant’s Br. at 18-20. They cite a sentence in *Phillips* supporting this proposition. 136 Wn.2d at 961 (“There is no public aspect when the County’s only action is to approve a private development under then existing regulations.”). The homeowners argue that the City did not issue the permit under then-existing

regulations because PSE could construct the substation only by virtue of the variance. Appellant's Br. at 18-19. We reject this argument for two reasons.

First, as noted by the trial court, and supported by the record, the City's zoning regulations allowed it to issue a variance for projects. Tautologically, a variance granted under the then-existing Kirkland Zoning Code is granted under the then-existing regulations. Even accepting the homeowners' reading of *Phillips*, the City granted the permit under then-existing regulations and the homeowners may not obtain relief for the City's variance decision. Holding otherwise reads an entire section out of the Kirkland Zoning Code.

Second, the homeowners read *Phillips* too narrowly. We did use the "then existing" language, but only because the case involved the vested rights doctrine. 136 Wn.2d at 961. In several places we reiterated that permit approval does not subject a governmental agency to liability and did so without the then-existing language.¹² The homeowners' restrictive interpretation of the then-existing

¹²For example, we stated that "[t]he County and various amici argue that the Court of Appeals decision improperly equates King County's approval of private development with liability for a public project. We agree." *Phillips*, 136 Wn.2d at 960. Similarly, we wrote that "[t]o the extent the *Wilber [Development Corp. v. Les Rowland Construction, Inc.]*, 83 Wn.2d 871, 523 P.2d 186 (1974)] case can be read to hold that approval of development alone is sufficient to give rise to liability on the part of a municipality, we overrule it." *Id.* at 961-62. Discussing the public duty doctrine, we also noted that "[i]n light of this doctrine, we reject the contention that a municipality will be liable for a developer's design which causes damage to neighbors when the county's only actions are in approval and permitting." *Id.* at 963. We also wrote that "[a]llowing an eminent domain cause of action based solely on a municipality's approval of private development, where the developer acts negligently and the municipality is

language would create exactly the kind of result we sought to avoid with *Phillips*: governmental agencies would become guarantors for private entities and our public duty doctrine would be seriously undermined. Instead, we read the language of *Phillips* as holding that governments have no liability for inverse condemnation for permitting decisions and reject the homeowners' interpretation.

IV. CONCLUSION

We reverse the trial court's exclusion of Carpenter's testimony under *Frye* and the trial court's determination that LUPA governs the homeowners' inverse condemnation claim. However, neither of these decisions requires reversal of the trial court's grant of summary judgment to both PSE and the City. Because the trial court properly determined both PSE and the City were entitled to judgment as a matter of law, we affirm its summary judgment decisions.

not actively involved in the project, would be an end-run around this Court's law on the public duty doctrine." *Id.* at 964. We summed up our analysis by stating:

The question of when legal liability attaches to one's acts is a policy question, and legal liability is always to be determined on the facts of each case upon mixed considerations of logic, common sense, justice, policy, and precedent. A governmental entity does not become a surety for every governmental enterprise involving an element of risk. Mere approval of a private developer's plans does not give rise to an action for inverse condemnation.

Id. at 965 (citations omitted).

Fairhurst, J.

WE CONCUR:

Madsen, C. J.

[Signature]

[Signature]

[Signature]

Stegm, J.

Wiggin, J.

Conzalez, J.

Chambers, J.P.T.

D É C I S I O N

QUÉBEC

RÉGIE DE L'ÉNERGIE

D-2012-127

R-3770-2011

5 octobre 2012

PRÉSENT :

Richard Lassonde
Régisseur

Hydro-Québec
Demanderesse

et

Intervenants dont les noms apparaissent ci-après

Décision finale

Demande relative à l'autorisation du projet Lecture à distance – Phase 1

compteurs, qui respectent aussi les normes de Santé Canada, n'ont jamais généré de plaintes de clients quant à leur impact sur leur santé²⁷⁹.

[406] Même si la preuve est clairement à l'effet que les émissions de RF des CNG sont bien en deçà des normes de Santé Canada et des autres organismes de normalisation, les préoccupations de certains intervenants et de clients du Distributeur portent sur la question de savoir si ce type de RF peut représenter un risque pour la santé suffisant pour appliquer le principe de précaution.

7.8.2.2 La preuve sur l'impact des RF sur la santé

Le témoignage de David Carpenter

[407] S.É./AQLPA a fait entendre David Carpenter. Ce dernier s'est présenté comme « *public health physician* ». Il est « *professor of Environmental Health Sciences at the University at Albany* ». Il est également « *Director of the Institute for Health and the Environment* » à la même université dans l'État de New York aux États-Unis.

[408] S.É./AQLPA a demandé à la Régie de le reconnaître comme témoin expert médecin en santé publique, incluant les risques de santé associés à l'exposition aux RF.

[409] La Régie a refusé d'accorder le statut d'expert demandé²⁸⁰ aux motifs que David Carpenter n'est pas médecin, n'a jamais eu d'expérience clinique auprès de patients et n'a jamais personnellement fait de recherches sur les effets des RF sur la santé. La Régie n'a cependant pas rejeté son témoignage du dossier en raison de ses connaissances sur les recherches faites par d'autres dans ce domaine. Elle a donc accepté ce témoignage, sous réserve d'établir la force probante à y accorder²⁸¹.

[410] La Régie est d'avis que le témoignage de David Carpenter n'est pas probant, notamment pour les motifs soumis par le Distributeur aux paragraphes 153 à 165 de son argumentation écrite²⁸².

²⁷⁹ Pièce A-0106, pages 150 à 162 et pièce A-0115, pages 200 et 201.

²⁸⁰ Pièce A-0148, décision du 17 mai 2012 rendue séance tenante, pages 110 à 113.

²⁸¹ Pièce A-0148, page 113.

²⁸² Pièce B-0163, pages 39 à 43.

[411] Le contre-interrogatoire du témoin a montré qu'il était biaisé. Ainsi, contrairement aux *Attentes de la Régie relatives au rôle des témoins experts*²⁸³ (les Attentes), ce témoin que l'intervenant voulait faire reconnaître comme expert n'a pas présenté une position indépendante et objective, mais il a fait ce que ces Attentes prescrivent de ne pas faire, c'est-à-dire qu'il s'est comporté en représentant du participant qui l'a engagé²⁸⁴. À cet égard, David Carpenter, en contre-interrogatoire, a eu de la difficulté à dissocier, aux deux rapports qu'il a produits, ce qui avait été rédigé par lui ou par son procureur²⁸⁵. Il a admis que M^e Neuman et d'autres représentants de S.É./AQLPA lui avaient suggéré des changements de texte²⁸⁶.

[412] S.É./AQLPA a même produit un commentaire récent du témoin Carpenter où il critique un rapport du CCST intitulé « *Health Impact of Radio Frequency from Smart Meters* ». Entre autres commentaires, le témoin Carpenter écrivait :

*« The benefit of the smart meters is entirely to the utilities, and is economic in nature. If they install smart meters they can fire those individuals who at present are employed to go around reading meters. Thus this is a job-killing proposal, and will increase unemployment in a state that already has too much. »*²⁸⁷

[413] Manifestement, le témoin Carpenter, expert ou pas, ne satisfait pas aux critères d'objectivité auxquels la Régie est en droit de s'attendre²⁸⁸.

Le témoignage du D^r Michel Plante

[414] Une des preuves des plus pertinentes et crédibles présentées à la Régie est celle du D^r Michel Plante.

²⁸³ http://www.regie-energie.qc.ca/regie/DirectivesInstructions/Regie_RoleExperts_18juillet2011.pdf.

²⁸⁴ Attentes, page 3.

²⁸⁵ Pièce A-0149, pages 33 à 36.

²⁸⁶ Pièce A-0149, page 36.

²⁸⁷ Pièce A-0149, pages 220 et 221 et pièce C-SÉ-AQLPA-0041.

²⁸⁸ http://www.regie-energie.qc.ca/regie/DirectivesInstructions/Regie_RoleExperts_18juillet2011.pdf.

Translate

Manifestement, le témoin Carpenter, expert ou pas, ne satisfait pas aux critères d'objectivité auxquels la Régie est en droit de s'attendre.

Obviously, the witness Carpenter, expert or not, does not meet the criteria of objectivity which the Régie is entitled to expect.



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Sage EMF Design is a division of Sage Associates, an environmental consulting firm located in Montecito, California which provides land use suitability analysis to private clients and public agencies regarding geologic, soils, agricultural, biologic and environmental policy constraints.

We specialize in project planning where electromagnetic field issues (EMF characterization and mitigation, visual impairment, noise, setback zones, undergrounding, property value loss) require characterization. [EMF computer modelling](#) and field measurements are performed to predict adequate setbacks for magnetic fields. Sage EMF Design conducts [home and commercial surveys of EMF](#), to identify areas of elevated magnetic fields as possible source. EMDEX II and EMDEX Lite Personal Dosimeters are available for surveys and consultations for EMF reduction. The firm has provided professional consulting services to cities, counties, various states and a national EMF policy group on the issue of EMF policy and prudent avoidance. Sage EMF Design offers [personal EMF monitoring](#) (meters which are worn) to characterize elevated EMF in homes and offices. We perform [remedial work](#) with an electrical contractor on electrical wiring and lighting to reduce EMF and [consult with architects and designers](#) in construction of low-EMF environments.

Sage EMF Design has several resources available for people who wish to design low electromagnetic field (EMF) environments or to characterize their exposure to EMF. We offer the following professional services and will be happy to answer questions you may have on EMF. Please e-mail us at sage@silcom.com for information or FAX your inquiry to (805) 969-5003 in Santa Barbara, California.

Sage EMF Design

1396 Danielson Road
Santa Barbara CA 93108

Phone: (805) 969-0557

FAX (805) 969-5003

e-mail: sage@silcom.com

Health Council of the Netherlands

The Minister of Housing, Spatial Planning
and the Environment (VROM)



Subject : BioInitiative report
Your ref. : -
Our ref. : U-5601/EvR/iv/673-L1 Publication nr 2008/17E
Annexes : -
Date : 2 September 2008

Dear Minister,

A report published on 31 August 2007 is playing an increasingly prominent role in the debate on electromagnetic fields and health: the *BioInitiative Report: A Rationale for a Biologically-based Public Exposure Standard for Electromagnetic Fields (ELF and RF)*¹. The report contains recommendations on establishing limits for exposure to electromagnetic fields that are much lower than the limits that are currently applied in the Netherlands and in many other countries, and is receiving increasing attention from society.

Your Ministry has expressed interest in a judgement of the Health Council on the BioInitiative report. In this advisory letter therefore, the Council's Electromagnetic Fields Committee, after consultation of the Standing Committee on Radiation and Health, gives its opinion as to the scientific value of this report.

Method used to compile the BioInitiative report

Scientific advisory reports are usually the result of a process in which a group of experts, using the current state of science, extensively discusses a topic until a consensus is reached. The group is made up of independent experts from the various areas of expertise relevant to the topic. In the case of electromagnetic fields, for example, this would be biologists, epidemiologists, technical experts, physicians and in some cases also psychologists and risk experts. This procedure is followed by bodies such as the World Health Organisation (WHO) and the Health Council, as well as organisations involved in drafting proposals for exposure limits, such as the International Commission on Non-ionizing Radiation Protection (ICNIRP) and the International Commission

¹ See www.bioinitiative.org.

Visiting address
Parnassusplein 5
2511 VX The Hague
Tel. +31(0)70 340 57 30
E-mail: e.van.rongen@gr.nl

Postal address
PO Box 16052
2500 BB The Hague
Fax +31(0)70 340 75 23
www.gr.nl

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Exhibit

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for Electromagnetic Safety (ICES) of the Institute of Electrical and Electronics Engineers (IEEE). The various experts and the interactions between them, combined with a review of all relevant scientific information, ensure that a balanced judgement on the latest scientific knowledge can be reached. It is of importance that this process is transparent. This multidisciplinary weight-of-evidence method leads to a scientifically sound judgement that is as objective as possible.

The BioInitiative report did not follow this procedure. The report is a collection of a number of chapters, called 'sections', written by individual authors. Seemingly no consultation or discussion on these sections took place between the authors. The report also does not indicate what, if any, brief was given to the authors. In any event, the sections were not written in a standardised way. Notably, not all authors are scientists. The methods used to collect literature are not defined. In many cases a selection of the available scientific material has been made, but the selection criterion is not stated. The Committee points for example to Section 12, in which the authors refer, among other things, to epidemiological studies into the association between exposure to 50 Hz magnetic fields and the prevalence of breast cancer. The authors dismiss a number of studies carried out in the home environment because exposure could not be determined with sufficient accuracy. However, this also applies to all studies into the association between living close to power lines and the prevalence of childhood leukaemia, which are discussed at length in another section of the report. The authors have also excluded various studies that did not find an association between breast cancer and exposure to magnetic fields from their analysis. It can be concluded that the scientific quality of the review sections is extremely varied.

The first section, written by one of the main initiators of the BioInitiative report, contains the summary and conclusions, which in many cases go further than the conclusions reached by the authors of the review sections. It is unclear if or how this has been discussed with them, whether they support the phrasing of conclusions in the Summary and on what basis the author reached different conclusions.

Why was the BioInitiative report written?

In Sections 2, 3 and 4, the same author presents exhaustive arguments in support of her belief why the current exposure limits are inadequate. In Section 2, the reason for writing the report is given:

The Report has been written to document the reasons why current public exposure standards for non-ionizing electromagnetic radiation are no longer good enough to protect public health.



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Upfront, therefore, the reason for writing the report was not to give an objective analysis of the current state of science, that would subsequently lead to recommendations. Instead, the aim was to present information to demonstrate why current standards are inadequate.

Shortcomings

In addition to the objections of principle and methodology outlined above, several sections also contain a number of factual errors. The Committee gives two examples. On page 6 of Section 1 the author states:

It appears it is the INFORMATION² conveyed by electromagnetic radiation (rather than heat) that causes biological changes - some of these biological changes may lead to loss of wellbeing, disease and even death.

This statement lacks a scientific basis and is, according to the Committee, incorrect. First of all no information is being transferred by low frequency fields and heating does not occur. With radiofrequency fields, information is being transferred by modulation. Some experimental studies found indications that certain biological effects may occur upon exposure to a modulated signal, but not, or to a lesser extent, with exposure to an unmodulated signal. As yet, there is no sufficient scientific evidence to confirm this. It is not known whether such effects may lead to health effects. The suggestion that some of the observed biological effects may lead to reduced wellbeing, disease, or even death lacks scientific basis.

On page 15 of Section 1 the author states:

For example, the roll-out of the new 3rd Generation wireless phones (and related community-wide antenna RF emissions in the Netherlands) caused almost immediate public complaints of illness.(5)

The reference is to a 2003 TNO study.³ Both the statement and the reference to the TNO study are not correct. Long before UMTS networks were put into service some people already attributed

² Capitalization by the author.



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various health complaints to electromagnetic fields, especially those generated by GSM base stations. The TNO study indicated that exposure to an UMTS base station-like signal (but not to a GSM signal) might have a negative influence on wellbeing. Publication of this study led to public concern and an increase in the number of complaints, even without UMTS signals being transmitted. Four independent follow-up studies did not find any indications to confirm the TNO results.⁴

The Committee will not go into further detail here with regard to the many other shortcomings of the report, which runs to over 600 pages. If necessary, this can be done in another publication. All these deficiencies also do not add to the Committee's confidence in the quality of the BioInitiative report.

Conclusion

In view of the way the BioInitiative report was compiled, the selective use of scientific data and the other shortcomings mentioned above, the Committee concludes that the BioInitiative report is not an objective and balanced reflection of the current state of scientific knowledge. Therefore, the report does not provide any grounds for revising the current views as to the risks of exposure to electromagnetic fields.

The BioInitiative report argues that any effect of electromagnetic fields on biological systems should be avoided, thereby ignoring the distinction between effect and damage. The Committee does not agree with this approach, as documented in previous publications (for example, in the

³ Zwamborn, APM, Vossen, SHJA, van Leersum, B, e.a. Effects of global communication system radio-frequency fields on well being and cognitive functions of human subjects with and without subjective complaints. The Hague: TNO Physics and Electronics Laboratory, 2003; FEL-03-C148.

⁴ - Regel, SJ, Negovetic, S, Rössli, M, e.a. UMTS base station-like exposure, well-being, and cognitive performance. *Environ Health Perspect*, 2006; 114(8): 1270-1275.
- Riddervold, IS, Pedersen, GF, Andersen, NT, e.a. Cognitive function and symptoms in adults and adolescents in relation to rf radiation from UMTS base stations. *Bioelectromagnetics*, 2008; 29(4): 257-267.
- Eltiti, S, Wallace, D, Ridgewell, A, e.a. Does short-term exposure to mobile phone base station signals increase symptoms in individuals who report sensitivity to electromagnetic fields? A double-blind randomised provocation study. *Environ Health Perspect*, 2007; 115(11): 1603-1608.
- Furubayashi, T, Ushiyama, A, Terao, Y, e.a. Effects of short-term W-CDMA mobile phone base stations exposure on women with and without mobile phone related symptoms. *Bioelectromagnetics*, 2008; in press.



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2002 advisory report entitled *Mobile telephones; an evaluation of health effects*). In the 2008 Annual Update on Electromagnetic Fields this topic will be further addressed.

Yours sincerely,

Prof M. de Visser
Vice-president

The following members served on the Electromagnetic fields committee while this advisory report was being produced:

- Dr G.C. van Rhoon, physicist; Erasmus University Medical Centre Rotterdam, *chairman* • Dr L.M. van Aernsbergen, physicist; Ministry of Housing, Spatial Planning and the Environment, The Hague, *advisor* • Prof G. Brussaard, Emeritus Professor of Radio communication; Eindhoven University of Technology • Dr G. Kelfkens, physicist, National Institute for Public Health and the Environment, Bilthoven, *advisor* • Prof H. Kromhout, Professor of Occupational Hygiene and Exposure Determination, Institute for Risk Assessment Sciences, University of Utrecht • Prof F.E. van Leeuwen, Professor of Cancer Epidemiology; Free University Amsterdam, and Dutch Cancer Institute, Amsterdam • Dr H.K. Leonhard, physicist; Ministry of Economic Affairs, Groningen, *advisor* • Prof W.J. Wadman, Professor of Neurobiology, University of Amsterdam • D.H.J. van de Weerd, MD, specialist in medical environmental affairs; Gelderland Midden emergency services / Arnhem mental health services • Prof A.P.M. Zwamborn, Professor of Electromagnetic Effects; Eindhoven University of Technology, and TNO, The Hague • Dr E. van Rongen, radiobiologist; Health Council, The Hague, *secretary*.

Visiting address
Parnassusplein 5
2511 VX The Hague
Tel. +31(0)70 340 57 30
E-mail: e.van.rongen@gr.nl

Postal address
PO Box 16052
2500 BB The Hague
Fax +31(0)70 340 75 23



**Australian Centre for
Radiofrequency Bioeffects Research (ACRBR)**

**Rodney Croft, Michael Abramson, Irena Cosic
John Finnie, Ray McKenzie, Andrew Wood**

**“ACRBR Position Statement on
BioInitiative Report”**



December 18, 2008

**EKPC
Exhibit**

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The ACRBR Perspective on The BioInitiative Report

In 2007 a group of interested individuals collated a series of views on the non-ionising radiation health debate. This was entitled the BioInitiative Report¹, a web document dated August 31, 2007. The BioInitiative Report presents a series of views that argue for a change in public exposure standards, but which are largely inconsistent with current scientific consensus. The ACRBR have received numerous queries about this report from the general public, and have provided this document to answer a few questions to clarify its perspective on the report.

Do the BioInitiative Report authors represent an authoritative international body?

Often in assessing public health issues, bodies are formed to evaluate evidence and offer recommendations about particular issues. The model that most scientific expert bodies in this area (e.g. World Health Organisation (WHO)) employ is to engage independent experts to provide a review and recommendations on an issue. Independent experts are engaged because it is meant to provide an objective evaluation of the issue. This contrasts strongly with the BioInitiative Report, which is the result of the opinions of a self-selected group of individuals who each have a strong belief that does not accord with that of current scientific consensus. An indication of this may be seen in the group's stated purpose, which is "*to document the reasons why current public exposure standards for non-ionizing electromagnetic radiation are no longer good enough to protect public health*" (Section 2, page 1), rather than to provide a scientific evaluation of the issue. Similarly, the standard model normally seeks a consensus view. In terms of the BioInitiative Report, the preface by Carpenter and Sage state that this is not a consensus document, but is rather a collection of individual views, where "*the information and conclusions in each chapter are the responsibilities of the authors of that chapter*" (Section i, page 1). Thus the 'Summary for the Public and Conclusions', released both independently and as part of the full Report, should be read as Sage's view on the matter, and there is no indication in the Report that the authors of other chapters share her views. This does not mean that what is written in the Report is invalid, but it means that we need to evaluate the content of the report itself, and cannot rely on there being a consensus from an independent authoritative body to help us judge the merits of these conclusions.

What is the scientific status of the BioInitiative Report?

In science we generally differentiate between peer-reviewed and non-peer-reviewed publications, where the peer-review comes from independent experts in the area. The reason for this is that peer-reviewed work is only published after independent scientific peers have reviewed the work and agreed with its scientific merit, making it easier for the reader to be confident with conclusions drawn in the publication. Conversely, without independent peer review, there is far less opportunity to correct errors and ensure that the conclusions are appropriate, and thus scientists treat peer-reviewed publications as their main scientific literature source. It should be noted that this does not mean that publications lacking independent peer review are flawed (or for that matter that peer-reviewed publications are perfect), it is more that scientists would typically withhold judgment about publications until peer review has occurred.

The BioInitiative Report has not undergone such independent peer review, and so the conclusions that it reaches would normally be viewed more as views of some of the authors, rather than strong contributions to science. In fact the Report does not identify the level of review that it has

undergone, merely mentioning that “another dozen outside reviewers have looked at and refined the Report” (Section 1, page 4). This is particularly important since many of the statements and conclusions in the Report are contrary to scientific consensus. Thus rigorous scientific evaluation would need to be performed to determine whether the inconsistencies are due to errors in the report, or errors in the scientific consensus. While such independent peer review would normally be undertaken prior to publication (to avoid misleading conclusions should problems be identified), some informal independent peer review has now occurred *in response to* publication of the BioInitiative Report. For example, the Health Council of the Netherlands (HCN) recently published a report that noted a number of inadequacies in the BioInitiative Report, inadequacies that would normally be addressed during the peer review process².

Of particular note is that the BioInitiative Report does not appear to apply principles consistently, which biases its conclusions. For example, in arguing for a link between 50/60 Hz power lines and breast cancer, the Report does not consider some of the evidence that argues against such an association. It also provides an argument for excluding other evidence (poor exposure assessment) that is not employed for studies arguing for an association between 50/60 Hz power lines and childhood leukemia (even though they are subject to the same exposure assessment limitations; see Section 12 of the Report). Another issue is that there are statements that do not accord with the standard view of science, and the Report does not provide a reasonable account of why we should reject the standard view in favour of the views espoused in the Report.

Should we be convinced by the BioInitiative Report?

Overall we think that the BioInitiative Report does not progress science, and would agree with the Health Council of the Netherlands² that the BioInitiative Report is “not an objective and balanced reflection of the current state of scientific knowledge” (page 4). As it stands it merely provides a set of views that are not consistent with the consensus of science, and it does not provide an analysis that is rigorous-enough to raise doubts about the scientific consensus.

It is worth noting that the state of science in this area is continually being debated and updated by a number of expert bodies comprised of the leading experts in this field. For example, the World Health Organisation (WHO) Electromagnetic Fields (EMF) project³, the International Commission on Non-Ionizing Radiation Protection (ICNIRP)⁴, the UK Mobile Telecommunications and Health Research (MTHR) programme⁵, and here in Australia the Australian Radiation Protection and Nuclear Science Agency (ARPANSA)⁶ have all provided authoritative analyses of the electromagnetic radiation bioeffects research. The WHO Environment Health Criteria 238 also provides a thorough analysis of the literature to date in relation to extremely low frequency (ELF, or powerline electromagnetic fields)⁷. We have provided some web links to these below, and would strongly urge the interested reader to consult these for a balanced perspective on this fascinating research domain.

¹ BioInitiative Report: A Rationale for a Biologically-based Public Exposure Standard for Electromagnetic Fields (ELF and RF), August 31, 2007 <http://www.bioinitiative.org/report/index.htm>.

² Health Council of the Netherlands. BioInitiative report. The Hague: Health Council of the Netherlands, 2008; publication no. 2008/17E. <http://www.gr.nl/pdf.php?ID=1743&p=1>

³ <http://www.who.int/peh-emf/en/>

⁴ <http://www.icnirp.de/>

⁵ http://www.mthr.org.uk/documents/MTHR_report_2007.pdf

⁶ <http://www.arpansa.gov.au/mobilephones/index.cfm>

⁷ http://www.who.int/peh-emf/publications/Complete_DEC_2007.pdf

COMAR TECHNICAL INFORMATION STATEMENT: EXPERT REVIEWS ON POTENTIAL HEALTH EFFECTS OF RADIOFREQUENCY ELECTROMAGNETIC FIELDS AND COMMENTS ON THE BIOINITIATIVE REPORT

The Committee on Man and Radiation (COMAR)*

Abstract—The Committee on Man and Radiation (COMAR) is a technical committee of the Engineering in Medicine and Biology Society (EMBS) of the Institute of Electrical and Electronics Engineers (IEEE). Its primary area of interest is biological effects of non-ionizing electromagnetic radiation, including radiofrequency (RF) energy. The public interest in possible health effects attributed to RF energy, such as emitted by mobile phones, wireless telephone base stations, TV and radio broadcasting facilities, Wi-Fi systems and many other sources, has been accompanied by commentary in the media that varies considerably in reliability and usefulness for their audience. The focus of this COMAR Technical Information Statement is to identify quality sources of scientific information on potential health risks from exposure to RF energy. This Statement provides readers with references to expert reports and other reliable sources of information about this topic, most of which are available on the Internet. This report summarizes the conclusions from several major reports and comments on the markedly different conclusions in the BioInitiative Report (abbreviated BIR below). Since appearing on the Internet in August 2007, the BIR has received much media attention but, more recently, has been criticized by several health organizations (see Section titled “Views of health agencies about BIR”). COMAR concludes that the weight of scientific evidence in the RF bioeffects literature does not support the safety limits recommended by the BioInitiative group. For this reason, COMAR recommends that public health officials continue to base their policies on RF safety limits recommended by established and sanctioned international organizations such as the Institute of Electrical and Electronics Engineers International Committee on Electromagnetic Safety and the International Commission on Non-Ionizing Radiation Protection, which is formally related to the World Health Organization.
Health Phys. 97(4):348–356; 2009

Key words: electromagnetic fields; exposure, radiofrequency; health effects; public information

INTRODUCTION

MANY STUDIES have been undertaken on biological effects and potential health and safety issues related to radiofrequency (RF) energy, dating back to the World War II era. This has resulted in an extensive scientific literature that contains several thousand scientific papers, including over 600 studies using mobile phone signals. The World Health Organization (WHO) database of this literature is freely available to the public (<http://www.who.int/peh-emf/research/database/en/index.html>).

Review of this large body of scientific literature on RF bioeffects requires special effort and expertise. The literature is highly variable in relevance to health, scientific quality, and the success (or failure) of independent investigators to confirm results reported by others. Evaluating potential health risks requires analyses of a variety of different lines of scientific evidence including studies of humans, animals, cells, mechanisms, dosimetry, etc. Consequently, a careful review of the scientific literature related to biological effects of RF fields (as well as other potentially toxic agents) requires examination of many studies, and considerable expert judgment must be used in arriving at final conclusions. The most reliable reviews are carried out by panels of experts with a broad range of expertise and operating under well-defined procedures for selecting and evaluating data.

As an example of this approach, WHO has a series of well-regarded Environmental Health Criteria (EHC) documents that are designed to provide expert scientific advice to policy makers in member states. The EHC for extremely low frequency (ELF) fields (WHO 2007), such as produced by power lines, states in its Preamble: “All studies, with either positive or negative effects, need to be evaluated and judged on their own merit, and then

* The Institute of Electrical and Electronics Engineers, Inc., Engineering in Medicine and Biology Society, Committee on Man and Radiation, 3 Park Avenue, New York, NY 10015-5997.

For correspondence contact: Marvin C. Ziskin, Center for Biomedical Physics, Temple University Medical School, 3420 N. Broad Street, Philadelphia, PA 19140, or email at ziskin@temple.edu.

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all together in a weight-of-evidence approach. It is important to determine how much a set of evidence changes the probability that exposure causes an outcome. Generally, studies must be replicated or be in agreement with similar studies. The evidence for an effect is further strengthened if the results from different types of studies (epidemiology and laboratory) point to the same conclusion."

The EHC on ELF fields was written by a Task Group of 25 members who were approved by the Assistant Director General of WHO, with additional input by as many as 150 individuals around the world who were sent drafts of the ELF-EHC to review (van Deventer and Foster 2008). WHO has started work on the preparation of the draft EHC document for RF fields and the final document is estimated to be published in 2011. One can be assured that the preparation of the RF document will use a similar approach as that used in the ELF-EHC document including a weight-of-evidence approach in evaluating the scientific literature.

This approach contrasts with the tendency of the media to write about individual studies or reports deemed newsworthy and to speculate about their significance, or of advocacy groups to focus on selected evidence to press a particular case.

REVIEWS

This Technical Information Statement (TIS) considers several kinds of reviews:

- Reviews by a standards-setting organization, notably the Institute of Electrical and Electronics Engineers International Committee on Electromagnetic Safety (IEEE/ICES), which works under the auspices of the IEEE Standards Association and develops IEEE standards C95.1 (IEEE 2005) and C95.6 (IEEE 2002), and by an organization that develops guidelines, i.e., the International Commission on Non-Ionizing Radiation Protection (ICNIRP 1998), which is formally related with WHO (see "Reviews by standards-setting organizations" below);
- Major reviews by expert panels under the auspices of health agencies or other branches of government, which evaluate the primary scientific literature related to possible health effects of RF fields (see "Reviews of the primary scientific literature by expert groups under government auspices" below); and
- The review called the BioInitiative Report (BIR 2007) that was written by an independent group. The differences in the BIR and the expert reviews considered here in regards to selection of committee members, the development of the report, and conclusions and recommendations are discussed below in "BioInitiative Report."

Reviews by standards-setting organizations

Comprehensive reviews of the scientific literature related to biological effects of RF fields are prepared by standards-setting organizations and organizations that develop international guidelines, of which the most influential around the world are IEEE/ICES and ICNIRP, respectively. The ICES subcommittee that developed the latest edition of the RF safety standard (IEEE 2005) had 132 participants from 24 countries from government, universities, industry, and the public. The variety of disciplines is listed below. ICES operates under the extensive rules, requirements, and audit procedures of the IEEE Standards Association to ensure openness, transparency and due process at every level.

The most recent revision of the IEEE C95.1 RF safety standard (IEEE 2005) was based on a review of more than 1,300 peer-reviewed research papers covering a 53-y span of the RF literature. The review included epidemiology and other human studies and animal, in vitro, mechanistic, dosimetric and engineering studies as well as other relevant papers. The studies addressed acute (short-term), intermittent and chronic (long-term) exposures, including lifetime exposure of animals, at a variety of exposure levels. Some of the exposures were at levels too low to produce significant heating ("non-thermal" exposures); others were at levels high enough to produce obvious RF heating ("thermal" exposures). The fields included continuous-wave RF energy, pulsed RF energy such as used in radar, and ELF-modulated RF energy such as used in communications systems. The scientific review was published in the IEEE standard (see IEEE C95.1-2005, Annex B, "Identification of levels of RF exposure responsible for adverse effects: summary of the literature," pages 34–77). To assist with the assessment of the extensive RF literature, ICES commissioned the series of review papers published in a special issue of the peer-reviewed journal *Bioelectromagnetics* (Supplement 6, 2003, 213 pages).

The other major international group, ICNIRP, develops guidelines (ICNIRP 1998) and consists of a Main Commission of 12 members plus a chairman and vice chairman; the Commission is assisted by a panel of 33 consulting experts from a variety of disciplines. Nearly all of these individuals are employees of government health agencies, with a few others employed by universities and none employed by industry. The ICNIRP guidelines, which are closely similar to the present IEEE standard, were published in 1998. It is to be noted that the IEEE standard and the ICNIRP guidelines are in agreement on the following major points with regards to RF safety: a) the dosimetric quantity *specific absorption rate* (SAR) as the basic restriction for frequencies from 100 kHz to a few GHz, b) the threshold SAR for adverse health

effects, c) whole-body and localized exposure limits, and d) safety factors for both occupational and public exposure limits. The ICES and ICNIRP limits are designed to protect against all proven hazards of RF energy.

Reviews of the primary scientific literature by expert groups under government auspices

Appendix A provides references and Internet links to recent expert reviews of the primary scientific literature recommended by COMAR.

To give the reader a sampling of current views of expert groups, the quotations below were taken from analyses completed in 2007–2008 by Ireland, WHO, a European Commission scientific committee and the United Kingdom. The consistent conclusion that there are no adverse effects from exposure to RF fields below internationally accepted limits is readily apparent.

Ireland Expert Group on Health Effects of Electromagnetic Fields (2007). “So far no adverse short or long-term health effects have been found from exposure to the RF signals produced by mobile phones and base station transmitters” (p. 3).

“The ICNIRP guidelines provides adequate protection for the public from any EMF sources” (p. 4). Available at: <http://www.dcenr.gov.ie/NR/rdonlyres/9E29937F-1A27-4A16-A8C3-F403A623300C/0/ElectromagneticReport.pdf>.

World Health Organization (2007). “Despite extensive research, to date there is no evidence to conclude that exposure to low level electromagnetic fields is harmful to human health” (Key Point #6). Available at: <http://www.who.int/peh-emf/about/WhatisEMF/en/index1.html>.

“To date, all expert reviews on the health effects of exposure to RF fields have reached the same conclusion: There have been no adverse health consequences established from exposure to RF fields at levels below the international guidelines on exposure limits published by the International Commission on Non-Ionizing Radiation Protection (ICNIRP 1998).” Children and Mobile Phones: Clarification statement (second paragraph). Available at: http://www.who.int/peh-emf/meetings/ottawa_june05/en/index4.html.

European Commission, Scientific Committee on Emerging and Newly Identified Health Risks (SCENIHR) (2008). Possible Effects of Electromagnetic Fields (EMF) on Human Health. “Since the adoption of the 2001 opinion extensive research has been conducted regarding possible health effects of exposure to low intensity RF fields, including epidemiologic, in

vivo, and *in vitro* research. In conclusion, no health effect has been consistently demonstrated at exposure levels below the limits of ICNIRP (International Committee on Non Ionising Radiation Protection) established in 1998. However, the data base for evaluation remains limited especially for long-term low-level exposure” (p. 4). Available at: http://ec.europa.eu/health/ph_risk/committees/04_scenihhr/docs/scenihhr_o_007.pdf. (See also Toxicol 246: 248–250; 2008.)

UK Government (2008). “The published evidence for health effects of radiofrequency (RF) electromagnetic fields in general is reviewed in *Health Effects from Radiofrequency Electromagnetic Fields: Report of an Independent Advisory Group on Non-ionising Radiation*. The report found that, as a whole, the research published since the report of the Independent Expert Group on Mobile Phones does not give cause for concern. The weight of evidence now available does not suggest that there are adverse health effects from exposures to RF fields below guideline levels.” Available at: <http://www.number10.gov.uk/output/Page14249.asp>.

In addition, Appendix B lists statements by health agencies and expert panels from around the world on RF safety issues that summarize the scientific literature without providing extensive technical details. Some of these statements comment on the current scientific uncertainty and gaps in knowledge [see WHO (Appendix B), Canada (Appendix B), and UK Mobile Telecommunications and Health Research Programme (Appendix B)]. Also, WHO (http://www.who.int/peh-emf/research/rf_research_agenda_2006.pdf) and the U.S. National Research Council (http://www.nap.edu/catalog.php?record_id=12036#toc) have developed RF research agendas to address unresolved issues.

BioInitiative Report

In August 2007, an independent group issued a report called the “BioInitiative Report: A Rationale for a Biologically-based Public Exposure Standard for Electromagnetic Fields (ELF and RF)” (BIR 2007). This report offers conclusions and recommendations that are very different from those of IEEE/ICES, ICNIRP, and health agencies (e.g., WHO) around the world, both in its assessment of the scientific evidence and in its policy recommendations. A paper summarizing the BIR has been published recently (Hardell and Sage 2008). The BIR considers both ELF (e.g., electric power frequency) fields as well as RF fields. For conciseness, this TIS considers only the BIR text about RF fields.

The BIR was written by 14 individuals under the direction of a 4-person organizing committee. Most of its 21 sections are authored by single individuals or (in a few

cases) pairs or trios of authors; the section “Key Scientific Evidence and Public Health Policy Recommendations” was written by a pair of individuals and appears to reflect their views only. There is no indication of how the members of the committee were chosen or how balance was provided in the group of contributors, a majority of whom have public records of criticism of existing exposure standards and guidelines.

In Section 2, the BIR states that it was written “to document the reasons why current public exposure standards for non-ionizing electromagnetic radiation are no longer good enough to protect public health.” Consequently, COMAR views the BIR as an advocacy document, rather than a balanced review of the scientific literature.

In contrast to the expert reviews by ICES and health agencies cited above, the BIR states that adverse health effects *have* been demonstrated from exposure to RF fields at levels below current guidelines: “*The lower limit for reported human health effects has dropped 100-fold below the safety standard (for mobile phones and PDAs); 1000- to 10,000-fold for other wireless (cell towers at distance; WI-FI and WLAN devices). The entire basis for safety standards is called into question, and it is not unreasonable to question the safety of RF [energy] at any level*” (BIR 2007, Section 17, p. 21). A careful reading of the BIR does not find supporting evidence for the conclusions in this quotation.

As a scientific review, the BIR has a number of weaknesses including internal inconsistency. The statement that “*A weight-of-evidence approach has been used to describe the body of evidence between health endpoints and exposure to electromagnetic fields (ELF and RF)*” (BIR 2007, Section 17, p. 5) and the text in another section referring to the weight-of-evidence approach as “*unscientific*” (BIR 2007, Section 7, p. 15) are not consistent.

A major weakness of the BIR is a selective, rather than a comprehensive, review of the literature in various topical areas. Two examples discussed here are a) animal tumor studies and b) genotoxicity (DNA damage).

Animal tumor studies. The BIR comments on only two studies investigating tumor development in laboratory animals exposed to RF energy. One of these studies (Repacholi et al. 1997) reported increased tumor development in exposed mice. Because of the potential health significance of the effect, a follow-on study by Utteridge et al. (2002) was conducted, but no change in tumor development was found. The BIR rejected the Utteridge et al. results for the reasons given in Section 7 (p. 16) and stated “the results of the Repacholi study are still looked upon as showing a relation between RF and cancer in an

animal model” (BIR 2007, Section 7, p. 16). As discussed below, a weight-of-evidence assessment of the animal tumor studies shows that the BIR conclusion to promote the result in Repacholi et al. and reject the Utteridge et al. study is wrong. Other expert groups and health agencies have also given little weight to the Repacholi et al. study in their review of the broader set of relevant evidence.

The results of a second follow-on study (Oberto et al. 2007) agreed with the results in Utteridge et al. that there was no relation between RF exposure and tumor development. Thus, two studies employing improved experimental protocols compared to those in the 1997 study failed to confirm the effect on tumor development. As mentioned, the BIR discussed only two animal studies investigating tumor development in RF-exposed animals. For comparison, the ICES review, which was published before the BIR was written, included 35 studies on this topic and the weight of evidence of these studies showed no association between RF exposure and tumor development (see IEEE C95.1-2005, Annex B, Clause B.7.1 “Animal cancer bioassays,” pp. 66–68). More than ten additional studies on this topic (see WHO database at <http://www.who.int/peh-emf/research/database/en/index.html>) have been published since the ICES review and the results of the more recent studies have strengthened the weight of evidence showing no association between RF exposure and tumor development in laboratory animals. In the BIR, the absence of a review of the large number of long term animal tumor studies is a major omission and, as a result, the BIR presents an incomplete scientific assessment that led to unsupportable claims of adverse biological effects and mechanisms of interaction.

Genotoxicity. The BIR concluded that “... RF exposures can be considered genotoxic (will damage DNA) under certain conditions of exposure, including exposure levels that are lower than existing safety limits” (BIR 2007, Section 1, p. 17). This conclusion is inconsistent with the conclusions from weight-of-evidence assessments by the UK Independent Expert Group on Mobile Phones (IEGMP 2000), called the Stewart Report, and the U.S. National Research Council Expert Panel (NRC 2008). Some of the evidence for the BIR conclusion was based on the results of Lai and Singh (1995, 1996), who reported DNA breaks in the brain cells of rats exposed to RF energy (BIR 2007, Section 6), and on the results from Rudiger’s lab showing DNA breaks in cells cultured in vitro (Diem et al. 2005; Schwarz et al. 2008; BIR, Section 1, p. 17). Follow-on research to the Lai and Singh reports at another university included an extensive study comparing different DNA damage methods and included an attempt at exact replication of the

original studies; the results failed to demonstrate an increase in DNA damage due to RF exposure (Lagroye et al. 2004). Other research (Malyapa et al. 1997) also failed to confirm DNA damage. The Stewart Report concluded that the evidence of Lai and Singh for DNA damage "is contradicted by a number of other studies in vivo and is not supported by in vitro work" (IEGMP 2000, Paragraph 5.134, page 70).

The in vitro results published by Rudiger's lab could not be confirmed by an independent lab that attempted an exact replication (Speit et al. 2007). More recently, Rudiger's results have been the subject of a scientific-misconduct investigation that revealed that some of the data used in at least one publication by the group had been fabricated (Vogel 2008).

The recent U.S. National Research Council report (NRC 2008), developed by an international expert group, concluded that "... most investigators in the field agree that no compelling body of evidence exists to support the hypothesis that RF fields are genotoxic" (page 39). These and other expert groups clearly gave little weight to the studies by Lai and Singh and Rudiger's group in the face of a large body of other related evidence. By failing to conduct a comprehensive review of the many animal tumor studies and focusing on isolated and disputed results from a few studies, the BIR arrived at unsupported conclusions regarding the genotoxic potential of RF exposure.

The BIR mixes discussion of social and scientific issues. For example, the scientific review of effects of RF fields on stress proteins has a long editorial section headed with "*The troubling context of today's science*" with speculation about the "*mind set*" of scientists working in the field, and other *ad hominem* comments which greatly detracts from the overall objectivity of the BIR review.

Exposure limits

Without providing a rationale in support of their recommendations, the BIR recommends "precautionary" limits for human exposure to electromagnetic fields that are very much lower than limits in effect in more than 40 countries. For example, the BIR recommends a general public exposure limit of 0.614 volts per meter for exposure to RF energy, which is a factor of about 100 (in terms of field strength) or 10,000 (measured in terms of incident power density) below present limits that are in effect in the U.S. and most other countries around the world. A major weakness of the BIR is the absence of a rationale to support reduction of internationally accepted RF exposure limits.

The BIR repeatedly states that current safety standards are inadequate and that the standards-setting processes are flawed because they "*have little, if any, input from other stakeholders outside professional engineering and closely-related commercial interests*" (BIR 2007, p. 5). This is incorrect. The ICES Technical Committee 95 Subcommittee (SC4) that developed the RF safety standard (C95.1-2005) is open to anyone with a direct and material interest in the activities of the subcommittee. During the development of IEEE C95.1-2005, SC4 had 132 participants from government, universities, industry, and the public; they represented 24 countries and 14 disciplines including medicine, epidemiology, biology, biophysics, physics, risk assessment, risk communications, and engineering. It is noteworthy that the participants included representatives from the U.S. Federal Communications Commission, Food and Drug Administration, National Institute of Occupational Safety and Health, and Occupational Safety and Health Administration. The unlimited access, transparency, and broad multi-discipline expertise of the international participants in the IEEE/ICES Committee stand in contrast to the small ad hoc group of 14 authors of the BIR.

COMAR notes that if the limits in the BIR were applied consistently, such limits would prevent, or at least greatly complicate, the installation and use of traditional radio and TV broadcasting services, airport radar systems, police and other emergency communications systems, wireless telephone and wireless Internet systems, and many other applications of the radiofrequency spectrum—all of which have important benefits to public health and safety. Therefore, the BIR recommendations would in effect potentially increase risks by degrading effectiveness of many safety systems employing RF energy.

Views of health agencies about BIR

Additional concerns about the BIR have been identified by the following scientific groups from Europe and Australia.

EMF-NET, a coordinating committee of the European Commission 6th Framework Programme (30 October 2007). The BIR is "*not a consensus report of a working group, but rather an assembly of chapters written by various scientists and consultants.*" The "Summary for the public" is "*written in an alarmist and emotive language and the arguments have no scientific support from well-conducted EMF research.*" "*There is a lack of balance in the report; no mention is made in fact of reports that do not concur with authors' statements and conclusions. The results and conclusions are*

very different from those of recent national and international reviews on this topic . . . If this report were to be believed, EMF would be the cause of a variety of diseases and subjective effects . . . None of these health effects has been classified as established in any national or international reviews that assessed biological and health effects from exposures below internationally accepted EMF limits when the whole database of scientific literature is reviewed according to well-accepted international risk assessment methods and criteria."

Available at: <http://web.jrc.ec.europa.eu/emf-net/doc/EFRTDocuments/EMF-NET%20Comments%20on%20the%20BioInitiative%20Report%2030OCT2007.pdf>. [See EMF-NET 6th Framework Program Coordination Action, Effects of the Exposure to Electromagnetic Fields: From Science to Public Health and Safer Workplace, Comments on the BioInitiative Working Group Report (BioInitiative Report), October 30, 2007.]

The Netherlands Health Council (2 September 2008). In its opinion as to the scientific value of the BIR, the Health Council concluded *"that the BioInitiative report is not an objective and balanced reflection of the current state of scientific knowledge. Therefore, the report does not provide any grounds for revising the current views as to the risks of exposure to electromagnetic fields."*

Available at: <http://www.gezondheidsraad.nl/sites/default/files/200817E.pdf>. Accessed 4 August 2009.

Australian Centre for Radiofrequency Bioeffects Research (ACRBR) (18 December 2008). *"Overall we think the BioInitiative Report does not progress science, and would agree with the Health Council of the Netherlands that the BioInitiative Report is 'not an objective and balanced reflection of the current state of scientific knowledge.' As it stands it merely provides a set of views that are not consistent with the consensus of science, and it does not provide an analysis that is rigorous enough to raise doubts about scientific consensus."*

Available at: <http://www.acrbr.org.au/FAQ/ACRBR%20Bioinitiative%20Report%2018%20Dec%202008.pdf>.

CONCLUSION

COMAR, in agreement with the three comments above, concludes that the weight of scientific evidence in the current RF bioeffects literature does not support the safety limits recommended by the BioInitiative group. For this reason, COMAR recommends that government authorities and public health officials continue to base their policies on RF safety limits recommended by established and sanctioned international organizations

such as IEEE/ICES and ICNIRP, which are formally recommended by WHO.

Acknowledgments—This TIS was reviewed and approved by the members of COMAR, all of whom have expertise in the general areas of the interactions of electromagnetic fields with humans. Although it represents a consensus of the opinions of COMAR Members, it does not necessarily reflect the opinion of the IEEE in general. At the time of the vote, the membership of COMAR consisted of:

Eleanor R. Adair, PhD
Rajeev Bansal, PhD
Howard Bassen, MS
David Black, MBChB
Ralf Bodemann, PhD
Aviva Brecher, PhD
Jerrold T. Bushberg, PhD
Philip Chadwick, PhD
Jules Cohen, PE
John D'Andrea, PhD
Richard L. Doyle, MS
Joe Elder, PhD
Linda S. Erdreich, PhD
Kenneth R. Foster, PhD, PE
Riadh Habash, PhD, PE
James Hatfield, PE
Daniel D. Hoolihan
Veronica Ivans
James Jauchem, PhD
Sheila Johnston, PhD
Rob Kavet, ScD
B. Jon Klauenberg, PhD
James H. Lambert, PhD, PE
Gregory D. Lapin, PhD, PE
Martin L. Meltz, PhD
Joseph Morrissey, PhD
John Moulder, PhD
Michael R. Murphy, PhD
John M. Osepchuk, PhD
Ronald C. Petersen, MS
Peter Polson, PhD
Kenneth R. Proctor
Pere J. Riu, PhD
Mays Swicord, PhD
Paul A. Testagrossa
Art Thansandote, PhD
Mohammad-Reza Tofighi, PhD
Eric van Rongen, PhD
David D. Royston
W. James Sarjeant, PhD
Richard A. Tell, MS, CHAIR
Arthur Varanelli, MS
Robert D. Weller, PE
John Zirix, PhD
Donald W. Zipse, PE
Marvin C. Ziskin, MD

Most recognized of COMAR products are the TIS on areas of technical interest or safety concerns and recommendations concerning electromagnetic fields. A list of COMAR Statements and Internet links are available to the public at <http://ewh.ieee.org/soc/embs/comar/>.

REFERENCES

- BioInitiative Report. A rationale for a biologically-based public exposure standard for electromagnetic fields (ELF and RF) [online]. 2007. Available at: <http://www.bioinitiative.org/report/index.htm>. Accessed 10 March 2009.
- Diem E, Schwarz C, Adlkofer F, Jahn O, Rüdiger H. Non-thermal DNA breakage by mobile-phone radiation (1800

- MHz) in human fibroblasts and in transformed GFSH-R17 rat granulosa cells in vitro. *Mut Res* 583:178–183; 2005.
- Hardell L, Sage C. Biological effects from electromagnetic field exposure and public exposure standards. *Biomed Pharmacother* 62:104–109; 2008.
- Independent Expert Group on Mobile Phones. Mobile phones and health. Chilton, Didcon, Oxon: UK National Radiological Protection Board, IEGMP; 2000.
- Institute of Electrical and Electronics Engineers, Inc. IEEE Standard for safety levels with respect to human exposure to electromagnetic fields, 0 to 3 kHz. New York: IEEE; IEEE C95.6-2002; 2002 (Reaffirmed 2007).
- Institute of Electrical and Electronics Engineers, Inc. IEEE Standard for safety levels with respect to human exposure to radio frequency electromagnetic fields, 3 kHz to 300 GHz. New York: IEEE; IEEE C95.1-2005; 2005.
- International Commission on Non-Ionizing Radiation Protection. Guidelines for limiting exposure to time-varying electric, magnetic, and electromagnetic fields (up to 300 GHz). *Health Phys* 74:494–522; 1998.
- Lagroye I, Anane R, Wettling BA, Moros EG, Straube WL, Laregina M, Niehoff M, Pickard WF, Baty J, Roti Roti JL. Measurement of DNA damage after acute exposure to pulsed wave 2450 microwaves in rat brain cells by two alkaline comet assay methods. *Int J Radiat Biol* 80:11–21; 2004.
- Lai H, Singh NP. Acute low-intensity microwave exposure increases DNA single-strand breaks in rat brain cells. *Bioelectromagnetics* 16:207–210; 1995.
- Lai H, Singh NP. Single- and double-strand DNA breaks in rat brain cells after acute exposure to radio frequency electromagnetic radiation. *Radiat Res* 69:513–521; 1996.
- Malyapa RS, Ahern EW, Straube WL, Moros EG, Pickard WF, Roti Roti JL. Measurement of DNA damage after exposure to 2450 MHz electromagnetic radiation. *Radiat Res* 148:608–617; 1997.
- National Research Council. Identification of research needs relating to potential biological or adverse health effects of wireless communication devices. Washington, DC: National Academies Press; 2008. Available at: http://www.nap.edu/catalog.php?record_id=12036#toc. Accessed 9 March 2009.
- Oberto G, Rolfo K, Yu P, Carbonatto M, Peano S, Kuster N, Ebert S, Tofani S. Carcinogenicity study of 217 Hz pulsed 900 MHz electromagnetic fields in Pim1 transgenic mice. *Radiat Res* 168:316–326; 2007.
- Repacholi MH, Basten A, Gebiski V, Noonan D, Finnie J, Harris AW. Lymphoma in Eμ-Pim1 transgenic mice exposed to pulsed 900 MHz electromagnetic fields. *Radiat Res* 147:631–640; 1997.
- Schwarz C, Kratochvil E, Pilger A, Kuster N, Adlkofer F, Rüdiger H. Radiofrequency electromagnetic fields (UMTS, 1950 MHz) induces genotoxic effects in vitro in human fibroblasts but not in lymphocytes. *Int Arch Occup Environ Health* 81:755–767; 2008.
- Speit G, Schütz P, Hoffman H. Genotoxic effects of exposure to radiofrequency electromagnetic fields (RF-EMF) in cultured mammalian cells are not independently reproducible. *Mut Res* 626:42–47; 2007.
- Utteridge TD, Gebiski V, Finnie JW, Vernon-Roberts B, Kuchel TR. Long-term exposure of Eμ-Pim1 transgenic mice to 898.4 MHz microwaves does not increase lymphoma incidence. *Int J Radiat Biol* 158:357–364; 2002.
- van Deventer E, Foster KR. Risk assessment and risk communication for electromagnetic fields: a World Health Organization perspective. In: Wiedemann PM, Schütz H, eds. *The role of evidence in risk characterization—making sense of conflicting data*. Weinheim, Germany: Wiley-VCH; 2008.
- Vogel G. Fraud charges cast doubt on claims of DNA damage from cell phone fields. *Science* 321:1144–1145; 2008.
- World Health Organization. WHO Environmental Health Criteria 238, Extremely low frequency fields. Geneva: WHO; 2007. Available at: http://www.who.int/peh-emf/publications/Complete_DEC_2007.pdf. Accessed 10 March 2009.

APPENDIX A

COMAR Recommended Scientific Reviews by Government Agencies and Expert Panels Concerning Health Effects and Safe Levels of Radiofrequency Exposure (2003–2008). [Additional reviews are listed on the GSM Association Web site at <http://www.gsmworld.com/health/links/independent.shtml> and listed with a summary at http://www.hpa.org.uk/web/HPAwebFile/HPAweb_C/1194947376017 (see 2 below).]

1. U.S. National Council on Radiation Protection and Measurements (NCRP) (2003). NCRP Commentary No. 18, Biological Effects of Modulated Radiofrequency Fields, 7910 Woodmont Avenue, Bethesda, MD 20814-3095.
2. UK National Radiological Protection Board (NRPB) (2004/2005). Mobile Phones and Health (2004), Volume 15, Number 5. http://www.hpa.org.uk/web/HPAwebFile/HPAweb_C/1194947333240.
Summary of 24 Recent Reports (2000–2004) on Mobile Phones and Health (2005). http://www.hpa.org.uk/web/HPAwebFile/HPAweb_C/1194947376017.
3. International Committee on Electromagnetic Safety (ICES), Institute of Electrical and Electronics Engineers (IEEE) (2006). IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz. IEEE Standard C95.1-2005, Annex B, Identification of levels of RF exposure responsible for adverse effects: summary of the literature, pp. 34–77. IEEE, 3 Park Avenue, New York, NY 10016-5997.
4. Health Council of the Netherlands (2007). Electromagnetic Fields: Annual Update 2006 (pp. 53–98 in English). <http://www.healthcouncil.nl/pdf.php?ID=1505&p=1>.
5. Ireland Expert Group on Health Effects of Electromagnetic Fields (2007). Health Effects of Electromagnetic Fields. <http://www.dcenr.gov.ie/NR/rdon/lyres/9E29937F-1A27-4A16-A8C3-F403A623300C/0/ElectromagneticReport.pdf>.
6. European Commission Scientific Committee on Emerging and Newly Identified Health Risks (2007). Possible Effects of Electromagnetic Fields (EMF)

- on Human Health. http://ec.europa.eu/health/ph_risk/committees/04_scenihp/docs/scenihp_o_007.pdf.
7. Finland (2007). HERMO—Health Risk Assessment of Mobile Communications. A Finnish Research Programme 2004–2007. http://www.uku.fi/hermo/english/Final_report.shtml.
 8. UK (2007). Mobile Telecommunications and Health Research Programme (MTHR). Report 2007. http://www.mthr.org.uk/documents/MTHR_report_2007.pdf.
 9. European Commission (2008). Possible Effects of Electromagnetic Fields (EMF) on Human Health—Opinion of the Scientific Committee on Emerging and Newly Identified Health Risks (SCENIHR). *Toxicol* 246:248–250; 2008. http://ec.europa.eu/health/ph_risk/committees/04_scenihp/docs/scenihp_o_007.pdf.
 10. Swedish State Radiation Protection Authority (SSI) (2008). Fifth Annual Report from SSI's Independent Expert Group on Electromagnetic Fields, Recent Research on EMF and Health Risks, 2007. http://www.ssi.se/ssi_rapporter/ssirapport.html?MenuType=2&Menu2=Publikationer.
 11. UK, The Institution of Engineering and Technology (2008). Position Statement by The Institution of Engineering and Technology: The Possible Harmful Biological Effects of Low-level Electromagnetic Fields of Frequencies up to 300 GHz. <http://www.theiet.org/publicaffairs/bepag/postat02final.pdf>.
 12. UK Government (2008). Official site of the Prime Minister's Office. Phonemasts—petition response. <http://www.number10.gov.uk/output/Page14249.asp>.

APPENDIX B

Public statements by health agencies and expert panels concerning health effects of electromagnetic fields

1. UK Independent Expert Group on Mobile Phones (IEGMP) (2000). <http://www.iegmp.org.uk/report/text.htm>: “The balance of evidence to date suggests that exposures to RF radiation below NRPB and ICNIRP guidelines do not cause adverse health effects to the general population” (p. 3).
2. World Health Organization (2004). <http://www.who.int/peh-emf/about/WhatisEMF/en/index1.html>: “Despite the feeling of some people that more research needs to be done, scientific knowledge in this area is now more extensive than for most chemicals. Based on a recent in-depth review of the scientific literature, the WHO concluded that current evidence does not confirm the existence of any health consequences from exposure to low level electromagnetic fields. However, some gaps in knowledge about biological effects exist and need further research.”
3. Health Council of the Netherlands. Mobile phones and children: Is precaution warranted? *Bioelectromagnetics* 25:142–144; 2004: “The Health Council therefore sees no reason to recommend limiting the use of mobile phones by children.”
4. U.S. Department of Health and Human Services, Centers for Disease Prevention and Control (2005). http://www.cdc.gov/nceh/radiation/factsheets/cellphone_facts.pdf: “In the last 10 years, hundreds of new research studies have been done to more directly study possible effects of cell phone use. Although some studies have raised concerns, the scientific research, when taken together, does not indicate a significant association between cell phone use and health effects.”
5. German Research Centre Jülich, Programme Group Humans, Environment, Technology (2005). http://www.emf-risiko.de/projekte/pdf/risikodialog_eng.pdf: “Overall, the hypothesis that EMF from mobile phone communication has a harmful effect is not substantiated” (p. 67).
6. Health Canada (2006). http://www.hc-sc.gc.ca/iyh-vsv/prod/cell_e.html: “... some studies claim that biological effects may occur at RF energy levels below the Safety Code 6 [Canadian national exposure] limits [which are similar to U.S. and ICNIRP health limits]. These biological effects are not well established and their implications for human health need further study. Right now, there is no convincing scientific evidence to support lowering the limits.”
7. New Zealand Ministry of Health, National Radiation Laboratory (2007). <http://www.nrl.moh.govt.nz/faq/cellphonesandcellsites.asp>: “The balance of current research evidence suggests that exposures to the radiofrequency energy produced by cellphones do not cause health problems provided they comply with international guidelines. Reviews of all the research have not found clear, consistent evidence of any adverse effects.”
8. Ireland Expert Group on Health Effects of Electromagnetic Fields (2007). <http://www.dcenr.gov.ie/NR/rdonlyres/9E29937F-1A27-4A16-A8C3-F403A623300C/0/ElectromagneticReport.pdf>: “There are no data available to suggest that the use of mobile phones by children is a health hazard” (p. 3).
9. States of Jersey (2007). http://www.scrutiny.gov.je/view_doc.asp?panelid=0&reviewid=0&target=Reports&doc=documents/reports/S-260-48911-3052007.htm: Regarding emissions from mobile masts, “... it is

equally clear that there is no scientific evidence to show that an actual risk exists."

10. Ministry of Internal Affairs and Communications, Japan (2007). http://www.soumu.go.jp/joho_tsusin/eng/Releases/NewsLetter/Vol18/Vol18_06/Vol18_06.html: "*Consequently, this committee cannot recognize that there is any firm evidence of effects on health, including nonthermal effects, from radio waves at strengths that do not exceed the policy for protection from radio waves.*"
11. UK Mobile Telecommunications and Health Research Programme (MTHR) (2007). http://www.mthr.org.uk/documents/MTHR_report_2007.pdf: "*The MTHR Programme was set up to resolve uncertainties identified by previous evaluations of the possible health risks associated with the widespread use of mobile phone technology. None of the research supported by the Programme and published so far demonstrates that biological or adverse health effects are produced by radiofrequency exposure from mobile phones... The Committee has recognized that, while many of the concerns raised by the Stewart Committee [see 1 above] have been reduced by the Programme and work done elsewhere, some still remain. It has therefore proposed a further programme of work to address these.*"
12. World Health Organization (2007). Fact Sheet #304. <http://www.who.int/mediacentre/factsheets/fs304/en/index.html>: "*Considering the very low exposure levels and research results collected to date, there is no convincing scientific evidence that the weak RF signals from base stations and wireless networks cause adverse health effects.*"
13. Australian Radiation Protection and Nuclear Safety Agency, Committee on Electromagnetic Energy Public Health Issues (2008): <http://www.arpansa.gov.au/pubs/erne/fact1.pdf>: "*The weight of national and international scientific opinion is that there is no substantiated evidence that exposure to low level RF EME [electromagnetic energy] causes adverse health effects.*"
14. UK Position Statement by The Institution of Engineering and Technology (2008): The Possible Harmful Biological Effects of Low-level Electromagnetic Fields of Frequencies up to 300 GHz (2008). <http://www.theiet.org/factfiles/bioeffects/index.cfm>: "*In summary, the absence of robust new evidence of harmful effects of EMFs in the past two years is reassuring and is consistent with findings over the past decade*" (p. 3).
15. U.S. Food and Drug Administration (2008). <http://www.fda.gov/cdrh/wireless/health-children.html>: "*The scientific evidence does not show a danger to any users of cell phones from RF exposure, including children and teenagers.*"
16. U.S. National Cancer Institute (2008). Fact Sheet on Cellular Telephone Use and Cancer Risk. <http://www.cancer.gov/cancertopics/factsheet/Risk/cellphones>: "*Incidence data from the Surveillance, Epidemiology and End Results (SEER) program of the National Cancer Institute have shown no increase between 1987 and 2005 in the age-adjusted incidence of brain or other nervous system cancers despite the dramatic increase in use of cellular telephones...*"
17. U.S. Federal Communications Commission (2008). <http://www.fcc.gov/cgb/cellular.html>: "*There is no scientific evidence that proves that wireless phone usage can lead to cancer or a variety of other problems, including headaches, dizziness or memory loss.*"



Picking Cherries in Science: The Bio-Initiative Report

Posted by [Lorne Trottier](#) on February 15, 2013 ([20](#) Comments)

by Kenneth R. Foster & Lorne Trottier

Science-based medicine is great, but it all depends on how you evaluate the scientific evidence. A bad example is the BioInitiative Report (BIR), an egregiously slanted review of health and biological effects of electromagnetic fields (EMF) of the sort that are produced by power lines, cellular telephones, Wi-Fi, and other mainstays of modern life. When first released in 2007, the BIR quickly became a key document used by anti-EMF activists in their various campaigns. Early in January 2013, the BIR appeared in a major update, to extensive media coverage.

The BIR concerns possible biological effects and health hazards of electromagnetic fields in two very different frequency ranges: at extremely low frequencies ELF's of the sort emitted by power lines and appliances, and at radiofrequencies (RFs) of the sort that are transmitted by mobile phones, Wi-Fi and a host of other technologies. Both ELF and RF fields (which are subsumed under the more general EMF) are part of the electromagnetic spectrum, which includes infrared energy, light, ultraviolet energy, as well as X-rays.

ELF and RF fields are nonionizing, in that the energy of their photons is far too low to break chemical bonds, an effect that makes ionizing radiation such as X-rays so hazardous. Fields from power lines are at 50 or 60 Hz or cycles per second; those from mobile phones and other RF communications and broadcasting systems are in the range of hundreds or thousands of MHz (megahertz or million cycles per second). Simple physics tell us that a photon of 1GHz frequency has an energy of 6 millionths of an electron volt (eV), while the average thermal energy of a molecule is 0.03 eV and the ionization energy of a chemical bond is on the order of 1 eV

There are, of course, well-established hazards from excessive exposures to ELF and RF fields, which are mainly associated with electric shock (ELF) and excessive heating of tissue (RF). Such problems, however, require exposure to fields at vastly higher levels than anything that would be encountered in ordinary life. Most countries around the world have adopted roughly similar exposure limits that are designed to protect against these known hazards.

The possibility that the electromagnetic fields at much lower exposure levels can be bad for you has been a matter of public concern for many years. Countless public, scientific, and legal battles have been waged about possible health hazards produced by fields from power lines, cellular base stations, broadcasting facilities, and other technologies, despite the fact that public exposures from such technologies are invariably far below government exposure limits.

In response to such concerns, government and other agencies have funded many studies over the years. Thousands of scientific papers have accumulated on biological and possible health effects

of ELF and RF fields, going back to the mid 20th Century and even before.

In many respects this scientific literature is uneven and confused. The studies vary widely in quality, biological endpoint, and relevance to health. The literature is filled with low-quality fishing expeditions in search of effects (as opposed to studies that tested hypotheses). Many of these studies were one-shot experiments, that were not followed up or even repeated by the investigators themselves. Many studies have obvious technical flaws, typically poor dosimetry (determining how much exposure the preparation actually received in an experiment) or poor temperature control (heating is a necessary consequence of RF exposure and most biological reactions are sensitive to temperature). Many of the reported effects were small, close to the level of background variability and small compared to potential artifacts (and hence difficult to identify reliably), with no particular relevance to health. The literature suffers badly from publication bias — researchers are more likely to report having found an “effect” and less likely to publish no effect studies. As might be expected, the literature abounds with reports of “effects”, many of which are simply artifacts from poorly conducted experiments.

At the opposite end of the quality spectrum are a number of well-done, massively funded studies that follow the lines of standard toxicological assays or epidemiology studies, which were designed to provide reliable evidence in assessing possible risks from ELF or RF fields. The results of these studies have been overwhelmingly negative, failing to document adverse (or any) effects of exposures at levels below current safety limits that are in effect throughout most of the world.

Expert Reviews

This massive literature has been reviewed by numerous expert groups, who, with the exception of the BIR as described below, have consistently failed to find clear evidence for health hazards from ELF or RF fields at levels below international and U.S. limits. Luc Verschaeve (Univ of Antwerp), a noted Belgian health expert in this field, has reviewed more than 30 recent expert reviews. His review is [available online](#).¹ Links to over 30 of these expert reviews by the health agencies of virtually every industrialized country can also be found at [EMFandHealth.com](#). Readers of this article are invited to review the findings of these reports.

But the science is hardly clear-cut. Some effects have been reported at levels below international safety limits from specialized exposure conditions, that health agencies regard as having some level of consistency. For example, several independent studies have reported minor changes in brain wave activity associated with use of a mobile phone handset. The effect has no clear health significance, and it is still an open question whether it is directly caused by exposure to RF fields or some other factor associated with exposure.

The second, and politically more inflammable, issue is whether EMF exposure is linked to cancer. The International Agency for Research on Cancer (IARC, a part of the World Health Organization) has classified powerline magnetic fields and RF energy from mobile telephone handsets as “possible carcinogens” (class 2B in the IARC terminology). This is based on weak epidemiological evidence that children living in homes near power lines, or long-term users of mobile phones, have

a slightly increased risk of, respectively, leukemia and brain tumors. Thus, in IARC's scheme of things, the evidence is sufficient to raise suspicions that a problem might possibly exist, but not enough for the agency to conclude that the fields actually (or even probably) do cause cancer.

While acknowledging the epidemiology data, health agencies have generally found them to be unpersuasive for several reasons. The studies report small increases in risk, close to statistical variability. While the increases may be "statistically significant" (unlikely to be due to chance), it is difficult to rule out possible errors or biases in the studies, of which there are many in epidemiology. The general lack of supporting evidence from the animal cancer tests showing no effect, and lack of generally accepted mechanism by which RF or ELF fields can cause any biological effects at the low level exposures considered here (apart from heating) are other stumbling blocks.

Two additional comments are in order. First, the epidemiology studies were simply not adequate to reliably detect small increases in risk after long term exposures to cell phones or powerline fields. Most of the cell phone-brain cancer studies determined exposure simply by asking subjects about their previous use of cell phones. (What reader can say for sure how much he or she used a mobile phone a year ago, much less in the distant past?).

Furthermore as we indicated in a [previous article on SBM](#), since the IARC ruling on cell phones, three recent studies on brain cancer incidence rates have appeared. The studies show no change in incidence rates in the U.K., U.S., and Israel over the past decade despite the tremendous increase in use of cell phones. While one might argue that there is not enough time for a real effect to appear (cancer can take years to develop), the fact remains that the data are inconsistent with epidemiology studies by a Swedish group that supposedly gave the strongest indication of a link between brain cancer and use of cell phones and strongly influenced IARC's 2B classification in the first place. In the long run we will all be dead, but there is little indication so far that it will be from use of mobile phones. It is for all these reasons that the World Health Organization issued [Fact Sheet 193](#) following IARC's ruling which stated the following: "A large number of studies have been performed over the last two decades to assess whether mobile phones pose a potential health risk. To date, no adverse health effects have been established as being caused by mobile phone use."

The same scenario has been in play for the 40 years in which one of us (KRF) has been involved with the issue. Activists on the issue typically present long lists of effects from exposure to ELF or RF fields. They imply that these fields are biologically active at all levels of exposure, and by presumption are hazardous to your health at even very low exposures. Health agencies, in response, sponsor massive reviews that find no convincing evidence for any health hazard at exposure levels below international exposure limits, even as they point to inconsistencies in the data and argue for more research. Making lists of reported effects, and conducting a proper weight-of-evidence assessment of potential health risks, are two very different things.

Excluding Bias

Scientific research on health, either concerning the effectiveness of treatments or possible health

risks, is invariably subject to differing interpretations even by well-intentioned reviewers. To improve the reliability of assessments, agencies generally insist on detailed protocols for admitting and evaluating evidence. The definitive Cochrane Reviews, for example, has a lengthy [handbook](#) that guide its assessments of the effectiveness of medical interventions. The manual points out, for example, “in order to minimize the potential for bias in the review process, these judgments [about effectiveness of medical interventions] should be made in ways that do not depend on the findings of the studies included in the review”.

For its own part, the World Health Organization has published a [set of guidelines](#) for the assessment of the health risks of EMF: “All studies, with either positive or negative effects, need to be evaluated and judged on their own merit, and then all together in a weight-of-evidence approach. It is important to determine how much a set of evidence changes the probability that exposure causes an outcome. Generally, studies must be replicated or be in agreement with similar studies. The evidence for an effect is further strengthened if the results from different types of studies (epidemiology or laboratory) point to the same conclusion”.

Enter the BioInitiative Report (BIR)

The latest (2012) version was released on the BioInitiative website early in January 2013. This massive 1479 page report contains 28 sections, incorporating in toto the original 2007 version together with new sections. It was prepared by a group of 29 individuals, most of them scientists who have long held controversial positions on health effects of electromagnetic fields. Two individuals (Carpenter and Sage) wrote the introductory and concluding sections. One of them, Cindy Sage, is not a scientist but a long time activist on the issue who runs a [consulting firm on hazards of EMF exposure](#). Sage, the organizer of the BioInitiative project, also contributed sections on the inadequacy of current exposure limits and other topics.

As might be expected from a compilation of separately authored chapters done at two points in time, the BIR is inconsistent in approach and content. The 2007 chapter by David Gee (European Environment Agency) says almost nothing about EMF but is largely taken from a separate paper that discusses “late lessons from early warnings” about, for example, the tragedy of Diethylstilbestrol (a drug that was supposed to prevent miscarriage but later was found to cause birth defects in children whose mothers had used the drug). Many pages consist simply of abstracts copied from the original papers or from Pubmed (which may raise fair-use issues). Several chapters discuss the idiosyncratic theory of Blank (retired from Columbia University) that DNA is a “[fractal antenna](#)”, a theory that has received no independent scientific support, much less general acceptance by the scientific community. Nevertheless, his theory is repeatedly cited throughout the BIR as being somehow related to a mechanism by which weak RF or ELF fields can damage DNA. A relatively balanced section by Fragopoulou and Margaritis (University of Athens) offers a detailed review of “omics” studies that search for effects of ELF or RF exposures using techniques of modern molecular biology. This section emphasizes the difficulty of drawing reliable conclusions from such work, and concludes merely that changes in protein expression that

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some studies report following EMF exposure “might potentially explain human health hazards”. But here again, the evidence is mixed and inconsistent among studies, and the endpoints studied are difficult to relate to health.

Given the structure of the BIR, there is no way to tell how many of the 29 authors of the various sections agree with the conclusions and recommendations of the report itself — or with each other for that matter. Indeed, Henry Lai, one of the authors in the BIR, recently wrote:

I don't think the BioInitiative Report came up with any unanimous conclusion. Each author wrote his/her chapter and the opinion in each chapter is that of the authors alone. There was no communication and discussion among the authors on the preparation of the Report. As a matter of fact, I don't personally know some of them.

Moreover, Sage and Carpenter, authors of the introductory and concluding sections, clearly have their own political axes to grind. In a recent letter they emotionally attacked the World Health Organization and a major standards setting group (The International Commission on Nonionizing Radiation Protection, ICNIRP). The overall impression is that the BIR has been structured to give scientific support to Sage's activist ideas.

Indeed, the BIR presents many alarming health claims. EMFs at ordinary environmental levels, the reader is told, are linked to autism, Alzheimer's disease, several forms of cancer, genetic damage, neurological problems in children whose mothers used mobile phones, hypersensitivity reactions to EMF (with symptoms similar to those of allergies), among many others. Readers who are looking for reasons to fear electromagnetic fields will find plenty of material in the BIR to justify their concerns.

Cautionary limits and the end of wireless communications

The latest BIR (or at least the two individuals who wrote the concluding sections) proposes “cautionary” limits of 0.3 to 0.6 nanowatts (billionths of a watt) per square centimeter (nW/cm^2) for exposure to RF fields – this is over 100X lower than the 2007 edition. This is roughly a million times below limits in effect in the US and most other countries at frequencies used by mobile telephone systems, Wi-Fi and other technologies.

As an example of another source of radiation, ordinary sunlight (one of the many forms of EMF) has an energy density of about 100 mW (milliwatt or a thousandth of a watt)/ cm^2 , which is more than 100 million times stronger than the proposed BIR limit for RF energy. Sunlight contains little RF energy, but about half of the solar energy that hits the earth is in the infrared part of the spectrum, which is just above the radiofrequency region considered by the BIR.

Depending on how these limits would be implemented (a matter not discussed in the BIR), their implications might be profound. All urban areas have many places where RF signals from cellular base stations, television and radio broadcasting facilities, public safety communications systems, and other useful technologies will exceed these limits – sometimes by a very large factor. Signals from Wi-Fi devices, mobile phone handsets, cordless phones, and many other useful devices would also exceed the limits, as would transmissions from the police car driving through your

neighborhood, and energy leaking from your kitchen microwave oven – the strongest RF source in most households. Radar for air traffic control would be ruled out by the recommendations. Assessing compliance with the proposed BIR limits would certainly create a lot of work for Sage Associates Environmental Consultants, and undoubtedly for legions of lawyers as well.

Cherry Picking

Selective attention to data, colloquially known as “cherry-picking” or more technically as confirmation bias, is a failure in reasoning that affects all aspects of life. Recent U.S. presidential candidate Mitt Romney recently fell victim to confirmation bias by allowing himself to be convinced by the results of (evidently) skewed Republican polls that he was about to win the election.

To guard against confirmation bias, good expert reviews incorporate safeguards to ensure that all relevant data, supportive or not of the hypothesis being tested. Thus the Cochrane Review, cited above, says “judgments [about effectiveness of medical interventions] should be made in ways that do not depend on the findings of the studies included in the review”. A review that focused only on studies that report positive outcomes of a drug (for example) and ignored no-effect studies would surely have biased and unreliable conclusions.

The authors of the BIR commit exactly this error with EMF bioeffects studies, by speculating at length about possible implications of studies reporting effects of EMF while saying little about studies that failed to find effects. Rather than taking a “weight-of-evidence approach” to put all the studies together in a coherent picture, most authors simply listed numbers of studies reporting effects (of whatever nature at whatever exposure level) in comparison with those that found none.

An egregious example is connected with a long table near the beginning that lists reported biological effects from RF energy at low-intensity levels. The authors (at least the two authors who wrote the summary sections) based their cautionary recommendations on the lowest exposure levels used in studies that reported effects – regardless of the health significance of the effects, the scientific credibility of the studies, and presence of contradictory evidence.

And here is where the cherry picking comes in. The table only includes lists of studies reporting effects, some at vanishingly small exposure levels. Studies that did not report effects, or which could not confirm studies that earlier had reported effects, are conspicuously missing.

For example, one of the effects at the lowest exposure levels was reported in 2000 by David de Pomerai (University of Nottingham) and colleagues² (see p. 106 of the PDF). In that study, exposure to low-level microwave radiation caused nematodes (a kind of worm) to express heat shock proteins. (Heat shock proteins are “expressed” or produced by the body as a way of adapting to temperature changes, an effect that can be observed at even slight temperature increases). Not mentioned is the fact that de Pomerai retracted the paper in 2006 after he had discovered that the earlier results were an artifact due to inadequately controlled temperature.³

The BIR also fails to discuss the high quality follow up studies (including one by de Pomerai and colleagues⁴) that found that RF exposure levels far above those used in the earlier studies did not

induce heat shock proteins in a different nematode. Health agencies in their reviews have paid little attention to the expression (or non-expression) of heat shock proteins induced by RF exposure, in part because of lack of a robust and repeatable effect and in part because of the difficulty in separating the effects of simple temperature change from any specific effect of RF. Also, one might question the relevance of a small biological effect reported in nematodes in response to mild heating to human health.

A further example: the BIR concludes: "One study reports that RF at levels equivalent to the vicinity of base stations and RF- transmission towers is genotoxic and could cause DNA damage" (see P 73 of the PDF), citing a 1998 paper by Phillips (University of Colorado) et al.⁵ In fact, this study reported both increases and decreases in damage to DNA after very low-level exposures. One might equally cite the study as showing a protective effect of RF exposure at low exposure levels.

More importantly, this 15-year old study is not supported by later work. A careful review in 2012 by Vijayalaxmi (Univ of Texas) of 88 studies found no clear evidence of genetic damage in cells produced by RF exposure, even though the exposure levels varied by more than a million.⁶ Some studies reported effects, and some did not. Most of the reported effects were within the range of "spontaneous levels reported in a large data-base" and may have been unrelated to the RF exposure. By focusing on the one positive (actually, mixed) report by Phillips et al., the authors imply that RF exposures at levels produced by wireless base stations are genotoxic, a conclusion that is not supported by many later studies and a more careful analysis of the literature.

The BIR dismisses the apparent lack of consistency among studies with the rhetorical statement: "some experts keep saying that all studies have to be consistent (turn out the same way every time) before they are comfortable saying an effect exists" (see P20 of the PDF).

To our knowledge, no expert report in this field requires such absolute consistency, which would be impossible to achieve in real experiments in any event. Instead, health agencies look for different lines of evidence to point to the same phenomena across studies, together with other criteria such as potential health relevance.

For example, the authoritative World Health Organization (WHO) Environment Health Criteria document for ELF Fields⁷ says, with respect to cancer risk assessment, "For laboratory studies, priority should be given to reported responses (i) for which there is at least some evidence of replication or confirmation, (ii) that are potentially relevant to carcinogenesis (for example, genotoxicity), (iii) that are strong enough to allow mechanistic analysis and (iv) that occur in mammalian or human systems."

This concern for confirmation is related to a fundamental requirement of science, that knowledge be generalizable. A study whose results cannot be generalized to other situations or yields no predictions that can be successfully tested by others, lacks external validity and is useless scientifically.

The BIR tries to have it both ways: it extrapolates from unconfirmed (or unconfirmable) laboratory studies to make dire predictions of health significance of RF exposures to humans. In effect it assumes that the results are generalizable from laboratory studies in cells or animals to human health. At the same time it dismisses the reluctance of health agencies to consider reports of biological effects that cannot be independently confirmed, which is to say that they cannot even

predict results in similar laboratory experiments by other scientists.

Bad reviews

The BIR has long been criticized by health agencies for slant. In its devastating review of the original 2007 version,⁸ the Health Council of the Netherlands concluded:

“In view of the way the BioInitiative report was compiled, the selective use of scientific data and the other shortcomings mentioned above, the Committee concludes that the BioInitiative report is not an objective and balanced reflection of the current state of scientific knowledge. Therefore, the report does not provide any grounds for revising the current views as to the risks of exposure to electromagnetic fields.”

The same weaknesses are still present in the 2012 version, which moreover does not address the criticisms of the Health Council of the Netherlands or other expert groups.

It takes only a glance at Verschaeve's article¹ to realize how far out of line the BIR is with assessments of the issue by mainstream agencies. Of the more than 30 reviews that he considered, all but one did not “consider that there is a demonstrated health risk from RF-exposure from mobile telephones and other wireless communication devices.” The single exception was the BioInitiative report, which Verschaeve judged to be by far the weakest of the group of reports that he considered.

Conclusion

Ultimately, the question reduces to the quality of judgments on what is, by all accounts, a mixed and in places contradictory scientific literature. This confusion may conceivably be the result of a small “signal” (a real but weak biological activity of ELF or RF electromagnetic fields at typical environmental exposure levels). But alternatively, it may also reflect the fact that science is difficult and often unreliable when searching for small effects in the face of a multitude of potential experimental artifacts.

It would require a more careful and balanced assessment than provided by the BIR to distinguish between these possibilities, or to fairly assess the potential health consequences of any effects from low-level exposures to electromagnetic fields in the environment, assuming that any can be definitely established.

The web page for the latest edition of the Bio-Initiative Report has been completely redesigned. The page is dominated by pictures of natural landscapes: retreating glaciers, wetlands, coral reefs, etc. that have nothing to do with the subject matter of EMF fields. They appear to be trying to associate themselves with legitimate concerns about the environment and climate change. But the analogy with climate change is the exact opposite of the impression they are trying to make. The consensus of the vast majority of climate scientists is that human caused climate change is real.

Only a small minority of climate scientists is opposed to this consensus. In the case of EMF and health, the overwhelming majority of scientists see no good evidence for health effects. The BIR represents the views of a small minority.

The first edition of the BIR was widely quoted by activist groups, but had no significant effect on public policy. The “cautionary” recommendations of the latest 2012 edition of the BIR, which are more than 100 times lower than the previous one, are made without clear scientific justification and at levels that would all but eliminate broadcasting and wireless technology. Perhaps they are hoping to gain more attention with such an extreme position. It will certainly excite the activists but it is unlikely to influence public policy any more than the first edition did.

Individuals can choose in whom to place their trust. However, governments, including health agencies, have an obligation to use the best available advice about matters of importance to the health of their populations, and the BIR falls short by a huge margin. As in U.S. presidential elections, cherry picking can lead to disastrously bad judgment.

About the authors

Kenneth R. Foster is a professor of Bioengineering at the University of Pennsylvania:
<http://www.seas.upenn.edu/~kfoster/kfoster.htm>

Lorne Trottier is co-founder of Matrox, a manufacturer of specialized video and graphics boards www.matrox.com. He maintains the website [EMF and health \(www.emfandhealth.com\)](http://www.emfandhealth.com), which provides more information on this issue

References

1. L. Verschaeve, Evaluations of International Expert Group Reports on the Biological Effects of Radiofrequency Fields. (2012). In Wireless Communications and Networks – Recent Advances, Dr. Ali Eksim (Ed.), ISBN: 978-953-51-0189-5, InTech, Available from: <http://www.intechopen.com/books/wireless-communications-and-networks-recent-advances/evaluations-of-international-expert-group-reports-on-the-biological-effects-of-radiofrequency-fields>
2. de Pomerai D, Daniells C, David H, Allan J, Duce I, Mutwakil M, Thomas D, Sewell P, Tattersall J, Jones D, Candido P. Cell biology – Non-thermal heat-shock response to microwaves Nature 405; 2000. [PubMed](#)
3. Retraction notice. Nature 440: pg 437, 2006.
4. Dawe AS, Nylund R, Leszczynski D, Kuster N, Reader T, De Pomerail DI. Continuous wave and simulated GSM exposure at 1.8 W/kg and 1.8 GHz do not induce hsp16-1 heat-shock gene expression in *Caenorhabditis elegans*. Bioelectromagnetics 29:92-

99; 2008. [PubMed](#)

5. Phillips JL, Ivaschuk O, Ishida-Jones T, Jones RA, Campbell-Beachler M, Haggren W. DNA damage in Molt-4 T-lymphoblastoid cells exposed to cellular telephone radiofrequency fields in vitro. *Bioelectrochem Bioenerget* 45; 1998. [PubMed](#)
6. Vijayalaxmi, Prihoda TJ. Genetic damage in human cells exposed to non-ionizing radiofrequency fields: A meta-analysis of the data from 88 publications (1990-2011). *Mutat Res -Genet Toxicol Environ Mutag* 749: 1-16; 2012. [PubMed](#)
7. WHO, Extremely Low Frequency Fields Environmental Health Criteria Monograph No.238, Geneva 2010. http://www.who.int/peh-emf/publications/elf_ehc/en/index.html
8. Critical Review of the BioInitiative Report, from the Health Council of the Netherlands http://www.gezondheidsraad.nl/sites/default/files/200817E_0.pdf

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20 thoughts on “Picking Cherries in Science: The Bio-Initiative Report”



1. PJLandis says:
[February 15, 2013 at 4:02 am](#)

That's all well and good, but I'm investing in tin foil.

2. Janet says:
[February 15, 2013 at 8:11 am](#)

That's all well and good, but you have people like Sheryl Crow telling Katie Couric her brain tumor was caused by her cell phone—who is the average person going to believe—better yet,



February 7, 2013

The Round-Table Proposal – Why It Is Obsolete

The publication of the 2007 BioInitiative Report - with the millions of website viewings over five years shows that the world is moving away already from the obsolete positions of ICNIRP and the FCC.

It is clearly counter-productive now to willingly enter the world of '*diversion, divide, conqueror and exhaust*' which is the time-honored ploy when industry interests decide that outsiders are making a good run at their power base. Our efforts to collaborate with entrenched power structures that have for decades held public health ransom and subverted* efforts for change would only dilute the progress our BioInitiative Working Group has achieved with its two major publications.

ICNIRP, the IEEE/FCC and lobby groups MMF, CTIA and EPRI have risked grave damage to generations of humans, and to the living species of our global environment by failing in their duty to document the science and public health consequences of uncontrolled EMF and RFR exposures, while encouraging the spread of such dangerous exposures. So, we have done it. And, people seem to read and trust it. In one month, the BioInitiative 2012 Report has had over 275 million kilobytes of data downloaded (about 10,000 full copies of a 1480 page report) and about 2.5 million hits in one month since publication at www.bioinitiative.org

The BioInitiative Working Group provided an independent and unbiased overview of the published scientific literature from four decades of work by researchers around the world. People can read and reason. There is a strong and growing movement that argues for change among decision-makers and the public, outside of the iron grasp of the industry-backed ICNIRP and IEEE/FCC clubs. Adoption of ICNIRP 'guidelines' for public safety limits are VOLUNTARILY adopted by each country. When the governments of these countries face public outrage, voter revolt and explosive health care costs, they will do the work themselves. They will reject ICNIRP dogma that has compromised human health, incurred catastrophic costs for disability from chronic diseases and caused economic disruption to global economies. Populations that lose resilience to disease cannot pull countries out of economic stagnation. This movement has arisen in thousands of geographic points, across widely diverse interest groups holding diametrically opposed political and social views around the world.



The reason the BioInitiative work has made such profound changes in world perception of EMF and wireless technologies is precisely because the Working Group did not ask permission. No established governmental group appointed us. We are not on anyones' payroll. We did not get sequestered behind closed doors where the lock-and-key belongs to an existing, self-serving power structure that controls public health by fiat. We certainly now do not intend to ask forgiveness at some round-table outgunned by the infinite resources of MMF, nor CTIA, nor their industry-backed lobby groups and attorneys and media-spinners. ICNIRP is a tired old group that has seen it's veil of secrecy and privacy challenged. The FCC ignores evidence of the risks it allows, while tossing the ball to the FDA on health matters, allowing industry to write the rules to accommodate new wireless technologies over health needs, and making money on the sale of the airwaves to spread the health harm to ever greater populations. These groups do not hold enough global respect to be at the table.

The WHO has revealed itself to be a partisan player that cannot be trusted to accept change, even when the documentation comes from its own programs and research experts. I speak here of the actions I observed when the ELF-EMF Health Criteria Monograph was presented by the WHO in Geneva in 2006. The WHO accepted 'rewrites' to the cover language for the ELF-EMF Health Criteria Monograph (Press Release) based on the covert input of the electric utility industry point persons (closet advisors from industry) to avoid taking any public health action on ELF-EMF and childhood leukemia. After more than a decade of obfuscation and misleading arguments that it was impossible for such weak fields to affect human biology and diseases, the strength of the evidence finally supported a classification for ELF-EMF as a 2B Possible Human Carcinogen by IARC. What did the upper WHO management do with this? They admitted yes... it may cause childhood leukemia... but the numbers are so few, and the other childhood diseases take so many children in comparison, we will do nothing. Worse, WHO management allowed the Press Release re-write of the Monograph findings – by the same electric utility industry 'closet advisor'. That inserted language specifically advised against taking any measurements of ELF-EMF to guide health assessments for risks of childhood leukemia, even though the Monograph itself clearly defined exposure levels of ELF-EMF that increased risks to children. The inserted language crippled any future work to remediate environments risky to children, and silenced the debate.



Any reasonable person would have to mistrust a plan that involves the WHO managing the process, that is still under the same Director of Environment and Public Health (Maria Neira, MD). People who do not learn from history are bound to repeat the same mistakes. I believe this proposal, as presented, will result in the same kind of sand-bagging for the RFR classification. Same management, different day, different toxin, same entombment of progress to address a preventable human toxin from affecting more generations of children.

One of the leading thinkers in this field is Alasdair Phillips of the UK Group Powerwatch. We talked recently about the industry-government tactic of 'managing dissent' by rounding up those with dissenting views (e.g. views in opposition to entrenched interests) appointing them to official-sounding groups with long meeting agendas over years of time to stymie real progress, exhaust the resources of public participants and weary them to the point of retirement. We compared notes on his experience with the SAGE Group in the UK and my experience in the US with the California Public Utilities Commission EMF Consensus Group; and later the US Department of Energy RAPID research program. In all these cases, the best and the brightest researchers and public health and policy experts were simply 'corralled' by the requirements of polite discourse, delayed for years from making real progress in any functional way for societal education or change; and finally spit out by these 'dialogues' that resulted in no change whatsoever. In the end, the inclusion of independent thinkers resulted in silencing of public concern but no progress. These were shrewd crisis-containment techniques that derailed legitimate discourse, and progress.

So, the Dariusz Leszczynski proposal for an ICNRP/MMF/BioInitiative Group round-table rings hollow. We have been 'detained' at such round-tables before, only to be sedated and diverted from any real progress.

So, we have chosen another avenue. We do not waste valuable time, our exceedingly limited resources, nor our good-will on such 'staged events' anymore.

Instead, we concentrate on presenting the best, independent, understandable, plain language, scientifically accurate compendium of ALL of the relevant information – to the entire world – for free download – at our own time and expense – so honest and reasonable people everywhere can read and reason. We went outside the construct. That is the reason that people trust our work.



It is a far more powerful way to let the world decide if social changes are necessary.

So, you can take down the corral, Dariusz, because no matter how you salt it, our herd is not coming.

Cindy Sage, MA
Co-Editor
BioInitiative 2007 and 2012 Reports
Sage Associates
Santa Barbara, CA USA

David O. Carpenter, M.D.
Co-Editor, BioInitiative 2007 and 2012 Reports
Director, Institute for Health and the Environment
5 University Place, Room A-217
University at Albany
Rensselaer, NY 12144

22. Maximum conductor sag for a specific span is calculated using the following formula:

$$S = \frac{T}{W} * \left(\cosh \frac{W * L}{2 * T} - 1 \right)$$

S = maximum sag

W = conductor weight (lbs/ft)

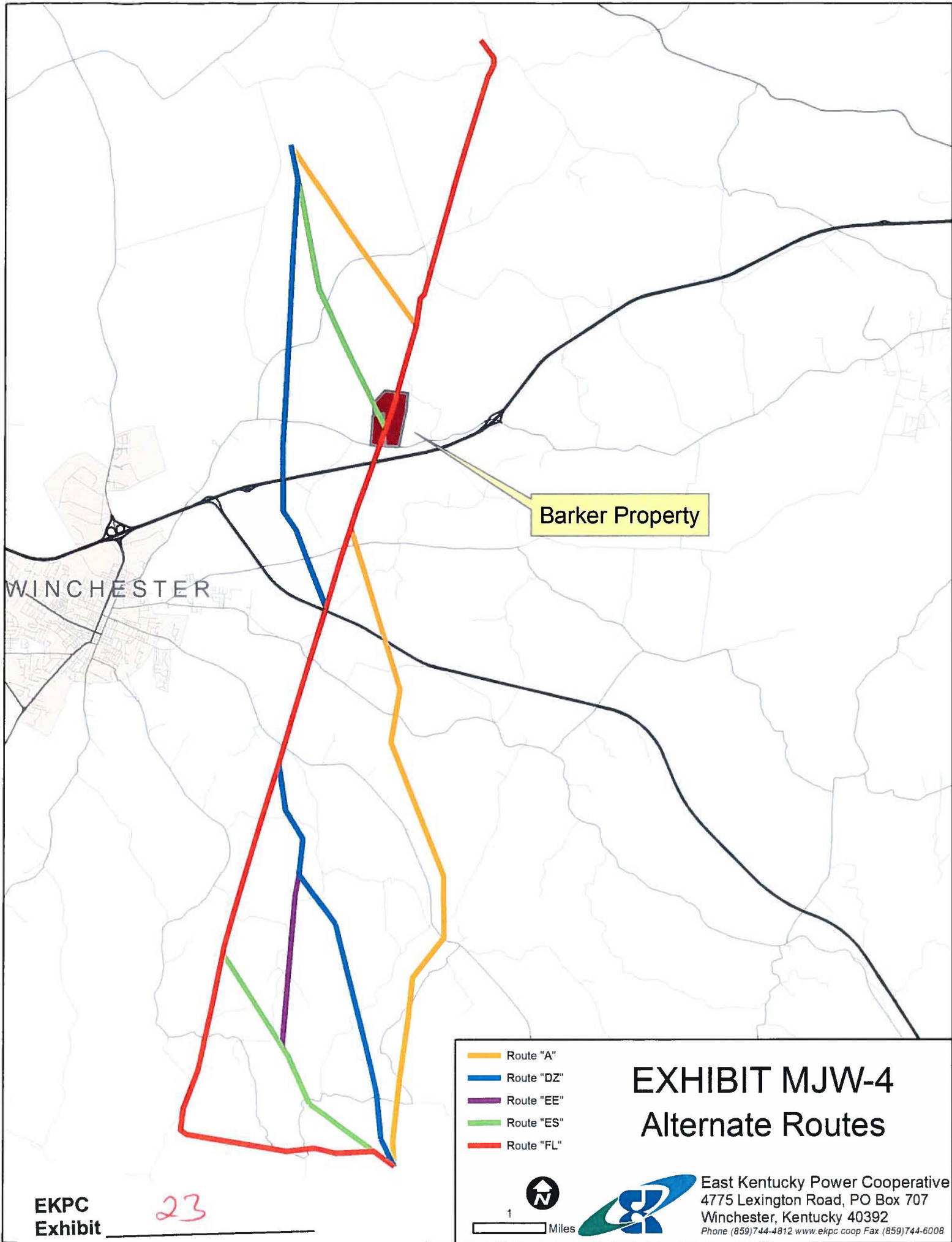
L = span length

T = horizontal tension in pounds

The following table displays the calculation of maximum sag for each span that crosses the Barker Property:

From Structure	To Structure	Span Length (ft)	345kv Conductor Weight (lbs /ft)	345kv Conductor Tension (lbs)	345kv Conductor Maximum Sag (ft)	69kv Conductor Weight (lbs /ft)	69kv Conductor Tension (lbs)	69kv Conductor Maximum Sag (ft)
UT-78	UT-80	1065.60	1.229	3609	48.47	1.094	3249	47.92
UT-80	UT-81	1007.48	1.229	3609	43.31	1.094	3249	42.82
UT-81	UT-82	747.56	1.229	3609	23.82	1.094	3249	23.55
UT-82	UT-83	480.64	1.229	3609	9.84	1.094	3249	9.73
UT-83	UT-84	899.36	1.229	3609	34.50	1.094	3249	34.11
UT-84	UT-85	705.12	1.229	3609	21.19	1.094	3249	20.95
Ruling Span		895.49	1.229	2609	34.20	1.094	3249	33.82

The horizontal tension of 3,609 pounds for the 345kv and 3,249 pounds for the 69kv is based on the maximum operating temperature of 212°.



Audio Clips From Meeting With Paul Dolloff Of EKPC Dated Dec. 2008 Concerning Electric/Magnetic Fields & Levels Experienced At The Barker Residence Including Ann, Harold And Brooks Barker.

1. Time-(~~23:05 to 23:32~~) - *Note: Corrected Time (41.00 to 41.48)*
(Harold Barker)----- Getting Shocked, that's what it comes down to.
(Brooks Barker)----- But if they, if they would have you know routed it down that hill, and you know nobody-nobody said anything about a field like this generating this much going to be a product of you know it going by the house & then you know I'm sure they wouldn't- coming through their not going to divulge that, now after the fact that it is up.....
(Paul Dolloff)----- Yea, so that's why they call me—, go figure it out you know & help these people.
2. Time-(~~41:00 to 41:48~~) *Note: Corrected time - (23.05 to 23.32)*
(Paul Dolloff)----- I mean we are not going to deny that electric power lines- they have fields associated with them, they just do- I mean this, were not going to lie about that and the higher the voltage the greater the electric field is going to be.
(Harold Barker)----- And because the others were such low voltage, we did not get a shock...
(Paul Dolloff)----- Because it was much lower voltage, the electric field was that much less-exactly.
3. Time-(43:29 to 43:41)
(Ann Barker)----- No, what we want remedied is a healthful—healthful—we don't want to all be fried here, or all die of cancer one day.
(Paul Dolloff)----- Well I understand that.
4. Time-(44:20 to 45:42)
(Paul Dolloff)-----But If you want me to get you some satisfaction on getting an answer for this I can go try to make that happen.
(Ann Barker)----- Well I think we've got bigger problems here and then we'll get this straightened out.
(Paul Dolloff)----- OK
(Harold Barker)----- And if she has somebody come to the candy shop in this driveway with a pacemaker or.....
(Ann Barker)----- Yea I've got one woman I have to meet, she can't mmm she had a pacemaker put in and actually the instructions she has with the pacemaker,-
(Paul Dolloff)----- Ok.
(Ann Barker)----- Tells her two things, not to be near the high voltage lines- the second thing is not to be like standing over a car with the hood raised when it's running. Because of I think she said the alternator..
(Paul Dolloff)----- Now that's- that's exactly right. And that's – we've known that for a long time, I think I've shared that with you before cause that sometimes those umm pacemakers can be susceptible to to voltage- It will make them either skip or make it run erratically, and we always are mindful of that and you've seen it before when you go into the hospital, in the little cafeteria and the microwave has a sign- right

Audio Clips From Meeting With Paul Dolloff Of EKPC Dated Dec. 2008 Concerning Electric/Magnetic Fields & Levels Experienced At The Barker Residence Including Ann, Harold And Brooks Barker.

(Ann Barker)----- uhm

(Paul Dolloff) ----- if you have a pacemaker you might not want to be in this room, so we've, we've learned that a long time ago. So we're sensitive to that as a utility.

5. Time-(53:50 to 54:03) *(53 min. 50 sec. to 54 min 03 sec.)*

(Paul Dolloff)-----But you know we're willing to help you as much as you want to, we're not going to hide anything, but that's all based on magnetic field, health related issues have always been based on magnetic field issues---apart from a pacemaker.

6. Time-(107:48 to 108:21) *(1 hr 7 min. 48 sec to 1 hr 8 min. 21 sec.)*

(Harold Barker)-----Surely somebody else has..

(Ann Barker)-----It's hard to believe that the whole United States though..

(Harold Barker)-----yea in the whole United States??

(Paul Dolloff)-----Well the thing is again,, I think it actually has been looked at and they deemed it not a problem if you stay 100 ft. away from 69kv and you stay 150 ft. away from 345...

(Brooks Barker)-----From the edge of the easement??

(Paul Dolloff)-----Exactly.

(Paul Dolloff)-----But if you build right on the edge we'll

(Brooks Barker)-----You would have to be at the other end of the house or just a little bit further...

(Paul Dolloff)-----Well you know if you build a metal structure right on the edge like a barn, we'll go ground the roof or building or the siding—it's not a problem.

7. Time-(111:04 to 112:35) *(1 hr 11 min. 04 sec. to 1 hr 12 min. 35 sec.)*

(Brooks Barker)-----When you touch the metal out there- you're the ground rod basically to discharge that from the truck and you're -- it's going through you the current and the voltage you know -- it's small --it's small current, but it's you're still grounding it all to ground- through you.

(Paul Dolloff)-----Ok, so now on what your issue is—is that we have an electric field and anything in that electric field that's metal or conductive-- that electric field is gonna put a charge on it, and it's gonna want to raise the voltage of that piece of metal to a voltage ---and it will be not 0, and the earth is 0, so if you grab the earth and you grab that metal object you're going to have a difference in voltage- and when that happens you're going to get a shock because you're at 0 and the truck if you will is not at 0 and you touch it you're going to get a shock. It's just like when you rub your feet on a carpet- now you get a charge right? But your door handle is at 0. When you grab the door handle and it discharges that electricity off of you back to 0 and it goes into the door handle. But as soon as that charge is gone-guess what --you're not going to get shocked the second time right—cause you're at 0.

(Brooks Barker)-----But it just stays on that though....

Audio Clips From Meeting With Paul Dolloff Of EKPC Dated Dec. 2008 Concerning Electric/Magnetic Fields & Levels Experienced At The Barker Residence Including Ann, Harold And Brooks Barker.

(Paul Dolloff)-----But it does stay on that- you're exactly right, you would have to re-rub your feet on a carper to build another charge--- if you're in the presence of a very strong electric field it will automatically charge back up.

(Brooks Barker)-----yea.

(Paul Dolloff)----- That's exactly right.



Barker
Exhibit

2



Barker
Exhibit

3



Barker
Exhibit

4

MS. Warner's Calculations

		Option 1			Original		
Average Straight Line, 2 Pole Structure	(0° - 7°), 2 Pole	1	\$39,762.96	\$39,762.96	2	\$39,762.96	\$79,525.92
Structure with 2 guy wires and 2 anchors	(7° - 45°), 3 Pole	0	\$42,188.04	\$0.00	1	\$42,188.04	\$42,188.04
Structure with 13 guy wires and 13 anchors		3	\$49,422.39	\$148,267.17	0		
3 Phases of 2 bundle 954 ACSR conductor for		2129.1	\$27.23	\$57,975.39	2075	\$27.23	\$56,502.25
3 Phases of single 795 ACSR conductor for 69kv / per foot		2129.1	\$13.46	\$28,657.69	2075	\$13.46	\$27,929.50
7no8 Overhead Ground Wire / per foot		2129.1	\$3.06	\$6,515.05	2075	\$3.06	\$6,349.50
470" Fiber Optic Cable / per		2129.1	\$2.13	\$4,534.98	2075	\$2.13	\$4,419.75
		\$285,713.24			\$216,914.96		
					Difference		
					\$68,798.28		

Backup cost Data

Original Additional Total
Distance Distance Distance

Feet	Feet	Feet
2075	54.1	2,129.10
2075	54.1	2,129.10
2075	54.1	2,129.10
2075	54.1	2,129.10

	Material	Labor	Total				
Average Straight Line, 2 Pole Structure	\$23,687.17	\$16,075.79	\$39,762.96		\$22,000.00	\$39,762.96	1.81
Structure with 2 guy wires and 2 anchors	\$24,348.27	\$17,839.77	\$42,188.04		\$23,341.75	\$42,188.04	1.81
Structure with 13 guy wires and 13 anchors	\$29,644.06	\$19,778.33	\$49,422.39		\$27,344.36	\$49,422.39	1.81
3 Phases of 2 bundle 954 ACSR conductor for 345kv / per foot	\$10.69	\$16.54	\$27.23		\$15.07	\$27.23	1.81
3 Phases of single 795 ACSR conductor for 69kv / per foot	\$5.19	\$8.27	\$13.46		\$7.45	\$13.46	1.81
7no8 Overhead Ground Wire / per foot	\$0.34	\$2.72	\$3.06		\$1.69	\$3.06	1.81
.470" Fiber Optic Cable / per foot	\$0.91	\$1.22	\$2.13		\$1.18	\$2.13	1.81
140' LD-08	\$12,000.00	\$10,000.00	\$22,000.00				

John Pfeiffer's new estimate based upon Ms. Warner's information

		Option 1			Original			
Average Straight Line, 2 Pole Structure	(0° - 7°), 2 Pole		\$22,000.00	\$0.00	2	\$22,000.00	\$44,000.00	
Structure with 2 guy wires and 2 anchors	(7° - 45°), 3 Pole		\$27,344.36	\$0.00	1	\$27,344.36	\$27,344.36	
Structure with 13 guy wires and 13 anchors		3	\$27,344.36	\$82,033.07				
3 Phases of 2 bundle 954 ACSR conductor for		2129.1	\$15.07	\$32,076.55	2075	\$15.07	\$31,261.49	
3 Phases of single 795 ACSR conductor for 69kv / per foot		2129.1	\$7.45	\$15,855.69	2075	\$7.45	\$15,452.80	
7no8 Overhead Ground Wire / per foot		2129.1	\$1.69	\$3,604.64	2075	\$1.69	\$3,513.04	
470" Fiber Optic Cable / per		2129.1	\$1.18	\$2,509.11	2075	\$1.18	\$2,445.35	Difference
				\$136,079.06				\$124,017.05
								\$12,062.01

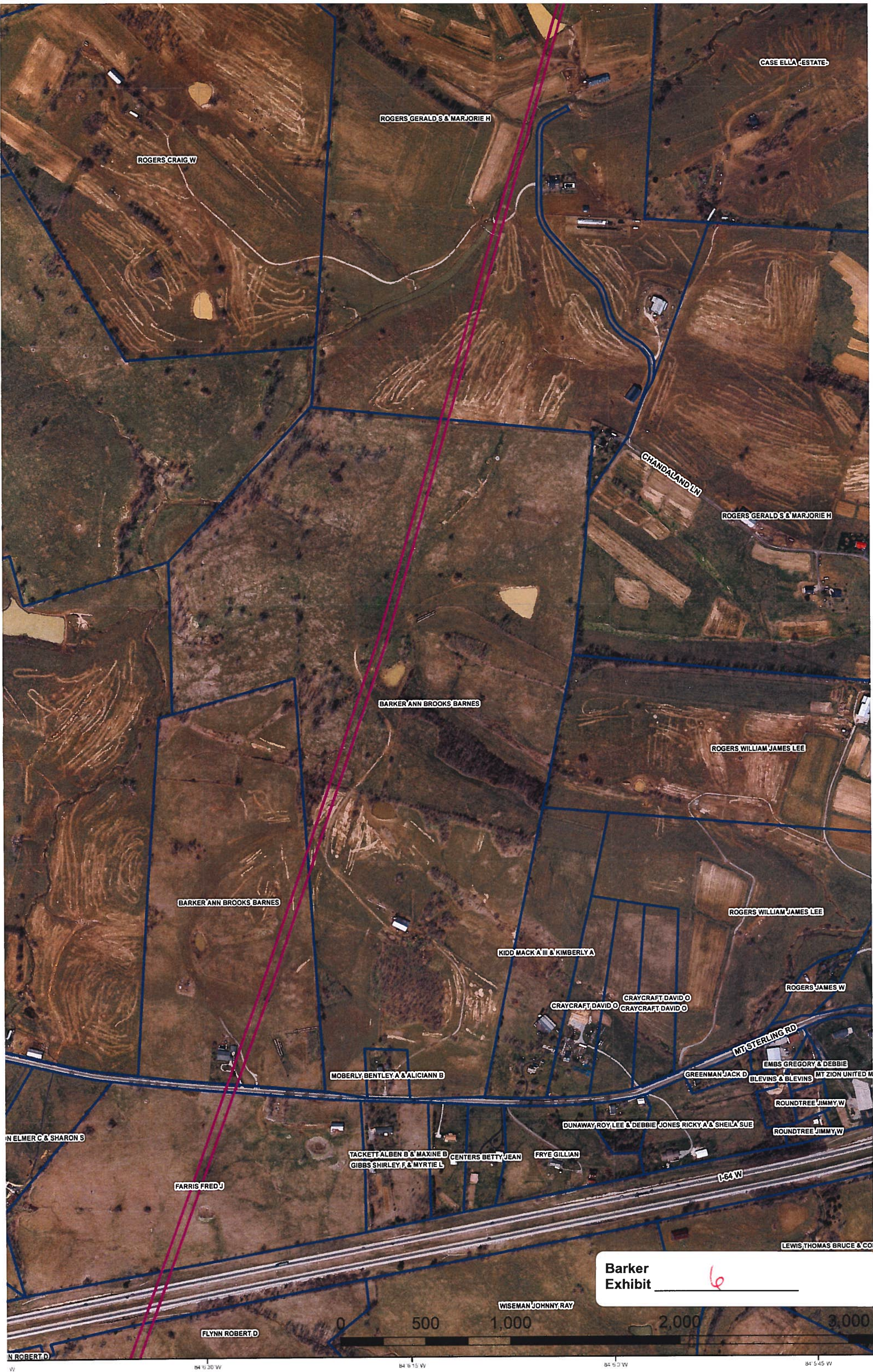
Exhibit 6-B-2

PSC Request 6

Page 3 of 3

Existing Design				Proposed Design			
UT-78	Material	Labor	Total	UT-78	Material	Labor	Total
95'-LD-05	\$5,282	\$6,126	\$11,408	140'-LD-08	\$12,000	\$10,000	\$22,000
95'-LD-05	\$5,282	\$6,126	\$11,408	140'-LD-08	\$12,000	\$10,000	\$22,000
			\$22,816				\$44,000
UT-79	Material	Labor	Total	UT-79	Material	Labor	Total
95'-LD-04	\$4,992	\$5,736	\$10,728	--	--	--	--
100'-LD-04	\$6,100	\$5,736	\$11,836	--	--	--	--
			\$22,564				\$0
UT-80	Material	Labor	Total	UT-80	Material	Labor	Total
100'-LD-04	\$6,100	\$6,395	\$12,495	140'-LD-05	\$10,586	\$10,000	\$20,586
100'-LD-04	\$6,100	\$6,395	\$12,495	140'-LD-05	\$10,586	\$10,000	\$20,586
			\$24,990				\$41,172
TOTAL		\$70,370		TOTAL		\$85,172	

DIFFERENCE = \$14,802



CASE ELLA - ESTATE -

ROGERS GERALD S & MARJORIE H

ROGERS CRAIG W

CHANDALAND LN

ROGERS GERALD S & MARJORIE H

BARKER ANN BROOKS BARNES

ROGERS WILLIAM JAMES LEE

BARKER ANN BROOKS BARNES

ROGERS WILLIAM JAMES LEE

KIDD MACK A III & KIMBERLY A

ROGERS JAMES W

CRAYCRAFT DAVID O

CRAYCRAFT DAVID O
CRAYCRAFT DAVID O

MOBERLY BENTLEY A & ALICIANN B

EMBS GREGORY & DEBBIE

GREENMAN JACK D

BLEVINS & BLEVINS

MT ZION UNITED M

ROUNDTREE JIMMY W

ROUNDTREE JIMMY W

DUNAWAY ROY, LEE & DEBBIE JONES RICKY A & SHEILA SUE

N ELMER C & SHARON S

FARRIS FRED J

TACKETT ALBEN B & MAXINE B
GIBBS SHIRLEY F & MYRTIE L

CENTERS BETTY JEAN

FRYE GILLIAN

I-64 W

LEWIS THOMAS BRUCE & CO

Barker
Exhibit

6

WISEMAN JOHNNY RAY

FLYNN ROBERT D

0 500 1,000 2,000 3,000

W 84° 16' 30" W 84° 16' 15" W 84° 16' 0" W 84° 15' 45" W

Occupational exposure to extremely low frequency magnetic fields and brain tumour risks in the INTEROCC study

Michelle C Turner¹⁻⁴, Geza Benke⁵, Joseph D Bowman⁶, Jordi Figuerola¹⁻³, Sarah Fleming⁷, Martine Hours⁸, Laurel Kincl⁹, Daniel Krewski^{4,10}, Dave McLean¹¹, Marie-Elise Parent¹², Lesley Richardson¹³, Siegal Sadetzki^{14,15}, Klaus Schlaefer¹⁶, Brigitte Schlehofer¹⁶, Joachim Schüz¹⁷, Jack Siemiatycki¹³, Martie van Tongeren¹⁸, Elisabeth Cardis¹⁻³

¹ Centre for Research in Environmental Epidemiology (CREAL), Barcelona, Spain

² Universitat Pompeu Fabra (UPF), Barcelona, Spain

³ CIBER Epidemiología y Salud Pública (CIBERESP), Barcelona, Spain

⁴ McLaughlin Centre for Population Health Risk Assessment, Institute of Population Health, University of Ottawa, Ottawa, Canada

⁵ Monash University, Melbourne, Australia

⁶ National Institute for Occupational Safety and Health, Cincinnati, Ohio, USA

⁷ University of Leeds, UK

⁸ Unité Mixte de Recherche Épidémiologique Transport Travail Environnement Université Lyon 1/IFSTTAR, Université de Lyon, Lyon, France

⁹ Oregon State University, Corvallis, Oregon, USA

¹⁰ Department of Epidemiology and Community Medicine, Faculty of Medicine, University of Ottawa, Ottawa, Canada

¹¹ Massey University, Wellington, New Zealand

¹² INRS-Institut Armand-Frappier, Université du Québec, Laval, Canada

¹³ University of Montreal Hospital Research Centre, Montreal

¹⁴ Sackler Faculty of Medicine, Tel-Aviv University, Tel-Aviv, Israel

¹⁵ The Cancer & Radiation Epidemiology Unit, The Gertner Institute, Chaim Sheba Medical Center, Israel

¹⁶ Unit of Environmental Epidemiology, German Cancer Research Center, Heidelberg, Germany

¹⁷ International Agency for Research on Cancer (IARC), Section of Environment and Radiation, Lyon, France

¹⁸ Institute of Occupational Medicine, Edinburgh, UK

Corresponding Author: Michelle C Turner, CREAL-Centre for Research in Environmental Epidemiology, Parc de Recerca Biomèdica de Barcelona, Doctor Aiguader, 88 | 08003 Barcelona Tel. +34 932 147 336 | Fax +34 932 147 302. E-mail: mturner@creal.cat

Short Title: ELF and brain tumour risks in the INTEROCC study

Keywords: extremely low frequency magnetic fields, occupation, glioma, meningioma, case-control study

Conflict of Interest: The authors have no conflict of interest to declare.

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ABSTRACT

Background: Occupational exposure to extremely low frequency magnetic fields (ELF) is a suspected risk factor for brain tumours, however the literature is inconsistent. Few studies have assessed whether ELF in different time windows of exposure may be associated with specific histologic types of brain tumours. This study examines the association between ELF and brain tumours in the large-scale INTEROCC study.

Methods: Cases of adult primary glioma and meningioma were recruited in seven countries (Australia, Canada, France, Germany, Israel, New Zealand, United Kingdom) between 2000 and 2004. Estimates of mean workday ELF exposure based on a job exposure matrix assigned. Estimates of cumulative exposure, average exposure, maximum exposure, and exposure duration were calculated for the lifetime, and 1-4, 5-9, and 10+ years prior to the diagnosis/reference date.

Results: There were 3,761 included brain tumour cases (1,939 glioma, 1,822 meningioma) and 5,404 population controls. There was no association between lifetime cumulative ELF exposure and glioma or meningioma risk. However, there were positive associations between cumulative ELF 1-4 years prior to the diagnosis/reference date and glioma (odds ratio (OR) $\geq 90^{\text{th}}$ percentile vs $< 25^{\text{th}}$ percentile = 1.67, 95% confidence interval (CI) 1.36-2.07, $p < 0.0001$ linear trend), and, somewhat weaker associations with meningioma (OR $\geq 90^{\text{th}}$ percentile vs $< 25^{\text{th}}$ percentile = 1.23, 95% CI 0.97-1.57, $p = 0.02$ linear trend).

Conclusions: Results showed positive associations between ELF in the recent past and glioma.

Impact: Occupational ELF exposure may play a role in the later stages (promotion and progression) of brain tumourigenesis.

INTRODUCTION

There are few established risk factors for brain tumours (1). In countries with cancer registries, it is estimated that the annual age-standardized incidence rate of primary malignant tumours of the brain and nervous system is between three and four per 100,000. It is slightly higher among males than females and in developed than developing countries (1,2). Small increases in the incidence of some types of brain tumours have been observed over recent decades, due to changes in diagnosis, classification, and coding (1,3).

Although ionizing radiation is an established risk factor for the disease, it accounts for a small fraction of the total number of cases (4,5). Possible associations between occupational exposure to non-ionizing radiation sources, in particular extremely low frequency magnetic fields (ELF), which occur during the generation, distribution and use of alternating current electricity, and brain tumours have been examined; however, results are inconsistent and limited by small study sizes and a lack of occupational history data (6). Previous studies have also varied widely in terms of methodology. There have been studies of highly exposed occupational groups, including for example electrical workers, railway professionals, and resistance welders, with study designs ranging from job title-based studies, comparing rates of brain tumours to those expected in the general population (7-9), to studies based on detailed measurements and modelling (10) or job exposure matrices (JEMs) (11-12). There are also general population studies with ELF exposure assessments ranging from self-report or expert judgment through to JEMs (13-17).

A meta-analysis of 48 studies published during 1993-2007 reported a small positive association between occupational ELF and brain tumours overall (relative risk (RR) = 1.14, 95% confidence interval (CI) 1.07-1.22); however, there was no exposure-response relationship using approximations of ELF exposure categories in the original papers (18). *Mezu* Study characteristics that tended to be associated with stronger positive findings included a poor quality exposure assessment, a poorly defined comparison group, as well as an adequate study design.

Most recently, a US study of 489 glioma cases, 197 meningioma cases, and 799 controls reported no association between ELF and glioma (odds ratios (OR) cumulative exposure > 45 milligauss(mG)-years ($1 \mu\text{T} = 10 \text{ mG}$) vs 0 exposure > 1.5 mG = 0.8, 95% CI 0.5-1.2) or meningioma risk (OR = 1.0, 95% CI 0.6-1.8) (19). A French study of 221 cases of central nervous system (CNS) tumours and 442 controls, reported a positive association between ELF and meningioma (OR = 3.02, 95% CI 1.10-8.25) (17). No association between ELF and incident brain tumours (n=233) was observed in the Netherlands Cohort Study (20) nor in a study of UK electricity supply workers (n=266) (21).

The International Agency for Research on Cancer (IARC) classified ELF as possibly carcinogenic to humans (Group 2B), based on studies of childhood leukemia, but with *inadequate evidence* for all other cancers (22). Similar conclusions have been reached more recently (6,23,24). Mechanistically, any role of ELF would likely manifest on the later stages of tumour development, specifically in cancer promotion/progression as suggested by some co-carcinogenicity studies (22,24,25). Few epidemiological studies have had sufficient power to address this hypothesis. Results from some, but not all, studies have observed stronger

associations between ELF and brain tumours in the more recent compared to the more distant past, or with more aggressive forms of glioma (11, 13, 16, 26-29).

This study assesses the role of occupational ELF exposure for specific histologic types of brain tumours, namely glioma and meningioma, using data from the large-scale INTEROCC study. Detailed lifetime occupational histories were collected, providing a unique opportunity to examine the potential impact of ELF exposure overall and in specific exposure time windows.

MATERIALS AND METHODS

Study Population

The INTEROCC study is based on a subset of countries from INTERPHONE, a large, 13-country, population-based case-control study conducted according to a common protocol (30). Cases of primary brain (glioma, meningioma), CNS (acoustic neuroma), and salivary gland tumours, aged between 30 and 59 years were recruited between 2000 and 2004. Although INTERPHONE's primary objective was to examine whether radiofrequency (RF) field exposure from cellular telephones was associated with cancer risk, seven of INTERPHONE 13 countries, collected detailed occupational data and participated in the subsequent INTEROCC study to address outstanding questions concerning occupational agents in glioma and meningioma.

Incident cases were rapidly recruited (median delay from diagnosis to interview ~3 months) from major treatment centers in areas of Australia, Canada, France, Germany, New Zealand, the

United Kingdom, and nationwide in Israel. with completeness verified through secondary sources. An expanded age range was used for INTEROCC with Germany including cases aged up to 69 years, the UK 18 to 69 years, and in Israel cases aged 18+ years were recruited to allow for greater case ascertainment. Cases were confirmed histologically or through unequivocal diagnostic imaging.

Controls were randomly selected from electoral lists (Australia, Canada-Montreal, France, New Zealand), population-based registries (Canada-Vancouver, Germany, Israel), patient lists (UK), or random digit dialing (Canada-Ottawa) according to study center. Controls were either frequency- or individually-matched to cases by sex, age (five year groups) and study center within country.

Although the original INTERPHONE protocol called for the selection of only one control for each case of glioma or meningioma, all eligible controls were used here to maximize statistical power. The reference date of controls was calculated as the date of interview minus the median difference between the date of case diagnosis and interview by country. Participants provided written informed consent prior to interview. There were 5,399 eligible brain tumour cases (3,017 gliomas and 2,382 meningiomas) and 11,112 controls (identified from the sampling frame) among whom 3,978 cases (2,054 gliomas and 1,924 meningiomas) and 5,601 controls were interviewed. Major reasons for non-participation among controls in the overall INTERPHONE study include refusal (64%) and inability to contact (27%) (30). Overall participation rates for high-grade and low-grade glioma cases were also similar (67 vs 71% respectively) (30). Ethics approval was obtained from appropriate national and regional research ethics boards including

the Ethical Review Board of IARC (Lyon) for INTERPHONE and the Municipal Institute for Medical Investigation (IMIM) Barcelona for INTEROCC.

Data Collection

Eligible participants were interviewed by trained interviewers using a computer-assisted personal interview questionnaire. If the participant had died or was unable to participate, a proxy respondent was allowed. The questionnaire captured detailed data on a range of personal and family characteristics. Participants also completed a lifetime occupational calendar for all jobs held for a minimum of six months, including job title, company name, company description, start and stop year.

Exposure Assessment

A total of 35,862 jobs were reported. A total of 599 jobs (1.7%) were excluded (assigned no ELF exposure) due to invalid start/stop dates; and an additional 23 jobs (0.06%) excluded that ceased prior to age 14 years. Job titles were coded to the International Standard Classification of Occupations 1988 (ISCO88) four digit codes as well as 1968 (ISCO68) five digit codes, since it contains codes for occupations in the utility industry. Coding guidelines were provided to study centers and an inter-coding trial conducted to ensure consistency (31). The mean (SD) number of jobs per subject was 3.9 (± 2.6) for glioma cases, 3.6 (± 2.6) for meningioma cases, and 3.8 (± 2.5) for controls. A small number of participants (103 glioma cases, 95 meningioma cases, and 122 controls) who reported having never been employed were excluded here.

Estimates of mean workday-average ELF exposures came from an enhancement of a measurement-based JEM (32). The JEM was linked to the ISCO88 code for each job unless a JEM estimate was available for a more specific electrical job in ISCO68. The JEM was substantially enhanced by including measurement data on jobs included in the INTEROCC study based on summary statistics or primary data from published occupational studies in Canada, England, Finland, Italy, the Netherlands, New Zealand, Sweden, and the US. These studies used personal monitors to measure ELF exposure reporting the full-shift time-weighted average (TWA) “resultant” of the magnetic flux density in μT . All measurements were made using monitors with bandwidths within a range of 3 to 1,000 Hz.

Pooling studies in the JEM, estimates of geometric mean (GM) were calculated for 278 primary ISCO codes. Where there were no measurement data for a specific ISCO code, exposures were inferred based on similar jobs within the ISCO hierarchy (72 ISCO codes, 4.2% of the jobs of INTEROCC subjects) or estimated using expert judgement (60 ISCO codes, 1.8% of INTEROCC jobs). Jobs classified as an unknown occupation ($n=105$, 0.3% of jobs) were assigned the geometric mean of control values by centre. Supplementary Table S1 presents a description of ELF levels in selected participant jobs. An online version of the JEM is available at: <http://www.crealradiation.com/index.php/en/databases?id=55>.

Statistical Analysis

Conditional logistic regression models were used to obtain adjusted ORs and 95% CIs for the association between occupational ELF and brain tumours in seven countries combined stratified by region, country, sex, and five-year age group, and adjusted for education. Categorical indicators of cumulative and average ELF exposure with cut points based on the 25th, 50th, 75th, and, due to the skewed nature of the distribution, the 90th percentile of the control exposure distribution were examined for the lifetime (1-year lag) and in separate exposure-time windows defined *a priori*, 1-4, 5-9, and 10+ years prior to the date of diagnosis/reference date. Since ELF exposure is ubiquitous, the reference group consisted of participants in the lowest exposure category. Since the most relevant ELF metric, if any, is unknown (19), indicators of maximum exposed job and duration of employment in a job in the highest quartile of participant jobs ($\geq 0.18 \mu\text{T}$) were also examined.

Potential confounding by marital status, cigarette smoking, socioeconomic position (Standard International Occupational Prestige Scale (SIOPS)) (33), allergy history, occupational ionizing radiation (reported wearing a radiation badge), occupational cosmic radiation (prior flight-related occupation), and cumulative cellular telephone use (deciles of minutes of call time for Australia, Canada, France, Israel, New Zealand) were examined but produced virtually no change ($<10\%$) in ORs (not presented) (34, 35, 36). Potential confounding by ever exposure to 29 occupational chemicals selected *a priori* was also examined, based on chemical exposure estimates assigned based on a modified version of the Finnish job exposure matrix (FINJEM) to study participants as part of INTEROCC (37).

Sensitivity analyses were conducted excluding proxy interviews (30), participants who were judged by the interviewer to be reticent and uninterested in the interview and, participants > 69 years of age, participants with a history of self-reported physician-diagnosed neurofibromatosis or tuberous sclerosis, and for low and high-grade glioma separately. Potential effect modification by country, age, sex, and education was assessed by entering product terms into conditional logistic regression models and assessing their significance according to the likelihood ratio test. Analyses were conducted using SAS version 9.3 (38).

RESULTS

A total of 1,939 (94.4%) glioma cases, 1,822 (94.7%) meningioma cases and 5,404 (96.5%) controls were retained for analysis. The majority of glioma cases were male (62.0%), with meningioma cases being predominantly female (72.5%) (Table 1). The mean (SD) age of study participants was 51.0 (\pm 12.3) years for glioma cases, 54.7 (\pm 11.6) years for meningioma cases, and 51.8 (\pm 11.3) years for controls. The majority of participants had at least a high school education. Levels of lifetime cumulative ELF exposure ranged from 0.02-0.05 μ T-years to 467.83-715.93 μ T-years in cases (glioma/meningioma) and 0.03 μ T-years to 609.38 μ T-years in controls (Supplementary Table S2).

For glioma, there was no association with lifetime cumulative exposure, average exposure, maximum exposed job, or duration of exposure, and there was no exposure-response relationship (Table 2). However, for cumulative ELF there were positive associations in the 1-4 year time window prior to tumour diagnosis/reference date, with ORs ranging from 1.19 (95% CI 1.00-

1.43) to 1.67 (95% CI 1.36-2.07) in the highest exposure category ($\geq 90^{\text{th}}$ percentile) (p linear trend < 0.0001) (Table 3), comprising ~76% of participants in that time window, relative to those $< 25^{\text{th}}$ percentile. There were weaker positive associations in the 5-9 year time window. In the 10+ year time window, there was a weak, non-monotonic inverse association with increasing ELF exposure (OR $\geq 90^{\text{th}}$ percentile vs $< 25^{\text{th}}$ percentile = 0.77, 95% CI 0.60-0.99, p linear trend = 0.04). ORs (95% CIs) from a simultaneous exposure time windows model, including cumulative ELF from all three exposure time windows together in the same model, are presented in Figure 1a. Strong correlations between levels of cumulative ELF were observed for glioma cases and controls in the 1-4 and 5-9 year time windows (Supplementary Table S3), but were weaker for other time windows. Results were similar for both high- and low-grade glioma (Supplementary Table S4). Results for average exposure were generally similar in the 5-9 and 10+ year time windows, but in the 1-4 year time window, the positive association was attenuated (Supplementary Table S5). For maximum exposed job, there was a significant inverse trend ($p = 0.003$) in the 10+ year time window (Supplementary Table S6).

For meningioma, there was no association with lifetime cumulative exposure, average exposure, or maximum exposed job (Table 2). However, there was an elevated OR in the highest exposure duration group (25+ vs < 5 years) (OR = 1.30, 95% CI 1.03-1.64). There was also a significant positive linear trend ($p = 0.02$) with cumulative ELF exposure 1-4 years prior to tumour diagnosis/reference date (Table 3). No associations were seen in the 5-9 or 10+ year time windows. Figure 1b presents ORs (95% CIs) from a simultaneous exposure time windows model. For maximum exposed job, there was a significant positive trend ($p = 0.03$) in the 1-4 year time window (Supplementary Table S6).

Results for glioma with cumulative ELF in the 1-4 year time window were virtually unchanged with adjustment for occupational chemical exposures, with the exception of adjustment for benzo(a)pyrene (BAP) or polycyclic aromatic hydrocarbon (PAH) exposures, where ORs increased in the highest ELF exposure categories (Supplementary Table S7). ORs in some categories increased for both glioma and meningioma when excluding participants who were judged by the interviewer to be reticent and uninterested in the interview for cumulative ELF in the 1-4 year time window, however in the 10+ year time window, the weak inverse trend attenuated (Table 4). There was no significant effect modification observed.

DISCUSSION

Results from this large-scale study revealed no association between lifetime occupational exposure to ELF, but positive associations with cumulative ELF 1-4 years prior to the diagnosis/reference date and glioma. Weaker positive associations were observed for meningioma. There was also a weak inverse association for glioma with ELF exposure in the distant past (10+ year time window), which attenuated when subjects judged to be reticent and unresponsive were excluded from analyses.

Some studies reported stronger associations with occupational ELF in more recent exposure time windows. Among general population studies, Villeneuve et al. (16), in a study of 543 incident brain tumour cases and controls, observed positive associations in the highest category of average ELF exposure ($\geq 0.6 \mu\text{T}$ vs $< 0.3 \mu\text{T}$) for all brain tumours (OR = 1.33, 95% CI 0.75-

2.36) and glioblastoma multiforme (OR = 5.36, 95% CI 1.16-24.78) which strengthened for ELF in the last held job (OR = 12.59, 95% CI 1.50-105.6, number of cases (controls) = 18 (6)). Floderus et al. (13), in a study of 261 brain tumour cases and 1,112 controls noted positive associations between ELF in the longest job 10 years prior to diagnosis.

Among more highly exposed occupational groups, previous results were mixed, however, there were small numbers of cases and few examined associations in different time windows (10). Savitz et al. (27), in a case-cohort study including 145 brain tumour deaths from five US electric utility companies, reported positive associations with cumulative ELF (OR = 1.79, 95% CI 0.69-4.65 highest exposed group, 4.33-12.20 vs 0-0.65 μ T-years) that strengthened 2-10 years in the past (OR highest exposed group, 1.14-2.23 vs 0 μ T-years = 2.62, 95% CI 1.15-5.97). Hakansson et al. (11) in a cohort of over 700,000 resistance welders, observed positive associations between average ELF and astrocytoma in women ($n = 66$, p for trend = 0.004) in 10 years of follow-up. However, this was not observed in other studies (21, 28, 29).

Although ELF exposure in the 1-4 year time window represents a small proportion of total lifetime occupational ELF exposure, these results are compatible with a role in tumour promotion. ELF cannot impart enough energy to DNA molecules to create mutations, however, it may act on signal transduction, cell proliferation, reactive oxygen species generation, the neuroendocrine or immune system, or interact with other chemical exposures (24, 25). Villeneuve et al. (16) suggested that stronger associations observed with more aggressive forms of glioma may also provide support for a promotional role of ELF, however similar findings were observed for both high- and low-grade glioma here. There was also a weak positive

association between ELF in the longest exposure duration category and meningioma (and possibly glioma), possibly suggesting a role for prolonged ELF exposure for that slower growing tumour. Alternatively, findings in different time windows of exposures may be due to chance.

Potential limitations include low participation rates, particularly among controls (ranging from 35-74%) (30). The Swedish INTERPHONE study noted participation was positively associated with working status, income, and education (39). However education was similar for participating cases and controls here. Cases and controls reported a similar number of lifetime jobs. Mean (SD) weighted indicators of occupational prestige (SIOPS) were similar (glioma = 43.0 (± 11.7), meningioma = 42.2 (± 12.4), controls = 43.8 (± 12.0)).

The positive association between ELF and glioma in the 1-4 year time window was seen for all exposure categories, including a large majority (~76%) of participants, across a wide spectrum of occupations, not solely “electrical occupations”. Although preclinical symptoms of a brain tumour might lead to earlier diagnosis in certain jobs; they might also influence changes in occupation in different time windows, particularly for low grade glioma. The mean (SD) difference between average ELF levels in the 10+ and 1-4 year time windows was 0.001 (± 0.58) for glioma cases and 0.02 (± 0.31) for controls, indicating slight increases in ELF in more recent years. The pre-clinical phase of brain tumours is poorly understood. Fewer participants reported working in a job in the 1-4 year time window; however this appears to be unrelated to case/control status with 84% and 82% of included glioma cases and controls respectively reporting a job in this time window. The association with glioma remained, though attenuated slightly, upon restriction to participants who worked for a full four years in the 1-4 year time

window (OR \geq 90th percentile vs $<$ 25th percentile = 1.44, 95% CI 1.02-2.05, $p = 0.05$ linear trend).

We also excluded a small number ($n=320$) of participants who reported having never been employed from analysis in an attempt to avoid potential selection bias by socioeconomic and/or employment status in analysis (5% of glioma cases, 5% of meningioma cases, and 2% of controls). Results including never employed participants in the reference category attenuated somewhat for glioma for ELF in the 1-4 year time window (OR \geq 90% vs $<$ 25 % = 1.45, 95% CI 1.20, 1.76) but the positive linear trend remained ($p < 0.0001$). For meningioma, the weak positive trend for ELF in the 1-4 year time window disappeared (OR \geq 90% vs $<$ 25 % = 1.07, 95% CI 0.86, 1.34) and was no longer significant ($p = 0.28$).

The weak inverse association between ELF in the 10+ year time window and glioma attenuating when subjects judged to be reticent and unresponsive were excluded from analyses may reflect some form of reporting bias among these subjects. Reticence and unresponsiveness was based solely on the personal opinion of the 130 interviewers in INTEROCC study countries.

Limitations of using a JEM include exposure misclassification, although it is likely non-differential. A US study modified JEM values based on time and distance information for ELF sources for 24% of jobs (19). This increased the ELF exposure category for 27% of jobs and decreased it for 15% of jobs. The modification also did not include the magnitude of a source's ELF emissions, which may introduce further misclassification. The representativeness of the JEM across different countries and time periods is also unclear. Although here we relied on the

overall JEM estimates, in sensitivity analyses using country-specific estimates where they were available in the JEM, as well as sex and time-period specific estimates, results were virtually identical to those obtained here. This study's focus on the TWA of the ELF magnetic field resultant also neglects other potentially important aspects of electromagnetic environment such as the magnetic field frequency spectrum, its polarization, intermittency, electric fields, shocks, contact currents, and neighboring bands of the EM spectrum. There is little evidence for a role of ELF electric fields in carcinogenesis (40).

In conclusion, in this large-scale study we observed no association with lifetime occupational ELF exposure. However, results from this, and several smaller previous studies showed positive associations between ELF in the more recent past and glioma, and probably with meningioma. Future work to better understand possible biological mechanisms of action, interactions with other occupational exposures, associations with other occupational EMF exposures including intermediate and RFs, and to consider inter-individual variation in ELF exposure is needed.

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REFERENCES

- 1 Bondy M, Scheurer M, Malmer B, Barnholtz-Sloan JS, Davis FG, Il'yasova D, et al. Brain tumor epidemiology: consensus from the brain tumor epidemiology consortium (BTEC). *Cancer* 2008;113:1953-68.
- 2 Ferlay J, Shin H, Bray F, Forman D, Mathers C, Parkin D. GLOBOCAN 2008 v2.0, Cancer Incidence and Mortality Worldwide: IARC CancerBase No. 10. Lyon, France: International Agency for Research on Cancer, 2010; Available from: <http://globocan.iarc.fr>
- 3 Kohler B, Ward E, McCarthy B, Schymura MJ, Ries LAG, Ehemann C, et al. Annual report to the nation on the status of cancer, 1975-2007, featuring tumors of the brain and other nervous system. *J Natl Cancer Inst* 2011;103:714-36.
- 4 Braganza M, Kitahara C, Berrington de Gonzalez A, Inskip P, Johnson K, Rajaraman P. Ionizing radiation and the risk of brain and central nervous system tumors: a systematic review. *Neuro Oncol* 2012;14:1316-24.
- 5 Preston D, Shimizu Y, Pierce D, Suyama A, Mabuchi K. Studies of mortality of atomic bomb survivors. Report 13: Solid cancer and noncancer disease mortality: 1950-1997. *Radiat Res* 2003;160:381-407.

- 6 Sienkiewicz Z, Schuz J, Poulsen A, Cardis E. Risk analysis of human exposure to electromagnetic fields (revised). 2012. European Health Risk Assessment Network on Electromagnetic Field Exposure. Available from:
http://efhran.polimi.it/docs/EFHRAN_D2_final.pdf.
- 7 McLaughlin JK, Malmer HS, Blot WJ, Malmer BK, Stone BJ, Weiner JA, et al. Occupational risks for intracranial gliomas in Sweden. *J Natl Cancer Inst* 1987;78:253-7.
- 8 Tornqvist S, Knave B, Ahlbom A, Persson T. Incidence of leukaemia and brain tumours in some "electrical occupations". *Br J Ind Med*. 1991;48:597-603.
- 9 Tynes T, Andersen A, Langmark F. Incidence of cancer in Norwegian workers potentially exposed to electromagnetic fields. *Am J Epidemiol* 1992;136:81-8.
- 10 Rösli M, Lörtscher M, Egger M, Pfluger D, Schreier N, Lörtscher E, et al. Leukaemia, brain tumours and exposure to extremely low frequency magnetic fields: cohort study of Swiss railway employees. *Occup Environ Med* 2007;64:553-9.
- 11 Hakansson N, Floderus B, Gustavsson P, Johansen C, Olsen JH. Cancer incidence and magnetic field exposure in industries using resistance welding in Sweden. *Occup Environ Med* 2002;59:481-6.

- 12 Johansen C, Raaschou Nielsen O, Olsen JH, Schuz J. Risk for leukaemia and brain and breast cancer among Danish utility workers: a second follow-up. *Occup Environ Med* 2007;64:782-4.
- 13 Floderus B, Persson T, Stenlund C, Wennberg A, Ost A, Knave B. Occupational exposure to electromagnetic fields in relation to leukemia and brain tumors: a case-control study in Sweden. *Cancer Causes Control* 1993;4:465-76.
- 14 Karipidis KK, Benke G, Sim MR, Yost M, Giles G. Occupational exposure to low frequency magnetic fields and the risk of low grade and high grade glioma. *Cancer Causes Control* 2007;18:305-13.
- 15 Karipidis KK, Benke G, Sim MR, Kauppinen T, Giles G. Occupational exposure to ionizing and nonionizing radiation and risk of glioma. *Occup Med* 2007;57:518-24.
- 16 Villeneuve P, Agnew D, Johnson K, Mao Y, and the Canadian Cancer Registries Epidemiology Research Group. Brain cancer and occupational exposure to magnetic fields among men: results from a Canadian population-based case-control study. *Int J Epidemiol* 2002;31:210-7.
- 17 Baldi I, Coureau G, Jaffre A, Gruber A, Ducamp S, Provost D, et al. Occupational and residential exposure to electromagnetic fields and risk of brain tumors in adults: a case-control study in Gironde, France. *Int J Cancer* 2011;129:1477-84.

- 18 Kheifets L, Monroe J, Vergara X, Mezei G, Afifi A. Occupational electromagnetic fields and leukemia and brain cancer: an update to two meta-analyses. *J Occup Environ Med* 2008; 50:677-88.
- 19 Coble J, Dosemeci M, Stewart P, Blair A, Bowman J, Fine HA, et al. Occupational exposure to magnetic fields and the risk of brain tumors. *Neuro Oncol* 2009;11:242-9.
- 20 Koeman T, van den Brandt P, Slottje P, Schouten LJ, Goldbohm RA, Kromhout H, et al. Occupational extremely low-frequency magnetic field exposure and selected cancer outcomes in a prospective Dutch cohort. *Cancer Causes Control* 2013; doi 10.1007/s10552-013-0322-x.
- 21 Sorahan T. Magnetic fields and brain tumour risks in UK electricity supply workers. *Occup Med* 2014;64:157-65.
- 22 IARC. Non-ionizing radiation, part 1: static and extremely low-frequency (ELF) electric and magnetic fields. *IARC Monogr Eval Carcinog Risks Hum* 2002;80:1-395.
- 23 Ahlbom A, Bridges J, de Seze R, Hillert L, Juutilainen J, Mattsson MO, et al. Possible effects of electromagnetic fields (EMF) on human health -- opinion of the scientific committee on emerging and newly identified health risks (SCENIHR). *Toxicology* 2008; 246:248-50.

- 24 WHO. Environmental health criteria 238. Extremely low frequency fields. Geneva, World Health Organization: 2007.
- 25 Poullietier de Gannes F, Lagroye I, Veyret B. D3 - Report on the analysis of risks associated to exposure to EMF: in vitro and in vivo (animals) studies. 2010. European Health Risk Assessment Network on Electromagnetic Fields Exposure. Available from: http://efhran.polimi.it/docs/IMS-EFHRAN_09072010.pdf
- 26 Feychting M, Forssen U, Floderus B. Occupational and residential magnetic field exposure and leukemia and central and nervous system tumors. *Epidemiology* 1997; 8:384-9.
- 27 Savitz D, Cai J, van Wijngaarden E, Loomis D, Mithlan G, Dufort V, et al. Case-cohort analysis of brain cancer and leukemia in electric utility workers using a refined magnetic field job-exposure matrix. *Am J Ind Med* 2000;38:417-25.
- 28 Sorahan T, Nichols L, van Tongeren M, Harrington J. Occupational exposure to magnetic fields relative to mortality from brain tumours: updated and revised findings from a study of United Kingdom electricity generation and transmission workers, 1973-97. *Occup Environ Med* 2001;58:626-30.

- 29 Theriault G, Goldberg M, Miller A, Armstrong B, Guenel P, Deadman J, et al. Cancer risks associated with occupational exposure to magnetic fields among electric utility workers in Ontario and Quebec, Canada, and France: 1970-1989. *Am J Epidemiol* 1994;139:550-72.
- 30 Cardis E, Richardson L, Deltour I, Armstrong B, Feychting M, Johansen C, et al. The INTERPHONE study: design, epidemiological methods, and description of the study population. *Eur J Epidemiol* 2007; 22:647-64.
- 31 McLean D, van Tongeren M, Richardson L, Cardis E, INTEROCC study group. Evaluation of the quality and comparability of job coding across seven countries in the INTEROCC study. EPICOH 2011: 23rd International Conference on Epidemiology in Occupational Health. 7-9 September 2011. Oxford, United Kingdom, University of Oxford.
- 32 Bowman J, Touchstone J, Yost M. A population-based job exposure matrix for power-frequency magnetic fields. *J Occup Environ Hyg* 2007;4:715-28.
- 33 Treiman D. *Occupational Prestige in Comparative Perspective*. New York, Academic Press: 1977.

- 34 Lacourt A, Cardis E, Pintos J, Richardson L, Kincl L, Benke G, et al. INTEROCC case-control study: lack of association between glioma tumors and occupational exposure to selected combustion produces, dusts and other chemical agents. *BMC Public Health* 2013;13:340.
- 35 McLean D, Fleming S, Turner MC, Kincl L, Richardson L, Benke G, et al. Occupational solvent exposure and risk of meningioma. Results from the INTEROCC study. *Occup Environ Med* 2014;71:253-8.
- 36 Turner MC, Krewski D, Armstrong B, Chetrit A, Hours M, McBride M, et al. Allergy and brain tumors in the INTERPHONE study: Australia, Canada, France, Israel, and New Zealand. *Cancer Causes Control* 2013;24:949-60.
- 37 van Tongeren M, Kincl L, Richardson L, Benke G, Figuerola J, Kauppinen T, et al. Assessing occupational exposure to chemicals in an international study of brain tumors. *Ann Occup Hyg* 2013;57:610-26.
- 38 SAS, version 9.3. Cary, NC: SAS Institute, Inc.: 2010.
- 39 Wigertz A, Lonn S, Hall P, Feychting M. Non-participant characteristics and the association between socioeconomic factors and brain tumour risk. *J Epidemiol Community Health* 2010;64:736-43.

- 40 Kheifets L, Renew D, Sias G, Swanson J. Extremely low frequency electric fields and cancer: assessing the evidence. *Bioelectromagnetics* 2010;31:89-101.

TABLES

Table 1. Characteristics of case and control participants at enrollment INTEROCC study, 2000-2004, Australia, Canada, France, Germany, Israel, New Zealand, and United Kingdom

	Glioma Cases (n=1,939)	Meningioma Cases (n=1,822)	Controls ^a (n=5,404)
	%	%	%
Sex			
Male	62.0	27.5	45.2
Female	38.0	72.5	54.8
Age at reference date			
<35	11.0	4.4	7.3
35-39	9.3	5.4	8.7
40-44	11.1	9.2	11.6
45-49	12.3	14.8	13.8
50-54	18.0	20.4	18.3
55-59	16.1	17.1	18.7
60-64	9.9	10.3	9.2
65-69	6.8	8.7	7.9
70+	5.6	9.8	4.4
Education			
High School or less	52.4	59.1	53.6
Medium level technical school	19.7	19.5	19.0
University	28.0	21.4	27.4
Country			
Australia	14.2	13.9	12.3
Canada	8.6	5.1	11.6
France	4.8	7.6	8.5
Germany	18.6	20.3	27.5
Israel	20.5	36.8	17.3
New Zealand	3.4	2.7	2.7
United Kingdom	30.0	13.5	20.1

^a Glioma and meningioma controls combined.

Table 2. Adjusted ORs (95% CIs)^a for glioma and meningioma in relation to categorical indicators of occupational ELF-MF exposure overall (1-year lag), INTEROCC study, 2000-2004, Australia, Canada, France, Germany, Israel, New Zealand, and United Kingdom

Exposure Metric	Glioma			Meningioma		
	Cases	Controls	OR (95% CI) ^a	Cases	Controls	OR 95% CI ^a
Cumulative Exposure (μT-years)						
< 2.11	475	1,334	1.00 (ref)	473	1,265	1.00 (ref)
2.11-< 3.40	454	1,327	1.00 (0.85, 1.18)	465	1,278	0.96 (0.82, 1.13)
3.40-< 5.00	441	1,344	0.93 (0.78, 1.11)	414	1,295	0.84 (0.70, 0.99)
5.00-< 7.50	370	808	1.07 (0.88, 1.31)	290	783	1.05 (0.86, 1.29)
7.50+	199	540	0.80 (0.63, 1.00)	180	524	0.89 (0.70, 1.12)
p-value trend			0.08			0.51
Average Exposure (μT)						
< 0.11	423	1,268	1.00 (ref)	426	1,224	1.00 (ref)
0.11-< 0.13	398	1,273	0.96 (0.82, 1.13)	419	1,244	0.94 (0.79, 1.10)
0.13-< 0.17	551	1,411	1.04 (0.89, 1.22)	510	1,345	1.18 (1.00, 1.38)
0.17-< 0.24	330	856	0.95 (0.80, 1.14)	262	809	1.03 (0.85, 1.25)
0.24+	237	545	1.00 (0.82, 1.23)	205	523	1.08 (0.87, 1.33)
p-value trend			0.99			0.41
Maximum Exposed Job (μT)						
< 0.13	453	1,370	1.00 (ref)	505	1,341	1.00 (ref)
0.13-< 0.17	458	1,290	0.92 (0.79, 1.08)	439	1,247	1.03 (0.88, 1.20)
0.17-< 0.23	430	1,202	0.85 (0.73, 1.00)	362	1,146	0.98 (0.83, 1.16)
0.23-< 0.62	382	947	0.92 (0.78, 1.09)	286	891	1.01 (0.84, 1.21)
0.62+	216	544	0.80 (0.65, 0.98)	230	520	1.15 (0.94, 1.42)
p-value trend			0.08			0.16
Exposure Duration (years)						
< 5	1,333	3,849	1.00 (ref)	1,324	3,716	1.00 (ref)
5-< 15	295	805	0.90 (0.77, 1.05)	255	754	0.99 (0.84, 1.17)
15-< 25	142	371	0.94 (0.76, 1.16)	104	353	0.85 (0.67, 1.08)
25+	169	328	1.22 (0.99, 1.51)	139	322	1.30 (1.03, 1.64)
p-value trend			0.26			0.20

^a OR estimated using conditional logistic regression models stratified by country, region, sex, and 5-year age group at the reference date and adjusted for level of educational attainment. Cut points based on the 25th, 50th, 75th, and 90th percentile of the control exposure distribution. Tests for linear trend used Wald χ^2 tests, with categorical medians modeled as ordinal variables.

Table 3. Adjusted ORs (95% CIs)^a for glioma and meningioma in relation to categorical indicators of cumulative occupational ELF-MF exposure in three separate exposure time windows, 1-4, 5-9, and 10+ years prior to the date of diagnosis/reference date, INTEROCC study, 2000-2004, Australia, Canada, France, Germany, Israel, New Zealand, and United Kingdom

Exposure Metric	Glioma			Meningioma		
Cumulative Exposure (μT-years)	Cases	Controls	OR 95% CI ^a	Cases	Controls	OR 95% CI ^a
1-4 Years						
< 0.34	332	1,115	1.00 (ref)	315	1,054	1.00 (ref)
0.34-< 0.46	338	1,012	1.19 (1.00, 1.43)	301	970	1.00 (0.83, 1.21)
0.46-< 0.58	432	1,140	1.42 (1.19, 1.69)	350	1,093	1.12 (0.93, 1.34)
0.58-< 0.80	297	632	1.54 (1.27, 1.88)	210	593	1.30 (1.05, 1.62)
0.80+	237	439	1.67 (1.36, 2.07)	142	420	1.23 (0.97, 1.57)
p-value trend			<0.0001			0.02
5-9 Years						
< 0.45	358	1,112	1.00 (ref)	367	1,057	1.00 (ref)
0.45-< 0.59	391	1,126	1.12 (0.95, 1.33)	391	1,075	1.00 (0.84, 1.20)
0.59-< 0.77	491	1,268	1.22 (1.03, 1.43)	398	1,228	1.03 (0.86, 1.22)
0.77-< 1.07	263	671	1.09 (0.89, 1.32)	185	636	0.97 (0.78, 1.20)
1.07+	204	447	1.19 (0.96, 1.47)	117	423	0.88 (0.68, 1.13)
p-value trend			0.20			0.31
10+ Years						
< 1.38	442	1,277	1.00 (ref)	435	1,198	1.00 (ref)
1.38-< 2.48	432	1,300	0.96 (0.81, 1.15)	436	1,251	0.91 (0.77, 1.08)
2.48-< 3.98	435	1,290	0.90 (0.75, 1.09)	433	1,247	0.90 (0.75, 1.08)
3.98-< 6.23	326	787	0.91 (0.73, 1.13)	279	762	0.99 (0.80, 1.23)
6.23+	197	522	0.77 (0.60, 0.99)	189	510	0.92 (0.72, 1.17)
p-value trend			0.04			0.76

^a OR estimated for each exposure time window separately using conditional logistic regression models stratified by country, region, sex, and 5-year age group at the reference date and adjusted for level of educational attainment. Cut points based on the 25th, 50th, 75th, and, 90th percentile of the control population's exposure distribution for each time window. Different cut-points used for each time window due to differences in exposure distribution. Different numbers of cases/controls in different time windows due to the exclusion of participants from particular time windows where they reported not being employed. Tests for linear trend used Wald χ^2 tests, with categorical medians modeled as ordinal variables.

Table 4. Adjusted ORs (95% CIs)^a for glioma and meningioma in relation to categorical and continuous indicators of cumulative occupational ELF-MF exposure in the 1-4 year and 10+ time window prior to the date of diagnosis/reference date, including only participants who were very cooperative, responsive, and interested as determined by the interviewer, INTEROCC study, 2000-2004, Australia, Canada, France, Germany, Israel, New Zealand, and United Kingdom

Cumulative Exposure (μ T-years) 1-4 Years	Glioma			Meningioma		
	Cases	Controls	OR 95% CI ^a	Cases	Controls	OR 95% CI ^a
< 0.34	218	826	1.00 (ref)	201	758	1.00 (ref)
0.34-< 0.46	218	729	1.21 (0.97, 1.51)	201	677	1.07 (0.85-1.35)
0.46-< 0.58	301	825	1.54 (1.24, 1.90)	248	778	1.24 (0.98, 1.55)
0.58-< 0.80	186	450	1.52 (1.20, 1.94)	133	400	1.39 (1.06, 1.82)
0.80+	149	304	1.76 (1.35, 2.28)	90	282	1.30 (0.96, 1.77)
p-value trend			<0.0001			0.03
10+ Years						
< 1.38	291	930	1.00 (ref)			
1.38-< 2.48	287	910	1.06 (0.85, 1.32)			
2.48-< 3.98	271	916	0.99 (0.78, 1.25)			
3.98-< 6.23	214	539	1.14 (0.87, 1.50)			
6.23+	109	335	0.88 (0.64, 1.21)			
p-value trend			0.44			

^a OR estimated for each exposure time window separately using conditional logistic regression models stratified by country, region, sex, and 5-year age group at the reference date and adjusted for level of educational attainment. Cut-points from Table 3 used here. Tests for linear trend used Wald χ^2 tests, with categorical medians modeled as ordinal variables.

FIGURE LEGENDS

Figure 1a. Adjusted ORs (95% CIs) for glioma in relation to categories of cumulative occupational ELF-MF exposure in the 1-4, 5-9, and 10+ year time windows prior to the date of diagnosis/reference date from a simultaneous exposure time windows model with cutpoints based on the 25th, 50th, 75th, and 90th percentile, INTEROCC study, 2000-2004, Australia, Canada, France, Germany, Israel, New Zealand, and United Kingdom

Figure 1b. Adjusted ORs (95% CIs) for meningioma in relation to categories of cumulative occupational ELF-MF exposure in the 1-4, 5-9, and 10+ year time windows prior to the date of diagnosis/reference date from a simultaneous exposure time windows model with cutpoints based on the 25th, 50th, 75th, and 90th percentile, INTEROCC study, 2000-2004, Australia, Canada, France, Germany, Israel, New Zealand, and United Kingdom

Figure 1a

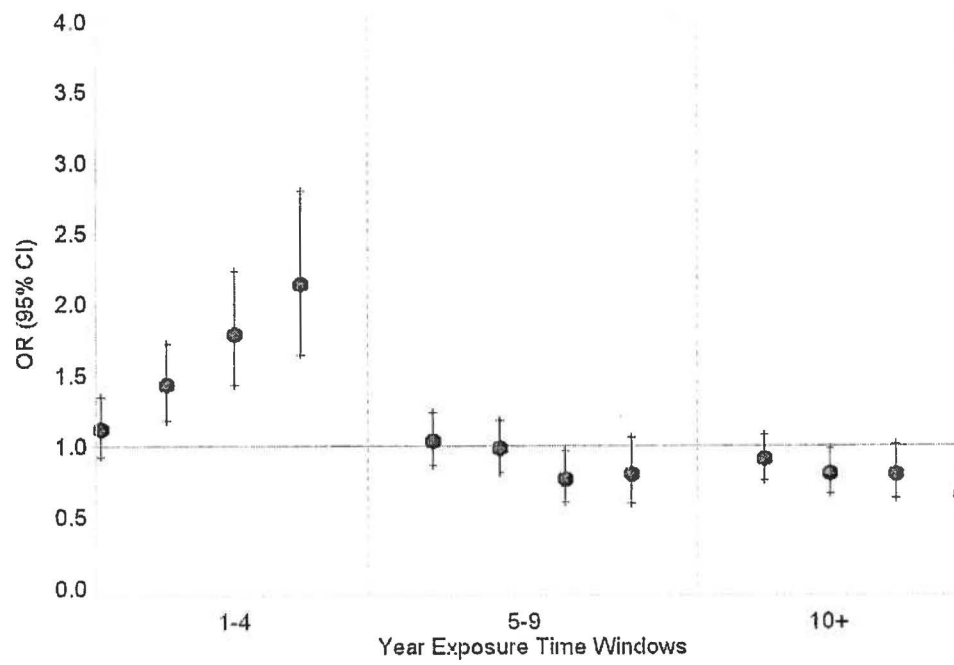
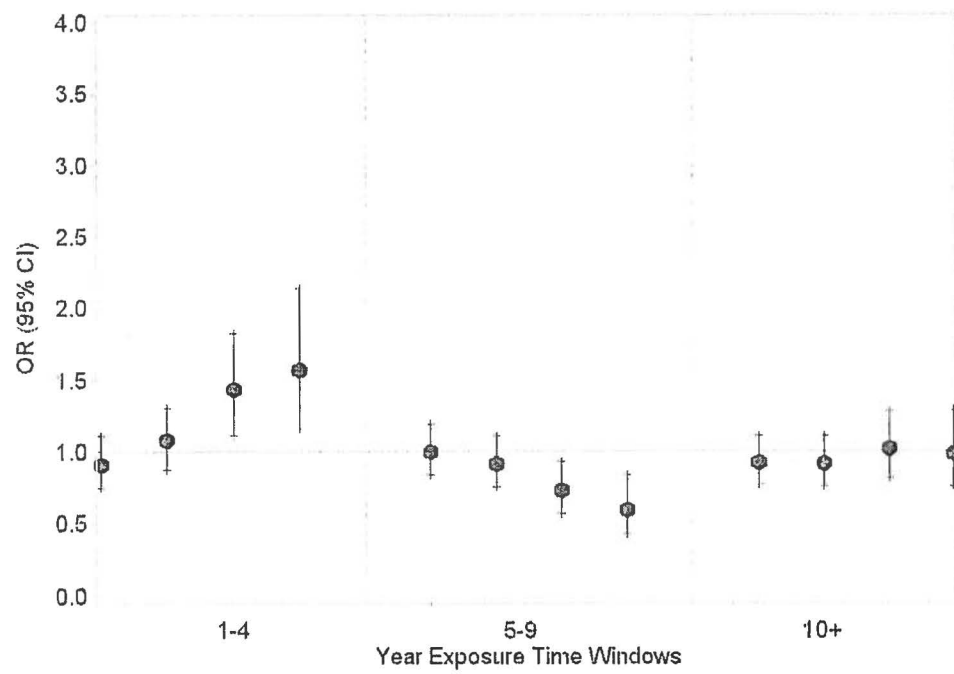


Figure 1b



EKPC Map No	Owner	Location	Type of Structure	Distance from Original Centerline	Date Structure was Built	Date EKPC Aware of Proximity	Final Resolution
27	Donald & Linda Cartwright	Jackson Ferry Rd	Occupied House	49	Unkown	Unkown	New centerline relocated off of property and on Foley Estate Property
137	Jerry & Dorothy Jessie	Morris Rd	Occupied House	63	Unkown	Unkown	New centerline moved 26' to the east
169	Leo & Kathleen Curley	Ecton Rd	Occupied House	52	Unkown	Unkown	New centerline moved 25' to the west
200	Ann Brooks Barker	Mt. Sterling Rd	Garage	44	Unkown	Unkown	New centerline moved 25' to the east
219	Taylor & Dorothy Reffett	White-Turley Rd	Occupied House	63	Unkown	Unkown	New centerline moved 20' to the east.
220	Cornelius & Brenda Blakeman	White-Turley Rd	Occupied House	24	Unkown	Unkown	EKPC purchased the property and relocated the property owners

EAST KENTUCKY POWER COOPERATIVE
Transmission Line Siting Data List
Smith - Sideview 345kV

COMMENTS

194	PALMER PALMER WILLIAM D & DEBORAH H	
195	VANSICKLE VANSICKLE RICHARD L	
196	BALDWIN BALDWIN WAYNE JOHN & CAROL SUE	
197	HARRISON HARRISON ELMER O & SHARON B	
198	MARTIN MARTIN JERRY E	
199	LITTLE LITTLE JAMES B	
200	BARKER	Survey OK
201	BARKER ANN BROOKS BARNES 859-744-1540 771-2282-6 EXISTING LINE	Please move away from house EMF concerns
202	GRAYCRAFT GRAYCRAFT PAULINE O	
203	ROGERS ROGERS JAMES W	
204	ROGERS	
205	ROGERS GERALD S & MARJORIE H EXISTING LINE	

1-18 Map 1
10-44 Map 2
45-63 Map 3

64-102 Map 4
103-153 Map 5
154-198 Map 6

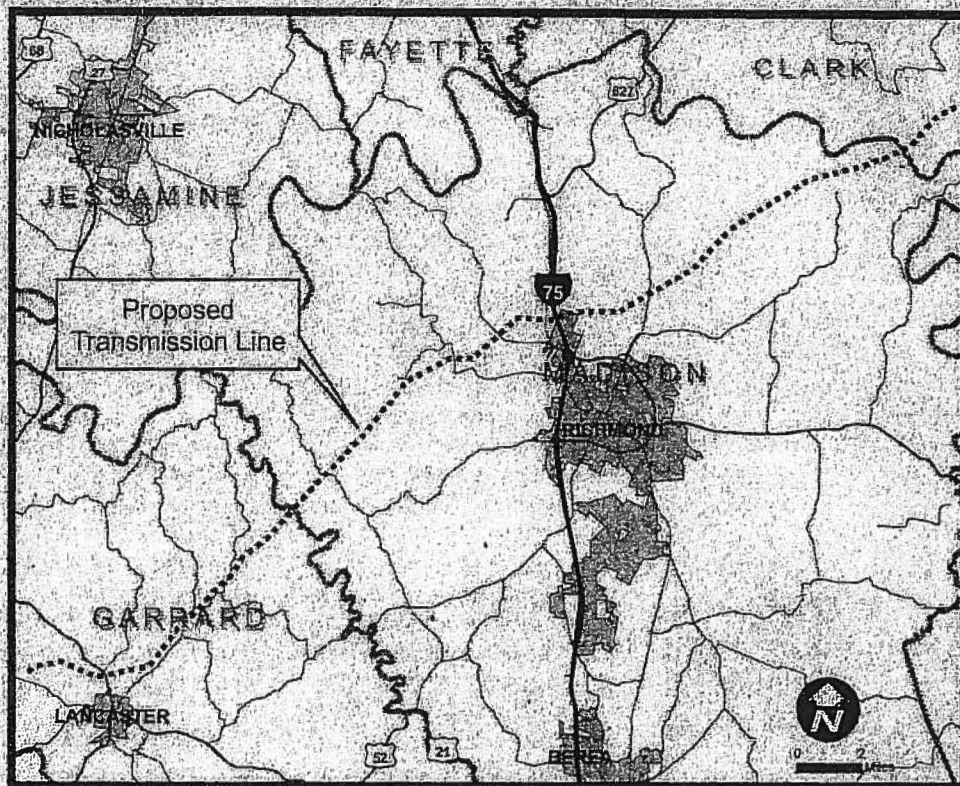
199-209 Map 7
210-254 Map 8
252-275 Map 9

Barker
Exhibit





Notice of Intent To Construct Proposed Transmission Lines



East Kentucky Power Cooperative proposes to construct approximately 36 miles 345-kilovolt transmission line from J.K. Smith Station located in southern Clark County near Trapp, Ky., southwest through Madison County to the northwest of Richmond, Ky., to a new substation to be constructed in Garrard County west of Lancaster, Ky. That substation will tie the new line into an existing 345-kV line owned by Kentucky Utilities. Construction will consist primarily of two-pole, H-frame steel structures, with three-pole steel structures needed for some angles and dead-ends. The purpose of this line is to help EKPC accommodate load growth in Central Kentucky and improve the reliability of the regional transmission grid.

The transmission line will require a certificate of public convenience and necessity to be issued by the Kentucky Public Service Commission (PSC). This process will proceed on PSC Docket 2006-00463. You have the right to request a local public hearing. Interested persons, including property owners crossed by the line, have the right to intervene. Should you have any questions concerning this process, the Executive Director of the Commission is Elizabeth O'Donnell, Kentucky Public Service Commission, P. O. Box 615, 211 Sower Boulevard, Frankfort, Kentucky 40602-0615, telephone (502) 564-3940.

*By working together
we will arrive at the
best solutions.*



Barker
Exhibit

12

Steven L. Beshear
Governor

Leonard K. Peters
Secretary
Energy and Environment Cabinet



Commonwealth of Kentucky
Public Service Commission
211 Sower Blvd.
P.O. Box 616
Frankfort, Kentucky 40602-0615
Telephone: (502) 564-3940
Fax: (502) 564-3460
psc.ky.gov

David L. Armstrong
Chairman

James W. Gardner
Vice Chairman

January 31, 2012

Edward T. Depp, Esquire
Dinsmore & Shohl LLP
101 South Fifth Street, Suite 2500
Louisville, KY 40202

PSC STAFF OPINION 2012-004

Re: Kentucky Association of Electric Cooperatives Staff Opinion Request
Electric Distribution Cooperative Work Plans

Dear Mr. Depp:

Commission Staff is in receipt of your letter sent on behalf of the Kentucky Association of Electric Cooperatives (KAEC) dated November 7, 2011. In that letter, you request "clarification" and "interpretation" of whether the electric distribution cooperatives' construction work plans require a certificate of public convenience and necessity ("CPCN") from the Commission prior to beginning work implementing their construction work plans ("CWP"). Commission Staff understands your request for "clarification" and "interpretation" is premised on the fact that "construction work plan" is not specifically stated in the applicable law, namely KRS 278.020 and 807 KAR 5:001 § 9, and the fact that "construction work plans" are considered by your client to be ordinary extensions of existing systems in the usual course of business, and therefore, exempt from prior Commission approval. Your letter presumes that application of the "10% rule" in implementing regulation, 807 KAR 5:001 § 9, supports your premise that CWPs are ordinary extensions of business.

Commission Staff understands that the guidance you request is not for a specific CWP but for electric distribution cooperatives' construction work plans in general. Historically, the Commission has treated CWPs as one construction project partly because the cooperatives have financed CWPs as one project.

The language in KRS 278.020 and 807 KAR 5:001 § 9 does not distinguish between construction projects which are part of a CWP and those that are not. Rather, prior approval from the Commission is required prior to beginning

. . . the construction of any plant, equipment, property, or facility for furnishing to the public any of the services enumerated in KRS 278.010. . .

The Commission has previously required prior approval through a CPCN for a construction project whether part of a CWP or not. The Commission has and continues to apply the CPCN requirement to construction projects on a project by project basis unless a particular project falls within two exemptions. KRS 278.020(1) exempts from prior approval through CPCN retail "electric suppliers from obtaining a CPCN for service connections to electric consuming facilities within its certified territory" and "ordinary extensions of existing systems in the usual course of business." The Commission has defined "ordinary extensions of existing systems in the usual course of business" by regulation found in 507 KAR 5:001 § 9(3):

No certificate of public convenience or necessity will be required for extensions that **do not create wasteful duplication of plant, equipment, property, or facilities**, or conflict with the existing certificates or service of other utilities operating in the same area and under the jurisdiction of the Commission that are in the general area in which the utility renders service or contiguous thereto, and that **do not involve sufficient capital outlay to materially affect the existing financial condition of the utility involved, or will not result in increased charges to its customers.** (*Emphasis added*).

The regulation provides for three areas of inquiry to determine whether a construction project is an "ordinary extension of existing systems in the usual course of business;" (1) whether there will be a wasteful duplication of plant, including interference with another utility's certificates or service; (2) whether the capital investment is so minimal that it will not "materially" affect the financial condition of the regulated utility; and (3) whether the rates will increase as a result of construction. Importantly, the Kentucky Court of Appeals has held that the purpose of KRS 278.020 and 807 KAR 5:001 § 9(3) is to "protect the public against exorbitant utility rates emanating from unnecessary and duplicitous power facilities." *Duerson v. East Kentucky Power Coop., Inc.*, Ky. App., 843 S.W.2d 340, 342 (1992) *superseded on other grounds by statute in Jent v. Kentucky Utilities Co.*, 332 S.W.3d 102 (Ky.App. 2010). Thus, 807 KAR 5:001 § 9(3) is the legal definition of "ordinary extension" in the "usual course of business." The focus of the review is duplication and cost not whether a construction project is part of an electric cooperative's CWP or that of an investor-owned utility's project.

¹ KRS 278.020(1).

In reviewing a CPCN application for a construction project, the Commission examines the project's capital investment in relation to the net plant investment of the regulated utility. Commission Staff respectfully disagrees with the position set forth in your letter that the "10%" rule is dispositive of whether a project requires a CPCN or not because it is an extension in the "ordinary course of business." This is no longer the criteria used by the Commission and has not been since the passage of KRS 13A in 1984. In response to KRS 13A, the Commission promulgated 807 KAR 5:001. Specifically, 807 KAR 001 § 9(3) directs the Commission to examine if the project will result in wasteful duplication; what the project's "material financial effect" on the financial condition of the utility; and whether the project will increase rates.

Your letter states that the Commission does not require investor-owned utilities to seek CPCNs for construction projects and requests that the Commission afford the electric distribution coops the "operational discretions enjoyed by the investor-owned utilities." While different standards appear to apply, it must be acknowledged that cooperative utilities and investor-owned utilities are fundamentally different. If the Commission finds that an investor-owned utility has built unnecessarily, the shareholders of that utility will bear the burden. A cooperative utility, in contrast, has no shareholders and only its customers will bear the burden. According to the Kentucky Court of Appeals in *Duerson*, this is exactly the situation 807 KAR5:001 § 9 is designed to prevent.² Furthermore, if an investor-owned utility does not secure a CPCN it assumes the risk of not recovering the construction project's costs in a subsequent rate case if the Commission finds that it resulted in wasteful duplication, or materially affected the utility's financial condition, or resulted in an increase of customer rates. Prior approval through a CPCN removes such a risk to the utility. Simply stated all construction projects are reviewable by the Commission.

The Commission's policy is to apply the law to all construction projects and it will continue to require CPCNs prior to construction of all projects not exempt by law. Commission Staff has reviewed the past 20 years of CPCN orders and advisory opinions and have attached examples. These orders demonstrate that the Commission reviews both investor owned utility projects as well as cooperative utility projects; these examples also demonstrate the Commission's policy of applying the statutory criteria to each project regardless of ownership. As you can see, of 11 cases in which the Commission determined a CPCN was not required due to low capital investment, five of those exemptions belong to East Kentucky Power Cooperative. Of the nine advisory opinions issued with regard to construction projects, seven projects belonging to electric cooperatives, the Commission deemed those projects to be an extension in the ordinary course of business and, thus, a CPCN was not required. Finally attached is a show cause order in which an investor owned utility was fined for failing to secure a CPCN.

² 843 S.W.2d at 342.

Commission Orders

- | | | |
|-----|------------|------------------------------------|
| 1. | 1991-00115 | KU Brown Combustion Turbines |
| 2. | 2004-00507 | LG&E/KU Trimble County 2 |
| 3. | 2011-00161 | KU Environmental Compliance Plan |
| 4. | 2011-00162 | LG&E Environmental Compliance Plan |
| 5. | 2002-00352 | EKPC Landfill Gas to Energy |
| 6. | 2002-00474 | EKPC Landfill Gas to Energy |
| 7. | 2005-00164 | EKPC Landfill Gas to Energy |
| 8. | 2006-00033 | EKPC Landfill Gas to Energy |
| 9. | 2007-00509 | EKPC Landfill Gas to Energy |
| 10. | 1994-00182 | Columbia Gas Show Cause Order |

Advisory Opinions

1. PSC Staff Opinion 2011-010 Kenegy replacement of certain cutouts
2. PSC Staff Opinion 2011-009 Owen Electric first phase of VVO project
3. PSC Staff Opinion 2011-002 EKPC office space expansion
4. PSC Staff Opinion 2010-0010 Cumberland Electric regarding jurisdiction
5. PSC Staff Opinion 2010-009 Big Rivers construction of improvements on substation
6. PSC Staff Opinion 2009-001 Salt River Electric warehouse and storage
7. PSC Staff Opinion dated 2-21-2008 Clark Energy warehouse
8. PSC Staff Opinion dated 1-26-2006 Cincinnati Gas and Electric replacement and upgrade of electric facilities
9. PSC Staff Opinion dated 10-26-2005 KPC replacement and upgrade of transmission line

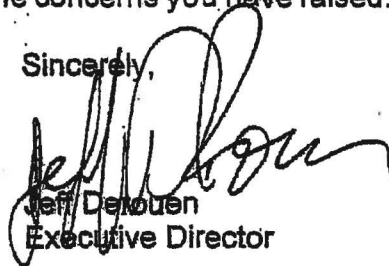
This letter represents Commission Staff's interpretation of the law as applied to the request presented. This opinion is advisory in nature and not binding on the Commission should the issues herein be formally presented for Commission resolution. Questions concerning this opinion should be directed to Helen C. Helton, General Counsel, at 502-546-3940, Ext. 244.

However, the Commission Staff plans to establish a work group to examine the current application of the law to CPCNs and invite you and Bill Corum to participate. We would like to form this group as soon as possible. Please expect the Commission

Edward T. Depp, Esquire
January 31, 2012
Page 5

Staff to contact you to begin the process. We are looking forward to working with the group to explore possible solutions to the concerns you have raised.

Sincerely,

A handwritten signature in black ink, appearing to read "Jeff Dehouen", written over the printed name and title.

Jeff Dehouen
Executive Director

HH/kar
Enclosures

COMMISSION ORDERS

- | | | |
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