

**BEFORE THE**  
**PENNSYLVANIA PUBLIC UTILITY COMMISSION**

<b>IN RE: APPLICATION OF TRANS-ALLEGHENY</b>	<b>:</b>	
<b>INTERSTATE LINE COMPANY FOR</b>	<b>:</b>	
<b>(I) A CERTIFICATE OF PUBLIC CONVENIENCE</b>	<b>:</b>	
<b>TO OFFER, RENDER, FURNISH AND/OR</b>	<b>:</b>	
<b>SUPPLY TRANSMISSION SERVICE IN THE</b>	<b>:</b>	
<b>COMMONWEALTH OF PENNSYLVANIA;</b>	<b>:</b>	
<b>(II) AUTHORIZATION AND CERTIFICATION</b>	<b>:</b>	
<b>TO LOCATE, CONSTRUCT, OPERATE AND</b>	<b>:</b>	<b>Docket Nos. A-110172</b>
<b>MAINTAIN CERTAIN HIGH VOLTAGE ELECTRIC</b>	<b>:</b>	<b>A-110172F0002</b>
<b>TRANSMISSION LINES AND RELATED ELECTRIC</b>	<b>:</b>	<b>A-110172F0003</b>
<b>SUBSTATION FACILITIES; (III) AUTHORITY</b>	<b>:</b>	<b>A-110172F0004</b>
<b>TO EXERCISE THE POWER OF EMINENT</b>	<b>:</b>	<b>G-00071229</b>
<b>DOMAIN FOR THE CONSTRUCTION AND</b>	<b>:</b>	
<b>INSTALLATION OF AERIAL ELECTRIC</b>	<b>:</b>	
<b>TRANSMISSION FACILITIES ALONG THE</b>	<b>:</b>	
<b>PROPOSED TRANSMISSION LINE ROUTES</b>	<b>:</b>	
<b>IN PENNSYLVANIA; (IV) APPROVAL OF AN</b>	<b>:</b>	
<b>EXEMPTION FROM MUNICIPAL ZONING</b>	<b>:</b>	
<b>REGULATION WITH RESPECT TO THE</b>	<b>:</b>	
<b>CONSTRUCTION OF BUILDINGS; AND</b>	<b>:</b>	
<b>(V) APPROVAL OF CERTAIN RELATED</b>	<b>:</b>	
<b>AFFILIATED INTEREST ARRANGEMENTS</b>	<b>:</b>	

**DIRECT TESTIMONY OF**  
**WILLIAM H. BAILEY, Ph.D.**

**Re: Current Status of Health-Related**  
**Research Of Electric and Magnetic Fields**

**April 13, 2007**

1 Q. PLEASE STATE YOUR NAME AND BUSINESS ADDRESS.

2 A. My name is William H. Bailey. My business address is Exponent, 420 Lexington  
3 Avenue, Suite 1740, New York, NY 10170.

4 Q. WHAT IS YOUR POSITION AT EXPONENT, INC.?

5 A. I am a Principal Scientist in the Health Sciences practice and Director of  
6 Exponent, Inc.'s New York office.

7 Q. PLEASE DESCRIBE YOUR CURRENT RESPONSIBILITIES AND  
8 PROFESSIONAL EXPERIENCE.

9 A. Exponent, Inc. (“Exponent”) is a research and consulting firm engaged in a broad  
10 spectrum of activities in science and technology. My practice specializes broadly  
11 in the health sciences and, more specifically, in human exposure assessment. My  
12 work involves reviewing, analyzing, and conducting research. One of the areas in  
13 which I have done a great deal of work over the past 25 years relates to potential  
14 biological and health effects of electrical facilities, such as transmission lines,  
15 substations, and electrified railroad lines.

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EDUCATION AND EXPERIENCE

18 Q. PLEASE SUMMARIZE YOUR EDUCATION AND YOUR ACADEMIC AND  
19 RESEARCH EXPERIENCE.

20 A. I earned a Ph.D. in neuropsychology from the City University of New York. My  
21 education includes a B.A. from Dartmouth College in 1966, and an MBA from  
22 University of Chicago, awarded in 1969. Since 1986, I have been a visiting  
23 research scientist at the Cornell University Medical College. I also have been a

1 visiting lecturer at Rutgers University, the University of Texas (San Antonio), and  
2 the Harvard School of Public Health. From 1983 to 1987, I was head of the  
3 Laboratory of Neuropharmacology and Environmental Toxicology at the New  
4 York State Institute for Basic Research. For the nine previous years, I was an  
5 Assistant Professor and Postdoctoral Fellow in Neurochemistry at The  
6 Rockefeller University.

7 Q. PLEASE OUTLINE YOUR SCIENTIFIC RESEARCH EXPERIENCE  
8 CONCERNING ELECTRIC AND MAGNETIC FIELDS.

9 A. I have studied and conducted research on electric and magnetic fields (“EMF”)  
10 for 25 years. My research has included laboratory, exposure assessment, and  
11 epidemiological studies concerning alternating current (“AC”) electric and  
12 magnetic fields and studies on direct current (“DC”) electric fields and air ions.

13 Q. HAVE YOU SERVED AS A REVIEWER AND SCIENTIFIC ADVISOR ON  
14 HEALTH-RELATED ISSUES FOR STATE AND FEDERAL AGENCIES OR  
15 SCIENTIFIC ORGANIZATIONS?

16 A. Yes. I have reviewed research for the National Institutes of Health, the National  
17 Science Foundation, and other government agencies. Concerning transmission  
18 lines in particular, I served on a Scientific Advisory Panel convened by the  
19 Minnesota Environmental Quality Board to review health aspects of a high-  
20 voltage transmission line. In addition, I served as a consultant on transmission  
21 line health and safety issues to the Vermont Department of Public Service, the  
22 New York State Department of Environmental Conservation, and the staffs of the

1 Maryland Public Service Commission and the Maryland Department of Natural  
2 Resources.

3 I also have worked with the National Institute of Occupational Health and Safety,  
4 the Oak Ridge National Laboratories, the U.S. Department of Energy, and the  
5 Federal Railroad Administration to review and evaluate health issues related to  
6 electric and magnetic fields from other sources. I also assisted the U.S. EMF  
7 Research and Policy Information Dissemination Program to evaluate biological  
8 and exposure research as part of its overall risk assessment process.

9 Most recently, I worked with scientific experts from 10 countries to evaluate  
10 possible hazards from exposures to static and extremely low frequency (“ELF”)  
11 EMF for the International Agency for Research in Cancer (“IARC”), a division of  
12 the World Health Organization located in Lyon, France. I also contributed to a  
13 workshop convened in March 2006 by the International Committee on Non-  
14 Ionizing Radiation Protection (“ICNIRP”) to update guidelines for human  
15 exposures to AC electric and magnetic fields.

16 Q. HAVE YOU PRESENTED THE RESULTS OF YOUR RESEARCH IN THIS  
17 AND OTHER AREAS TO THE SCIENTIFIC COMMUNITY?

18 A. I have published or presented more than 50 scientific papers on this and related  
19 subjects.

20 Q. ARE YOU A MEMBER OF ANY PROFESSIONAL ORGANIZATIONS?

21 A. I am a member of The Rockefeller University Chapter of Sigma Xi, a national  
22 scientific honor society; the Health Physics Society; the International Committee  
23 on Electromagnetic Safety, Subcommittees 3 and 4 – Safety Levels with respect

1 to Human Exposure to Fields; the Bioelectromagnetics Society; the IEEE  
2 Engineering in Medicine and Biology Society; the American Association for the  
3 Advancement of Science; the New York Academy of Sciences; the Society for  
4 Neuroscience; the Air & Waste Management Association; the Society for Risk  
5 Analysis, and the International Society for Exposure Analysis.

6 Q. ARE YOUR EDUCATIONAL AND PROFESSIONAL EXPERIENCE  
7 SUMMARIZED ELSEWHERE?

8 A. Yes. Additional details of my educational and professional experience are  
9 summarized in my curriculum vitae, which is attached as TrAILCo Exhibit WHB-  
10 1. In addition, the publications and other documents referred to in my testimony  
11 and used to support my conclusions are listed in TrAILCo Exhibit WHB-2,  
12 attached to my testimony.

13 Q. HAVE YOU EVER APPEARED AS A WITNESS BEFORE REGULATORY  
14 AGENCIES?

15 A. Yes. I have testified in regulatory proceedings on behalf of state public utility  
16 commissions and siting boards as well as project applicants in various states.

17 Q. WILL THE USE OF VARIOUS TERMS IN YOUR TESTIMONY BE  
18 CONSISTENT WITH THE DEFINITIONS ASSIGNED TO THOSE TERMS IN  
19 THE TABLE OF NOMENCLATURE ATTACHED TO TrAILCo Witness  
20 Flitman's Testimony as TrAILCo Exhibit DEF-1?

21 A. Yes. In addition, I may define other specific terms in my direct testimony.

PROJECT EVALUATION

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Q. WHAT IS EXPONENT'S ROLE IN THIS PROJECT?

A. TrAILCo requested that Exponent calculate the levels of EMF and other electrical parameters associated with the operation of the Trans-Allegheny Interstate Line (“TrAIL”). TrAIL in Pennsylvania includes a 500-kV line connecting the 502 Junction Substation and the Prexy Substation, a 500-kV line from 502 Junction Substation to the Pennsylvania-West Virginia state line, three 138-kV lines connecting to the Prexy Substation, the Prexy Substation, and the 502 Junction Substation. The results of field calculations for profiles across the transmission line rights-of-way are summarized in the testimony of Dr. Gary Johnson filed on behalf of TrAILCo in this proceeding. TrAILCo also requested that Exponent evaluate these data and provide information about the current status of health-related research on EMF, which is the subject of my testimony here.

Q. WHAT IS THE PROPOSED ROUTE OF THE TRAIL LINE IN PENNSYLVANIA?

A. TrAIL is to be routed on approximately 36.1 miles of right-of-way that would extend from the Prexy Substation south to 502 Junction Substation. From the 502 Junction Substation the line would continue another 1.2 miles to the Pennsylvania/West Virginia border. For the first 4.8 miles after the Prexy Substation, TrAIL would be constructed on a 430-foot wide right-of-way adjacent to a new 138-kV line supported on double-circuit structures. For the remainder of the route TrAIL would continue alone on a 200 foot-wide right-of-way to the state

1 border. Two new 138-kV lines would also extend east and west from the Prexy  
2 Substation on empty or shared rights-of-way.

3 It is my understanding that, to the extent possible, the route proposed by TrAILCo  
4 was chosen because it minimizes the potential for disruption of existing land uses  
5 and enables the line to be situated as far from existing residences and other public  
6 facilities as practical, given topographic and other constraints.

7 Q. WHAT EMF LEVELS ARE ASSOCIATED WITH THE TRAIL IN  
8 PENNSYLVANIA?

9 A. The EMF levels associated with TrAIL as proposed in Pennsylvania have been  
10 calculated by standard methods and are described in the testimony of Dr. Johnson.  
11 In general, the EMF levels will be highest directly under the conductors, and will  
12 decrease with distance from the line. Because of the wide right-of-way, the levels  
13 of EMF will have diminished at the right-of-way edges and beyond to levels  
14 similar to those outside the rights-of-way of lower voltage transmission lines in  
15 the state. The range of magnetic field levels will be similar to those we  
16 experience when we are near other sources: on or near the right-of-way the  
17 magnitude of the magnetic field is similar to appliances, further from the right-of-  
18 way the magnitude is similar to that of distribution lines which run in front or  
19 behind our houses, and, at greater distances, the field from the line will drop to  
20 background levels commonly measured in residences, schools and workplaces.  
21 This is illustrated in TrAILCo Exhibit WHB-3.

1 Q. WILL TRAIL CONTRIBUTE SIGNIFICANTLY TO THE EXPOSURES OF  
2 THE PUBLIC IN PENNSYLVANIA?

3 A. No. We all encounter EMF at varying levels in our homes, schools, workplaces,  
4 and other locations in our communities. Given the nature of the proposed route, it  
5 is very unlikely that people will experience higher, average background levels of  
6 EMF because of the line. The proposed route is situated mainly in rural areas at a  
7 distance from most residences. Exposures to fields from the proposed line would  
8 be of limited duration and intermittent, such as those experienced by persons  
9 hiking on trails or crossing the right-of-way. Riders in vehicles passing under the  
10 line would be largely shielded from exposures to the electric field.

11 The electric fields associated with the new line would contribute little to  
12 exposures at residences because of distance from the line and the effective  
13 blocking of these fields by trees, fences, shrubbery, and buildings. Likewise, the  
14 magnetic fields from the line would likely contribute little to the average  
15 background levels inside nearby residences because of their distance from the  
16 line.

17 Q. ARE THERE ANY STATE OR FEDERAL STANDARDS THAT TRAILCO  
18 MUST MEET IN REGARD TO EMF AND HEALTH?

19 A. There are no federal standards for either magnetic fields or electric fields from  
20 power lines or other sources at power frequencies, and there are no state standards  
21 in Pennsylvania.

1 Q. WILL THE EXPECTED TRAIL EMF LEVELS BE BELOW THOSE  
2 RECOMMENDED IN EXPOSURE GUIDELINES BY INTERNATIONAL  
3 ORGANIZATIONS?

4 A. The United States government has not adopted the exposure guidelines  
5 recommended by the International Committee on Electromagnetic Safety (ICES,  
6 2002) or the limits adopted by the European Union based on recommendations of  
7 the ICNIRP (EC, 1999) to protect public health and safety of the general public.  
8 However, the levels of EMF associated with operation of the line would be lower  
9 than the limits recommended in these guidelines (ICES - 10 kV/m on transmission  
10 line right-of-way; EC – induced current density  $\leq 2$  millamperes/m<sup>2</sup> at locations  
11 where people spend significant time).

12 Q. IS THE ROUTING AND DESIGN OF THE PROPOSED LINE ALSO  
13 CONSISTENT WITH THE RECOMMENDATIONS OF THE DIRECTOR OF  
14 THE NATIONAL INSTITUTE OF ENVIRONMENTAL HEALTH SCIENCES  
15 AND THE WORLD HEALTH ORGANIZATION REGARDING MEASURES  
16 TO MINIMIZE POTENTIAL MAGNETIC FIELD EXPOSURES?

17 A. Yes. In light of marginal scientific support for concerns that exposure to EMF  
18 might be a health hazard or what aspect of exposure may be important, e.g.,  
19 intensity, duration, frequency, alignment with the geomagnetic field, etc., these  
20 organizations have suggested that utilities voluntarily undertake measures to  
21 minimize public exposure through siting practices or design. In this  
22 project, the strategy of attempting to avoid routing TrAIL near residences, where  
23 possible, will result in lower EMF exposures. The paralleling of other

1 transmission line rights-of-way, where available, also reduces potential exposure  
2 at other land uses. In addition, the transmission of electric power at a higher  
3 voltage (e.g., at 500 kV) reduces the current flow on the line to a level below that  
4 required for transport of the same amount of power over lower-voltage lines, and  
5 therefore reduces magnetic field levels.

6 SCIENTIFIC METHODS FOR ASSESSING EMF AND HEALTH

7 Q. THERE HAS BEEN CONSIDERABLE RESEARCH ON EXPOSURE TO EMF  
8 AND HEALTH. ARE THERE STANDARD METHODS FOR INTERPRETING  
9 A LARGE BODY OF RESEARCH LIKE THIS?

10 A. Yes. The standard methods for assessing potential health risks from the relevant  
11 scientific research call for a process that involves evaluating all of the evidence,  
12 and giving more weight to studies of better quality. For example, the IARC  
13 defines this risk assessment process as follows:

14 “Each *Monograph* reviews all pertinent epidemiological studies  
15 and cancer bioassays in experimental animals. Those judged  
16 inadequate or irrelevant to the evaluation may be cited but not  
17 summarized.” (p. 5, IARC, 2006).

18  
19 IARC, like many other scientific organizations, considers pertinent studies to be  
20 those reports of scientific research or reviews that have been published or  
21 accepted for publication in the openly-available scientific literature (IARC, 2006).

1 Q. WHAT KINDS OF DATA ARE CONSIDERED IN MAKING JUDGMENTS  
2 ABOUT POTENTIAL RISKS TO HUMAN HEALTH?

3 A. To assess the potential health effects from any exposure, data from several types  
4 of studies must be critically evaluated: epidemiologic observations in people,  
5 experimental studies with laboratory animals, and other biological test systems.

6 Q. WHAT ARE EPIDEMIOLOGIC STUDIES?

7 A. Epidemiology is the science that studies the patterns of health and disease in  
8 human populations in their normal environments. The objective of environmental  
9 epidemiology studies is to quantify and evaluate the associations between  
10 exposures to environmental factors (*e.g.*, vegetables in diet) and health outcomes  
11 (*e.g.*, diabetes).

12 Q. WHAT ARE LABORATORY STUDIES?

13 A. In contrast to epidemiology investigations, laboratory studies are designed to  
14 control exposures of the experimental subjects (*e.g.*, human volunteers, animals,  
15 tissues, cells, molecules) to other things in the environment, so that the effects of  
16 exposure to just one variable at known intensities and durations can be studied in  
17 relative isolation to determine cause and effect relationships.

18 Q. WHY ARE BOTH KINDS OF STUDY IMPORTANT?

19 A. Epidemiologic studies can help to suggest associations, but they usually cannot be  
20 used as the sole basis for inferences about cause-and-effect relationships, and they  
21 usually provide information about only a limited range of exposures. To establish  
22 cause-and-effect relationships, laboratory research designed to test specific  
23 hypotheses under controlled conditions is generally required. Conversely, the

1 results of laboratory studies, by themselves, may be difficult to extrapolate  
2 directly to the human population. Hence, the data from epidemiology studies and  
3 laboratory experiments are complementary, balancing the precision of laboratory  
4 studies with the real world experience of epidemiology.

5 It is therefore both desirable and important that biological responses to agents that  
6 could present a potential health threat be explored by epidemiologic methods in  
7 human populations, whenever feasible, as well as under controlled conditions in  
8 the research laboratory.

9 Q. WHY IS IT IMPORTANT TO EVALUATE ALL OF THE PERTINENT  
10 RESEARCH STUDIES?

11 A. It is essential to evaluate all of the studies, regardless of the direction of their  
12 results, in order to ensure that studies are not singled out from those available to  
13 support a preconceived position. It is considered a biased approach to evaluate  
14 only those studies that support a specific position. The appropriate question to  
15 keep in mind is “how strong is the evidence to support the hypothesis of cause  
16 and effect?”

17 Q. WHY IS IT FURTHER IMPORTANT TO CONSIDER THE QUALITY OF  
18 EACH STUDY — EXPERIMENTAL LABORATORY STUDIES AS WELL AS  
19 EPIDEMIOLOGY STUDIES?

20 A. Valid conclusions cannot be drawn from studies presenting data that are  
21 incomplete, or flawed in their methodology, execution, or interpretation. Hence,  
22 it is critically important to evaluate each study and give data from studies with

1 better quality design and analysis more weight in a weight-of-evidence  
2 evaluation.

3 Q. IS RELIANCE ON RESEARCH THAT IS PUBLISHED AND PEER  
4 REVIEWED A FIRST STEP IN THE EVALUATION OF ITS QUALITY?

5 A. Yes. Peer review is the process by which research proposals and studies reporting  
6 research are reviewed and evaluated by other scientists before they are approved  
7 for funding or publication. Peer review is one of the important procedures used to  
8 ensure that the quality of published information meets the standards of the  
9 scientific and technical community. Although it is not a guarantee of validity and  
10 varies widely across journals, peer review provides an indication that the data,  
11 interpretations and conclusions of the authors have passed a minimal level of  
12 scientific assessment and review. Without the procedure of peer review to screen  
13 and evaluate material, we could be inundated by material that is incomplete,  
14 poorly written, and unsubstantiated.

15 Q. WHAT IS THE UNIQUE ROLE OF EXPERIMENTAL LABORATORY  
16 STUDIES (*I.E.*, ANIMALS AND *IN VITRO* STUDIES) IN THE EVALUATION  
17 OF HEALTH RISKS TO HUMANS?

18 A. For obvious reasons, studies in humans are limited to either naturally occurring  
19 exposure, as in epidemiologic studies, or short-term exposure with presumed  
20 reversible effects (laboratory studies). Experimental studies can use higher  
21 exposures, for long time periods, and study processes in cell and tissues to  
22 directly examine for any carcinogenetic effects of EMF. In addition,  
23 experimental studies are designed to isolate the effects of a single variable from

1 other factors. Moreover, they can minimize potential bias and systematic error  
2 because the subjects are randomly assigned to exposed and unexposed (control)  
3 groups.

4 Q. HAVE EXPERIMENTAL STUDIES BEEN SHOWN TO PLAY AN  
5 IMPORTANT ROLE IN THE IDENTIFICATION AND STUDY OF CANCER-  
6 CAUSING AGENTS?

7 A. Yes. This role was highlighted by the IARC:

8 All known human carcinogens that have been studied adequately  
9 for carcinogenicity in experimental animals have produced positive  
10 results in one or more animal species.” (p. 14, IARC, 2006)

11  
12 And, more generally, experimental studies are the primary basis by which  
13 we evaluate the safety of all of our drugs and medicines.

14 Q. WHAT ORGANIZATIONS HAVE CONDUCTED WEIGHT-OF-EVIDENCE  
15 REVIEWS OF RESEARCH STUDIES OF EMF AND HEALTH?

16 A. Numerous scientific organizations have performed weight-of-evidence reviews of  
17 EMF research, including IARC, ICNIRP, the Health Council of Netherlands  
18 (“HCN”), UK National Radiological Protection Board (“NRPB”), and the  
19 National Institutes of Environmental Health Sciences (“NIEHS”). The scientific  
20 consensus among these agencies is that the evidence is insufficient to conclude  
21 that EMF is a cause of any long-term health effect.

22 One of the most comprehensive reviews of the relevant research was performed  
23 by the IARC Working Group, which consisted of scientists (including myself)  
24 drawn from 10 countries.



1 Q. CAN YOU PROVIDE SOME ADDITIONAL PERSPECTIVE ON THE  
2 CONCLUSIONS OF THE IARC REPORT?

3 A. Yes. It is important to understand that we concluded that the EMF data do not  
4 merit classification as "carcinogenic to humans" or "probably carcinogenic to  
5 humans." Moreover, the classification of EMF in the 2B category as a "possible  
6 carcinogen" does not mean that magnetic fields cause cancer, nor does it mean  
7 that they are likely to do so, but only that a possibility exists, given the weak  
8 evidence for the association. The category of all possible events includes highly  
9 unlikely events.

10 Many hypotheses have been suggested and tested to explain possible carcinogenic  
11 effects of electric or magnetic fields; however, no scientific explanation for  
12 carcinogenicity of these fields has been established (IARC, 2002). The Working  
13 Group did not find that the scientific evidence supported associations between  
14 magnetic fields and any other type of cancer or between electric fields and cancer.  
15 Coffee (IARC, 1991), pickled vegetables (IARC, 1993) and gasoline engine  
16 exhaust (IARC, 1989) are some other common exposures that have been classified  
17 in the Group 2B category. In other words, the scientific evidence to date suggests  
18 that magnetic fields (but not electric fields) at certain levels *might* bear some  
19 relation to one type of cancer, putting EMF in the same IARC risk category as  
20 pickled vegetable beets and coffee.

1 Q. HAVE ANY OF THE SUBSEQUENT MULTIDISCIPLINARY SCIENTIFIC  
2 REVIEWS PERFORMED FOR NATIONAL OR INTERNATIONAL  
3 AGENCIES REACHED DIFFERENT CONCLUSIONS?

4 A. No. Consideration of additional epidemiology and experimental studies has not  
5 prompted agencies including the HCN (2006), ICNIRP (2003), NRPB (2004), or  
6 Sweden's Radiation Protection Authority (2007) to change the basic conclusions  
7 of IARC regarding cancer, or to prompt concern about potential adverse effects of  
8 EMF on health.

9 Q. YOU JUST STATED THAT CONCLUSIONS OF THE IARC WORKING  
10 GROUP AND OTHER AGENCIES THAT HAVE ASSEMBLED  
11 MULTIDISCIPLINARY PANELS TO REVIEW EMF RESEARCH ARE  
12 GENERALLY CONSISTENT. ARE THEY ALSO GENERALLY  
13 CONSISTENT WITH THE CONCLUSIONS OF A REVIEW BY THREE  
14 SCIENTISTS FROM CALIFORNIA DEPARTMENT OF HEALTH SERVICES  
15 (CDHS, 2002)?

16 A. No. The review by these three scientists gave more weight to the body of  
17 research on other health outcomes, expressing their belief that EMF to one degree  
18 or another may pose a possible risk of adult leukemia, adult brain cancer,  
19 miscarriage, and amyotrophic lateral sclerosis. However, there are a number of  
20 procedures used in the preparation of the California report that are of concern and,  
21 in my opinion, caused the discrepancy between the reviewers' conclusions and the  
22 conclusions of the other scientific reviews. The review represented the opinions  
23 of just three scientists and lacked the multidisciplinary expertise of the other

1 national and international panels (specifically with regard to biological sciences)  
2 and, in contrast to the other reviews, did not adequately consider animal studies or  
3 other types of laboratory studies, as is required for a valid health risk assessment.

4 Q. WHY DID THE IARC WORKING GROUP AND OTHER REVIEWERS,  
5 INCLUDING THOSE FROM CDHS, NOT REGARD STATISTICAL  
6 ASSOCIATIONS BETWEEN ESTIMATES OF MAGNETIC FIELD  
7 EXPOSURE AND CHILDHOOD LEUKEMIA AS EVIDENCE CONFIRMING  
8 A CAUSAL RELATIONSHIP?

9 A. It is widely recognized that statistical associations do not by themselves mean that  
10 one factor is the cause of another. Other factors must be considered to assess  
11 causation, including the limitations and weaknesses of these epidemiology  
12 studies, and the biological evidence. For magnetic fields, there was neither  
13 sufficient evidence from epidemiology studies that magnetic fields caused cancer  
14 in humans, nor sufficient evidence that magnetic fields caused cancer in  
15 laboratory studies of animals. Furthermore, there was no strong evidence for a  
16 biological mechanism to cause cancer.

17 Q. WHAT ARE THE RESULTS OF EXPERIMENTAL STUDIES THAT HAVE  
18 EXPOSED ANIMALS TO EMF?

19 A. There are a large number of studies in which animals and cells have been exposed  
20 to EMF over a wide range of intensities. With respect to cancer, particularly  
21 leukemia, the most important studies are those in which animals had been  
22 exposed over most of their lifetime to magnetic fields as high as 50,000 mG and  
23 then examined for visible and microscopic evidence of cancer. These studies

1 conducted in several species provide no evidence for a carcinogenic effect of  
2 magnetic fields.

3 Q. IN SOME OF THESE STUDIES, WERE ANIMALS TESTED THAT WERE  
4 ALREADY AT HIGHER RISK OF CANCER, THAT IS, MORE LIKELY TO  
5 DEVELOP LEUKEMIA OR RELATED TYPES OF CANCER?

6 A. Yes. A number of studies were designed to increase the possibility of finding  
7 cancer even if the increased risk of magnetic field exposure was quite small, by  
8 testing animals with increased susceptibility to these diseases. In some of the  
9 studies, mice were tested that were more sensitive to the development of cancer  
10 because they had a genetic mutation that increased their risk. In other studies,  
11 mice and rats were first exposed to a known carcinogen and then exposed to  
12 magnetic fields, to see whether more cancers developed compared to controls.  
13 Overall, this collection of studies, which consisted of large sample sizes and high  
14 doses, showed no consistent evidence of increased rates of leukemia or any  
15 related lymphohematopoietic cancers in the animals exposed to magnetic fields.

16 Q. HOW WOULD YOU SUMMARIZE THE EVALUATIONS OF THE  
17 OVERALL EVIDENCE BY SCIENTIFIC AGENCIES?

18 A. Several of the epidemiologic studies have reported statistical associations between  
19 higher, average exposure levels to magnetic fields (greater than 3-4 mG) and  
20 childhood leukemia, although potential biases and other factors cannot be ruled  
21 out as the explanation. Other epidemiologic studies provide little evidence  
22 suggesting that EMF is the cause of cancer or other long-term adverse health  
23 effects. The experimental laboratory data do not support a causal link between

1 EMF and any adverse health effect because a) laboratory animals were exposed to  
2 EMF over their entire lifespan, and these studies have not shown a consistent  
3 increase in any cancer including leukemia, and b) the laboratory data in animals,  
4 cells, and tissues do not provide evidence of a mechanism to explain how  
5 magnetic fields could cause cancer. In the context of all the evidence, the data do  
6 not support a cause-and-effect relationship. For these reasons, the organizations  
7 that have reviewed the research have not recommended exposure limits at the  
8 levels typically produced by sources in communities, including distribution and  
9 transmission lines, and appliances.

10 Q. IS THIS A SUMMARY OF THE CONSENSUS OF THE  
11 MULTIDISCIPLINARY REVIEWS UP TO THE PRESENT?

12 A. Yes. The conclusions in the most recent weight-of evidence review performed by  
13 eight scientists for the Swedish Radiation Protection Authority reflect the  
14 consensus expressed in earlier reviews by NIEHS (NIEHS, 1998, 1999), IARC  
15 (2002), NRPB (NRPB, 2001; NRPB, 2004), ICNIRP (2003) and HCN (2001,  
16 2004, 2006) that the data do not support a causal link between EMF and any  
17 adverse health effects.

18 CONCLUSIONS

19 Q. IF EMF AT LEVELS TYPICALLY FOUND IN OUR COMMUNITIES  
20 WHERE INDIVIDUALS WORK AND PLAY IS NOT HARMFUL, WHY IS  
21 RESEARCH STILL CONTINUING?

22 A. As in other areas of science, research on EMF is an ongoing activity. Even  
23 though no adverse effects of EMF exposure at the levels found in our

1 communities have been confirmed, research is continuing to explore new  
2 questions that arise, to attempt to replicate previous studies, and to ensure that  
3 even the smallest possibility of a risk has not been overlooked. Because  
4 essentially everyone in developed countries like the United States is exposed to  
5 EMF throughout the day from a variety of sources, even a very small risk applied  
6 to these large populations would be of public health importance. However, given  
7 the limitations of epidemiology and the absence of data from laboratory studies to  
8 suggest that magnetic fields are carcinogenic, scientists have not concluded that  
9 the research, in total, suggests that electric or magnetic field have an adverse  
10 effect on human health.

11 Q. DOES SCIENTIFIC RESEARCH SHOW THAT ELECTRIC AND MAGNETIC  
12 FIELDS ARE HARMFUL TO HUMAN HEALTH?

13 A. Electric and magnetic fields are not harmful at the levels people are exposed to  
14 under transmission lines, in homes, or near machines and electrical appliances.  
15 With some appliances, an electric shaver and hair dryer for example, the user is  
16 exposed to magnetic fields that can be tens to hundreds of times higher than  
17 transmission line fields. Electric and magnetic fields can be harmful at extremely  
18 high levels, but not at the levels found under transmission lines or even near home  
19 appliances.

20 Q. DOES THIS CONCLUDE YOUR TESTIMONY?

21 A. Yes. However, I reserve the right to file such additional testimony as may be  
22 necessary or appropriate.

**William H. Bailey, Ph.D.**  
**Principal Scientist and Director, New York Office**

**Professional Profile**

Dr. William H. Bailey is a Principal Scientist in Exponent's Health Sciences practice and Director of the New York office. Before joining Exponent, Dr. Bailey was President of Bailey Research Associates, Inc., the oldest research and consulting firm with specialized expertise in electromagnetic fields and health. Dr. Bailey specializes in applying state-of-the-art assessment methods to environmental and occupational health issues. His 30 years of training and experience include laboratory and epidemiologic research, health risk assessment, and comprehensive exposure analysis. Dr. Bailey has investigated exposures to alternating current, direct current, and radiofrequency electromagnetic fields, 'stray voltage', and electrical shock, as well as to a variety of chemical agents and air pollutants. He is particularly well known for his research on potential health effects of electromagnetic fields and has served as an advisor to numerous state, federal, and international agencies. Dr. Bailey was one of the scientists invited from the U.S. and 9 other countries to evaluate possible health hazards of exposures to static and extremely low frequency (ELF) electric and magnetic fields for the International Agency for Research in Cancer in 2002. Most recently, he has been invited to participate in the International Workshop on EMF dosimetry and biophysical aspects relevant for setting exposure guidelines, organized by the International Commission on Non-ionizing Radiation Protection (ICNIRP). He also participated in a working group that advises a committee of the World Health Organization on risk assessment, perception, and communication. Currently, he is involved in research on respiratory exposures to ultrafine- and nanoparticles. Dr. Bailey is a visiting scientist at the Cornell University Medical College and has lectured at Rutgers University, the University of Texas (San Antonio), and the Harvard School of Public Health. He was formerly Head of the Laboratory of Neuropharmacology and Environmental Toxicology at the New York State Institute for Basic Research, Staten Island, New York, and an Assistant Professor and NIH postdoctoral fellow in Neurochemistry at The Rockefeller University in New York.

**Credentials and Professional Honors**

Ph.D., Neuropsychology, City University of New York, 1975  
M.B.A., University of Chicago, 1969  
B.A., Dartmouth College, 1966

Sigma Xi; The Institute of Electrical and Electronics Engineers/International Committee on Electromagnetic Safety (Subcommittee 3, Safety Levels with Respect to Human Exposure to Fields (0 to –3 kHz) and Subcommittee 4, Safety Levels with Respect to Human Exposure to Radiofrequency Fields (3 kHz to 3 GHz); Elected member of the Committee on Man and Radiation (COMAR) of the IEEE Engineering in Medicine and Biology Society (1998-2001); Invited Speaker, First Institute of Neurological Sciences Symposium in Neurobiology, University of Pennsylvania (1980); Invited Speaker, National Heart and Lung Institute (1977).

### **Prior Experience**

Bailey Research Associates, Inc., President, 1991-2000  
Environmental Research Information, Inc., Vice President, 1987-1990  
New York State Institute for Basic Research, Head of Laboratory of Environmental Toxicology and Neuropharmacology, 1983-1987  
The Rockefeller University, Assistant Professor, 1976-1983

### **Publications**

Bailey, WH, Erdreich, L. Accounting for human variability and sensitivity in setting standards for electromagnetic fields. *Health Phys* 2006 (in press).

Bailey, WH, Nyenhuis, JA. Thresholds for 60-Hz magnetic field stimulation of peripheral nerves in human subjects. *Bioelectromagnetics* 2005; 26:462–468.

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### **Presentations**

Bailey WH, Erdreich LS. Human sensitivity and variability in response to electromagnetic fields: Implications for standard setting. International Workshop on EMF Dosimetry and Biophysical Aspects Relevant to Setting Exposure Guidelines. International Commission on Non-Ionizing Radiation Protection, Berlin, March 2006.

Bailey WH. Research-based approach to setting electric and magnetic field exposure guidelines (0-3000 Hz). IEEE Committee on Electromagnetic Safety, December 2005.

Bailey, WH. *Conference Keynote Presentation*. Research supporting 50/60 Hz electric and magnetic field exposure guidelines. Canadian Radiation Protection Association, Annual Conference, Winnipeg, June 2005.

Bailey WH. Scientific methodology for assessing public health issues: a case study of EMF. Canadian Radiation Protection Association, Annual Conference, Public Information for Teachers, Winnipeg, June 2005.

Bailey, WH, Johnson, G, and Bracken TD. Method for measuring charge on aerosol particles near AC transmission lines. Joint Meeting of The Bioelectromagnetics Society and The European BioElectromagnetics Association, Dublin Ireland, June 2005.

Bailey, WH. Assessment of potential environmental effects of electromagnetic fields from submarine cables. Connecticut Academy of Science and Engineering, Long Island Sound Bottomlands Symposium: Study of Benthic Habitats, July 2004.

Bailey, WH, Bracken, TD, Senior, RS. Long-term monitoring of static electric field and space charge near AC transmission Lines. The Bioelectromagnetics Society, 26<sup>th</sup> Annual Meeting, Washington, DC, June 2004.

Bailey, WH, Erdreich, L, Waller, L, Mariano, K. Childhood leukemia in relation to 25-Hz and 60-Hz magnetic fields along the Washington DC—Boston rail line. Society for Epidemiologic Research, 35<sup>th</sup> Annual Meeting, Palm Desert CA, June 2002. *American Journal of Epidemiology*. 155:S38, 2002.

De Santo, RS, Coe, M, Bailey, WH. Environmental justice assessment and the use of GIS tools and methods. National Association of Environmental Professionals, 27<sup>th</sup> Annual Conference, Dearborn, MI, June 2002.

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Bailey WH. Current guidelines for occupational exposure to power frequency magnetic fields. EPRI EMF Seminar, New Research Horizons, March 1997.

Bailey WH. Methods to assess potential health risks of cell telephone electromagnetic fields. IBC Conference—Cell Telephones: Is there a Health Risk? Washington, DC, June 1997.

Bailey WH. Principles of risk assessment and their limitations. Symposium on Risk Perception, Risk Communication and its Application to EMF Exposure, International Commission on Non-Ionizing Radiation Protection, Vienna, Austria, October 1997.

Bailey WH. Probabilistic approach for setting guidelines to limit induction effects. IEEE Standards Coordinating Committee 28: Non-Ionizing Radiation, Subcommittee 3 (0–3 kHz), June 1997.

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Weil DE, Erdreich LS, Bailey WH. Are 60-Hz magnetic fields cancer causing agents? Mechanisms and Prevention of Environmentally Caused Cancers, The Lovelace Institutes 1995 Annual Symposium, La Fonda, Santa Fe, NM, October 1995.

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Blondin J-P, Nguyen D-H, Sbeghen J, Maruvada PS, Plante M, Bailey WH, Goulet D. The perception of DC electric fields and ion currents in human observers. Annual Meeting of the Canadian Psychological Association, Penticton, British Columbia, Canada, June 1994.

Erdreich LS, Bailey WH, Weil DE. Science, standards and public policy challenges for ELF fields. American Public Health Association 122nd Annual Meeting, Washington, DC, October 1994.

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Charry JM, Bailey WH. Contribution of charge on VDTs and simulated VDT operators to DC electric fields at facial surfaces. Tenth Annual Meeting of the Bioelectromagnetics Society, June 1988.

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Bailey WH, Collins RL, Lahita RG. Cerebral lateralization: association with serum antibodies to DNA in selected bred mouse lines. Society for Neuroscience, 1985.

Kavet R, Bailey WH, Charry JM. Respiratory neuroendocrine cells: a plausible site for air ion effects. Seventh Annual Meeting of The Bioelectromagnetics Society, June 1985.

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Bailey WH, Charry JM, Weiss JM, Cardle K, Shapiro M. Regional analysis of biogenic amine turnover in rat brain after exposure to electrically charged air molecules (air ions). Society for Neuroscience, 1983.

Bailey WH. Biological effects of air ions: fact and fancy. American Institute of Medical Climatology Conference on Environmental Ions and Related Biological Effects, October 1982.

Goodman PA, Weiss JM, Hoffman LJ, Ambrose MJ, Bailey WH, Charry, JM. Reversal of behavioral depression by infusion of an A2 adrenergic agonist into the locus coeruleus. Society for Neuroscience, November 1982.

Charry JM, Bailey WH. Biochemical and behavioral effects of small air ions. Electric Power Research Institute Workshop, April 1981.

Bailey WH, Alonzo DR, Weiss JM, Chin S. Predictability: a psychological/ behavioral variable affecting stress-induced myocardial pathology in the rat. Society for Neuroscience, November 1980.

Salman SL, Weiss JM, Bailey WH, Joh TH. Relationship between endogenous brain tyrosine hydroxylase and social behavior of rats. Society of Neuroscience, November 1980.

Bailey WH, Maclusky S. Appearance of creatine kinase isoenzymes in rat plasma following myocardial injury produced by isoproterenol. Fed Assoc Soc Exp Biol, April 1978.

Bailey WH, Maclusky S. Appearance of creatine kinase isoenzymes in rat plasma following myocardial injury by isoproterenol. Fed Proc 1978; 37:889.

Bailey WH, Weiss JM. Psychological factors in experimental heart pathology. Visiting Scholar Presentation, National Heart Lung and Blood Institute, March 1977.

Bailey WH, Weiss JM. Effect of ACTH 4-10 on passive avoidance of rats lacking vasopressin (Brambleboro strain). Eastern Psychological Association, April 1976.

### **Academic and Research Appointments**

- Visiting Fellow, Department of Pharmacology, Cornell University Medical College, New York, NY (1986–present)
- Visiting Scientist, The Jackson Laboratory, Bar Harbor, ME (1984–1985)
- Head, Laboratory of Neuropharmacology and Environmental Toxicology, NYS Institute for Basic Research in Developmental Disabilities, Staten Island, NY (1983–1987)
- Assistant Professor, The Rockefeller University, New York, NY (1976–1983)
- Postdoctoral Fellow, Neurochemistry, The Rockefeller University, New York, NY (1974–1976)

- Dissertation Research, The Rockefeller University, New York, NY (1972–1974)
- CUNY Research Fellow, Dept. of Psychology, Queens College, City University of New York, Flushing, NY (1969–1971)
- Clinical Research Assistant, Department of Psychiatry, University of Chicago; Psychiatric Psychosomatic Inst., Michael Reese Hospital, and Illinois State Psychiatric Inst, Chicago, IL (1968–1969)

### Teaching Appointments

- Lecturer, University of Texas Health Science Center, Center for Environmental Radiation Toxicology, San Antonio, TX (1998)
- Lecturer, Harvard School of Public Health, Office of Continuing Education, Boston, MA (1995, 1997)
- Lecturer, Rutgers University, Office of Continuing Education, New Brunswick, NJ (1991–1995)
- Adjunct Assistant Professor, Queens College, CUNY, Flushing, NY (1978)
- Lecturer, Queens College, CUNY, Flushing, NY (1969–1974)

### Advisory Positions

- National Institute of Environmental Health Sciences/ National Institutes of Health, Review Committee, Neurotoxicology, Superfund Hazardous Substances Basic Research and Training Program (2004)
- National Institute of Environmental Health Sciences, Review Committee Role of Air Pollutants in Cardiovascular Disease (2004)
- Working Group on Non-Ionizing Radiation, Static and Extremely Low-Frequency Electromagnetic Fields, International Agency for Research on Cancer (2000–2002)
- Working Group, EMF Risk Perception and Communication, World Health Organization (1998–2005)
- Associate Editor, Non-Ionizing Radiation, *Health Physics* (1996–present)
- Member, International Committee on Electromagnetic Safety, Subcommittee 3 - Safety Levels with Respect to Human Exposure to Fields (0 to 3 kHz) and Subcommittee 4 - Safety Levels with Respect to Human Exposure (3kHz to 3GHz) Institute of Electrical and Electronics Engineers (IEEE) (1996–present)

- Invited participant, National Institute of Environmental Health Sciences EMF Science Review Symposium: Clinical and *In Vivo* Laboratory Findings (1998)
- Working Group, EMF Risk Perception and Communication, International Commission on Non-Ionizing Radiation Protection (1997)
- U.S. Department of Energy, RAPID EMF Engineering Review (1997)
- Oak Ridge National Laboratory (1996)
- American Arbitration Association International Center for Dispute Resolution (1995–1996)
- U.S. Department of Energy (1995)
- National Institute for Occupational Safety and Health (1994–1995)
- Federal Rail Administration (1993–1996)
- U.S. Forest Service (1993)
- New York State Department of Environmental Conservation (1993)
- National Science Foundation
- National Institutes of Health, Special Study Section—Electromagnetics (1991–1993)
- Maryland Public Service Commission and Maryland Department of Natural Resources, Scientific Advisor on health issues pertaining to HVAC Transmission Lines (1988–1989)
- Scientific advisor on biological aspects of electromagnetic fields, Electric Power Research Institute, Palo Alto, CA (1985–1989)
- U.S. Public Health Service, NIMH: Psychopharmacology and Neuropsychology Review Committee (1984)
- Consultant on biochemical analysis, Colgan Institute of Nutritional Science, Carlsbad, CA (1982–1983)
- Behavioral Medicine Abstracts, Editor, animal behavior and physiology (1981–1983)
- Consultant on biological and behavioral effects of high-voltage DC transmission lines, Vermont Department of Public Service, Montpelier, VT (1981–1982)
- Scientific advisory committee on health and safety effects of a high-voltage DC transmission line, Minnesota Environmental Quality Board, St. Paul, MN (1981–1982)

- Consultant on biochemical diagnostics, Biokinetix Corp., Stamford, CT (1978–1980)

**Professional Affiliations**

- The Health Physics Society (Affiliate of the International Radiation Protection Society)
- Society for Risk Analysis
- New York Academy of Sciences
- American Association for the Advancement of Science
- Air and Waste Management Association
- Society for Neuroscience/International Brain Research Organization
- Bioelectromagnetics Society
- The Institute of Electrical and Electronics Engineers/Engineering in Medicine and Biology Society

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# Magnetic Fields at Different Distances from 500-kV Transmission Lines, Distribution Lines, and Appliances

