

**STATE OF NEW JERSEY  
BOARD OF PUBLIC UTILITIES**

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<b>IN THE MATTER OF THE PETITION OF PUBLIC SERVICE ELECTRIC AND GAS COMPANY FOR A DETERMINATION PURSUANT TO THE PROVISIONS OF N.J.S.A. 40:55D-19</b>	:	
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**BPU DOCKET**

**TO THE HONORABLE COMMISSIONERS OF THE  
NEW JERSEY BOARD OF PUBLIC UTILITIES:**

**SUMMARY OF PRE-FILED DIRECT TESTIMONY  
OF WILLIAM H. BAILEY, PH.D. PREPARED AT THE REQUEST OF  
PUBLIC SERVICE ELECTRIC AND GAS COMPANY**

Dr. William H. Bailey is the Principal Scientist of the Health Sciences Practice and the Director of the New York offices of Exponent and consultant to Public Service Electric and Gas Company (“PSE&G”) for the Susquehanna-Roseland Transmission Line Project (“Project”). He testifies on behalf of PSE&G in this proceeding.

On behalf of PSE&G, Dr. Bailey has advised the Project on the current state of the science regarding potential health risks associated with exposure to electrical facilities, including exposure to electric and magnetic fields (“EMF”).

In his testimony, Dr. Bailey identifies the electric and magnetic fields produced by the transmission lines associated with the Project as extremely low frequency (“ELF”) EMF. Dr. Bailey testifies that there are no state or federal standards in the United States limiting exposure to ELF EMF based on health effects. A division of the New Jersey Department of Environmental Protection has provided interim guidance to electric

facilities limiting the electric field at the edge of a right-of-way of a transmission line to 3 kV/m. In his testimony, Dr. Bailey states that the Project would produce electric fields well below this interim limit at the edge of the right-of-way. Dr. Bailey further testifies that the expected EMF levels outside the right-of-way will be below those limits recommended in exposure guidance by international scientific organizations.

In his testimony, Dr. Bailey also reviews the standard scientific method for assessing exposure to EMF and related potential health effects. Summarizing the evaluations of the overall evidence presented by scientific agencies, Dr. Bailey testifies that the conclusions of multidisciplinary scientific review panels have been consistent and that no panel has concluded that long-term exposure to magnetic fields is a known or likely cause of any adverse health effect. Dr. Bailey further testifies that the conclusions reached by national and international scientific and health agencies from their evaluation of EMF research and the guidelines for exposure they have recommended above, make clear that exposures to EMF that people encounter in their daily life, including those from transmission lines like the one considered here as part of the Project, do not pose any recognized long-term health risks.



1 **Q. What are your current responsibilities as a Principal Scientist?**

2 **A.** I am part of the Center for Exposure Assessment in the Health Science Practice at  
3 Exponent. My work involves reviewing, analyzing, and conducting health  
4 research. Much of my work over the past 25 years relates to the potential  
5 biological and health effects of electrical facilities, such as transmission lines,  
6 substations, and electrified railroad lines, including the possible effects of electric  
7 and magnetic fields (“EMF”).

8 **Q. Please describe your educational background, research experience, and list**  
9 **any professional degrees you have been awarded.**

10 **A.** I earned a Ph.D. in neuropsychology from the City University of New York. My  
11 education includes a B.A. from Dartmouth College in 1966 and an MBA from the  
12 University of Chicago, awarded in 1969. Since 1986, I have been a visiting  
13 research scientist at the Cornell University Medical College. I also have been a  
14 visiting lecturer at Rutgers University, the University of Texas (San Antonio), and  
15 the Harvard School of Public Health. From 1983 through 1987, I was head of the  
16 Laboratory of Neuropharmacology and Environmental Toxicology at the New  
17 York State Institute for Basic Research. For the nine previous years, I was an  
18 Assistant Professor and Postdoctoral Fellow in Neurochemistry at The  
19 Rockefeller University.

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1 **Q. Are you a member of any professional organizations?**

2 **A.** I am a member of The Rockefeller University Chapter of Sigma Xi, a national  
3 scientific honor society; the Health Physics Society; the International Committee  
4 on Electromagnetic Safety, Subcommittees 3 and 4 – Safety Levels with respect  
5 to Human Exposure to Fields; the Bioelectromagnetics Society; the IEEE  
6 Engineering in Medicine and Biology Society; the Conseil International des  
7 Grands Reseaux Electriques; the American Association for the Advancement of  
8 Science; the New York Academy of Sciences; the Society for Neuroscience; the  
9 Air & Waste Management Association; the Society for Risk Analysis; and the  
10 International Society for Exposure Analysis.

11 **Q. Have you served as a reviewer and scientific advisor on health-related issues**  
12 **for State and Federal agencies or scientific organizations? If so, please**  
13 **describe.**

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

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

Most recently, I worked with scientists from 10 countries to evaluate possible hazards from exposures to static and extremely low frequency (“ELF”) EMF for the International Agency for Research in Cancer (“IARC”), a division of the World Health Organization located in Lyon, France. I also was an invited participant in the workshop convened in March 2006 by the International Committee on Non-Ionizing Radiation Protection (“ICNIRP”) to update guidelines for human exposures to alternating current (“AC”) EMF.

**Q. Please describe the research you have conducted concerning exposure to electric and magnetic fields.**

**A.** I have studied and conducted research on EMF for 25 years. My research has included laboratory, exposure assessment and dosimetry, and epidemiologic studies of AC EMF and studies on direct current (“DC”) electric fields and air ions.

1 **Q. Have you published and/or presented your research in this and other areas**  
2 **to the scientific community?**

3 **A.** I have published or presented more than 50 scientific papers on this and related  
4 subjects. My *curriculum vitae* is attached as Exhibit WHB-1.

5 **Q. Have you ever appeared as a witness before a regulatory agency?**

6 **A.** Yes. I have appeared before state (including the New Jersey Board of Public  
7 Utilities), provincial, and national regulatory agencies to summarize the status of  
8 research on EMF at the request of applicants as well as the agencies.

9

## 10 **II. PROJECT EVALUATION**

11 **Q. Are you familiar with the Susquehanna-Roseland Transmission Line Project**  
12 **(the “Project”) that is the subject of these proceedings?**

13 **A.** Yes, I am.

14 **Q. What is Exponent’s role in this Project?**

15 **A.** My colleagues and I have advised PSE&G on the current state of the science with  
16 regard to EMF and health and attended public open houses to address questions  
17 from community members.

18 **Q. Are you sponsoring any exhibits?**

19 **A.** Yes. My *curriculum vitae* is attached as Exhibit WHB-1.

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3 **Q. Are you familiar with the proposed route and configuration of the Project?**

4 **A.** Yes, I am familiar with the proposed route for the Project. The proposed 500kV  
5 transmission upgrade will run from PPL's Susquehanna station near Berwick, Pa.  
6 to PSE&G's switching station in East Hanover/Roseland, New Jersey. The entire  
7 line will be about 130 miles long, approximately 45 miles of which will be  
8 located in New Jersey. The existing 230-kV structures would be removed and  
9 the existing 230-kV circuit would be installed on the new double-circuit structures  
10 opposite to the 500-kV line.

11 **Q. What type of electric and magnetic fields will be produced by the Project?**

12 **A.** The fields produced by transmission lines oscillate at a frequency of 60 Hertz and  
13 are classified in the extremely low frequency (ELF) range and are therefore  
14 sometimes referred to as ELF EMF. Both the existing 230-kV transmission line  
15 and the proposed 500-kV transmission line, as well all other parts of the electric  
16 system (e.g., distribution lines, service connections, substations) and any device  
17 or appliance connected to the electric system (e.g., appliances, building wiring)  
18 are sources of ELF EMF.

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1 **Q. What levels of EMF will be associated with the operation of the Project?**

2 **A.** Calculations of EMF are provided in the testimony and report of PSE&G witness  
3 Kyle G. King, P.E. of K&R Consulting, LLC. In summary, the levels of EMF  
4 from either the existing 230-kV line or the proposed 500/230-kV line will be  
5 highest on the right-of-way and diminish with distance from the conductors. At  
6 the edge of the right-of-way near the 500-kV conductors, Mr. King has calculated  
7 that the electric and magnetic field levels will be less than or equal to 1.6  
8 kilovolts/meter (kV/m) and 57 milligauss (mG), respectively, at median line  
9 loadings. On the opposite edge of the right-of-way near the 230-kV conductors,  
10 the levels will be lower, less than 0.5 kV/m and 21 mG, respectively. Except for  
11 the section between the Montville and Roseland, the magnetic field level on the  
12 230-kV side of the right-of-way will be lower than that associated with the  
13 operation of the existing 230-kV transmission line.

14 The values of the magnetic field calculated at median line loadings are the best  
15 descriptors of the magnetic field for the purposes of estimating 'typical' potential  
16 exposures. Mr. King has calculated magnetic field values at peak loading but a  
17 peak load on the lines might only be reached for a few hours on a few days each  
18 year.

19 **Q. Are there any state or federal standards that PSE&G must meet with regard**  
20 **to EMF and health?**

21 **A.** There are no state or federal standards in the United States limiting exposure to  
22 ELF EMF based on health effects. Only two states, Florida and New York, have

1 enacted standards to limit magnetic and electric fields from transmission lines at  
2 the edge of the right of way (“ROW”). These limits are 200 mG (for 500-kV  
3 lines) and 2 kV/m in Florida, and 200 mG and 1.6 kV/m in New York (FDER,  
4 1989; FDEP, 1996; NYPSC, 1978; NYPSC, 1990). The basis for limiting  
5 magnetic fields from transmission lines in Florida and New York was to maintain  
6 the “status quo” so that fields from new transmission lines would be no higher  
7 than fields produced by existing transmission lines.

8 Several states, including New Jersey, also have guidelines for electric fields from  
9 transmission lines that date back twenty years or so. To address public concern in  
10 1981, the New Jersey Commission on Radiation Protection, a division of the  
11 Department of Environmental Protection, provided interim guidance to electric  
12 utilities that the electric field at the edge of the right-of-way of new transmission  
13 lines be limited to 3 kV/m. The proposed Project would produce electric field  
14 levels well below this interim limit at the edges of the right-of-way.

15 **Q. Will the expected EMF levels outside the right-of-way be below those**  
16 **recommended in exposure guidelines by international organizations?**

17 **A.** Yes. Several scientific organizations have published guidelines for exposure to  
18 EMF based on acute effects that can occur at very high field levels. The  
19 guidelines put forth by ICNIRP in their 1998 document set limits to protect  
20 against the acute effects (i.e., the stimulation of nerves and muscles) that occur at  
21 very high field levels. The ICNIRP recommends a screening value of 833 mG  
22 and 4.2 kV/m for the public (ICNIRP, 1998). The 27 member countries of the

1 European Union apply the ICNIRP recommendation “to relevant areas where  
2 members of the public spend significant time” (CEU, 1999).

3 The International Committee on Electromagnetic Safety (ICES) also recommends  
4 limiting magnetic and electric field exposures at high levels because of the risk of  
5 acute effects, although their guidelines are higher than ICNIRP’s guidelines at 60  
6 Hz. The ICES recommends a residential exposure limit of 9,040 mG and 5  
7 kV/m<sup>1</sup>, respectively (ICES, 2002). Both guidelines incorporate large safety  
8 factors.

### 9 **III. SCIENTIFIC METHOD FOR ASSESSING EMF AND HEALTH**

10 **Q. There has been considerable research on exposure to EMF and related**  
11 **potential health effects. Are there standard methods for interpreting a large**  
12 **body of research like this?**

13 **A.** Yes. Scientists use systematic methods to evaluate observations and assess the  
14 potential impact of a specific agent on human health. The scientific process  
15 involves looking at all the evidence on a particular issue in a systematic and  
16 thorough manner (i.e., a weight-of-evidence review). This process is designed to  
17 ensure that more weight is given to studies of better quality and that studies with a  
18 given result are not selected out from all available evidence to advocate or  
19 suppress a preconceived idea of an adverse effect.

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<sup>1</sup> Within power line right-of-ways, the guideline is 10 kV/m.

1 **Q. What kinds of data are considered in making judgments about potential**  
2 **risks to human health?**

3 **A.** Data from several types of studies must be evaluated together in a weight-of-  
4 evidence review, including epidemiologic observations in people, experimental  
5 studies of humans, experimental studies in animals (*in vivo*), and experimental  
6 studies in isolated cells and tissues (*in vitro*). Each study type has its unique  
7 weaknesses that are addressed by the strengths of the other study types; therefore,  
8 all three study-types must be considered together in a weight-of-evidence review.  
9 The weakness of epidemiology studies, for example, is that they are observational  
10 in nature, meaning they are not able to control many of the factors that could  
11 possibly affect the outcome; *in vivo* studies and other experimental studies  
12 conducted in laboratories, on the other hand, are designed to control factors that  
13 might inadvertently affect the interpretation of the study.

14 **Q. What are epidemiology studies?**

15 **A.** Epidemiology is the science of understanding the causes of disease by enrolling  
16 people in studies, asking them questions about their exposures, and correlating  
17 their health events with these exposures. Scientists use two major analytic study  
18 designs in the field of epidemiology: case-control studies and cohort studies. A  
19 cohort study follows a pre-defined population (e.g., workers at a specific  
20 company) over time to see who develops disease and examines whether disease  
21 rates are different between people who were exposed to a particular agent (i.e., the  
22 exposed group) and people who were not exposed (i.e., the unexposed group). A

1 case-control study compares people who have already been diagnosed with a  
2 disease (i.e., the cases) to a similar group of people who do not have the disease  
3 (i.e., controls) to see if there are differences in the prevalence of exposure.

4 **Q. Why are experimental studies important?**

5 **A.** Experimental studies are designed to isolate the effects of a single variable from  
6 other factors because they have control over the many variables that may affect  
7 the outcome of interest. Moreover, they can minimize potential bias and  
8 systematic error because the subjects are randomly assigned to exposed and  
9 unexposed groups. There are two types of experimental studies:

10 *In vivo* studies in which laboratory animals receive high exposures in a controlled  
11 environment provide an important basis for evaluating the safety of  
12 environmental, occupational, and drug exposures. These approaches are widely  
13 used by health agencies to assess risks to humans from medicines, chemicals and  
14 physical agents (USEPA, 2002; USEPA, 2005; IARC, 2002 preamble; Health  
15 Canada, 1994; WHO, 1994).

16 *In vitro* studies are designed to evaluate the way that the exposure acts on cells  
17 and tissues outside of the body and are used to investigate the possible  
18 mechanisms for effects that may be observed in living organisms. However, since  
19 responses of cells and tissues outside the body may not reflect the response of  
20 those same cells if maintained in a living system, the relevance of the results of *in*  
21 *vitro* research to true effects within the body cannot be assumed (IARC, 1992).

1           Thus, while epidemiologic studies can help suggest factors that may contribute to  
2           the development of disease, they are not used as the sole basis for drawing  
3           inferences about cause-and-effect relationships because of the weaknesses  
4           inherent in their design. Epidemiology and experimental studies complement one  
5           another because the inherent limitations of epidemiology studies are addressed in  
6           experimental studies and vice versa. Similar to puzzle pieces, scientists attempt to  
7           fit the results of epidemiology and experimental studies together to determine  
8           whether a picture of the possible relationship between exposure to a particular  
9           agent and disease can be constructed.

10   **Q.    Why is it important to evaluate all of the pertinent 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. If all of the relevant research studies are not  
14           considered in a weight-of-evidence fashion by persons with the required  
15           expertise, then any conclusions that are drawn from selected studies may be  
16           biased.

17   **Q.    Why is it important to consider the quality of each study?**

18   **A.**    Every study varies considerably in the quality of its design and the methods that  
19           were used to assess exposure, evaluate the effect, etc. Often times, the first group  
20           of studies in a field of research use cheaper and quicker methods to get initial  
21           results and, if further research is suggested, more expensive studies with better  
22           methods are carried out. It also may happen that, after a study is completed, the

1 investigators find an error that makes the results carry little weight. Scientists  
2 cannot draw valid conclusions from studies presenting data that are incomplete or  
3 flawed in their methodology, execution, or interpretation. Therefore, it is  
4 critically important to evaluate each study individually and give data from studies  
5 with a better quality design more weight in a weight-of-evidence review.

6 **Q. Is reliance on research that is published and peer-reviewed a first step in the**  
7 **evaluation of a study's quality?**

8 **A.** Yes. Peer review ensures that the quality of published information meets the  
9 standards of the scientific and technical community. Research proposals and  
10 studies are reviewed and evaluated by other scientists *before* they are funded or  
11 published. Although there is a wide variety among reviewers and reviewing  
12 criteria across journals and peer review does not guarantee the validity of a study,  
13 it does provide an indication that the data, interpretations and conclusions of the  
14 authors have passed a minimum level of scientific assessment and review. Peer  
15 review screens out most of the material that is incomplete, poorly written, and  
16 unsubstantiated.

17 **Q. What is the unique role of experimental laboratory studies of animals in the**  
18 **evaluation of health risks to humans, particularly cancer?**

19 **A.** Experimental studies of animals often use higher exposures for long periods, and  
20 study processes in cell and tissues to examine directly the possible carcinogenic  
21 effects of an exposure. Since the process by which cells become cancerous may  
22 evolve over long periods of time and can be critically affected by developmental

1 factors, life-long studies play an important role in the assessment of exposures  
2 that might affect the risk of cancer and other chronic diseases.

3 **Q. Have experimental studies been shown to play an important role in the**  
4 **identification and study of cancer causing agents?**

5 **A.** Yes. This role was highlighted by the IARC in 2006:

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

9 In addition, more generally, experimental studies are the primary basis by  
10 which we evaluate the safety of all of our drugs and medicines.

11 **Q. What organizations have conducted weight-of-evidence reviews of research**  
12 **studies of EMF and human health?**

13 **A.** There are quite a number of weight-of-evidence reviews published over the past  
14 ten years by national and international scientific health agencies. Four deserve  
15 special mention because they are relatively recent and comprehensive. The  
16 National Institute of Environmental Health Sciences (NIEHS) published, “Health  
17 Effects from Exposure to Power-Line Frequency Electric and Magnetic Fields,”  
18 in 1999. This was followed in 2002 by the publication of “Static and Extremely  
19 Low Frequency (ELF) Electric and Magnetic Fields,” by the International Agency  
20 for Cancer Research (IARC) and in 2004, the publication of “Review of the  
21 Scientific Evidence for Limiting Exposure to Electromagnetic Fields (0-300 Hz),”

1 by the National Radiological Protection Board (NRPB) of Great Britain. Most  
2 recently, the World Health Organization (WHO) released an evaluation of the  
3 research literature through 2005 with “Extremely Low Frequency Fields  
4 Environmental Health Criteria Monograph No. 238,” published in 2007.

5 **Q. What were the conclusions of the World Health Organization’s 2007 report**  
6 **regarding EMF and health?**

7 **A.** The WHO provided the following conclusions:

8 • “there are no substantive health issues related to ELF  
9 electric fields at levels generally encountered by  
10 members of the public” (WHO, 2007a).

11 • “New human, animal, and in vitro studies published  
12 since the 2002 IARC Monograph, 2002 [sic] do not  
13 change the overall classification of ELF as a possible  
14 human carcinogen” (p. 347, WHO, 2007b.).

15 • “Acute biological effects [i.e., short-term, transient  
16 health effects such as a small shock have been  
17 established for exposure to ELF electric and magnetic  
18 fields in the frequency range up to 100 kHz that may  
19 have adverse consequences on health. Therefore,  
20 exposure limits are needed. International guidelines  
21 exist that have addressed this issue. Compliance with

1                   these guidelines provides adequate protection.  
2                   Consistent epidemiological evidence suggests that  
3                   chronic low-intensity ELF magnetic field exposure is  
4                   associated with an increased risk of childhood  
5                   leukaemia. However, the evidence for a causal  
6                   relationship is limited, therefore exposure limits  
7                   based upon epidemiological evidence are not  
8                   recommended, but some precautionary measures are  
9                   warranted” (p. 355, WHO, 2007b).

10 **Q. Can you explain in greater detail the conclusions of the WHO Report?**

11 **A.** Yes. While the WHO report confirmed the IARC classification of magnetic fields  
12 as possibly carcinogenic, it is important to understand the context of this  
13 classification. The EMF data did not merit the classification of "carcinogenic to  
14 humans" or "probably carcinogenic to humans." Moreover, the classification of  
15 EMF in the 2B category as a “possible carcinogen” does not mean that magnetic  
16 fields cause cancer, nor does it mean that they are likely to do so, but only that a  
17 possibility exists, given the weak evidence related to the association between  
18 childhood leukemia and exposure to high average magnetic field levels. Note that  
19 possible events include highly unlikely events.

20

21 Many hypotheses have been suggested and tested to explain the possible  
22 carcinogenic effects of electric or magnetic fields; however, no scientific  
23 explanation for carcinogenicity of these fields has been established (IARC, 2002).

1 The WHO did not find that the scientific evidence supported associations between  
2 magnetic fields and any other type of cancer or between electric fields and cancer.  
3 Coffee (IARC, 1991), pickled vegetables (IARC, 1993) and gasoline engine  
4 exhaust (IARC, 1989) are some other common exposures that have been classified  
5 as possible carcinogens. In other words, the scientific evidence to date suggests  
6 that magnetic fields (but not electric fields) at certain levels *might* bear some  
7 relation to one type of cancer, putting EMF in the same IARC risk category as  
8 pickled vegetables, and coffee.

9

10 **Q. Have any other subsequent multi-disciplinary scientific reviews performed**  
11 **for national or international scientific agencies reached different**  
12 **conclusions?**

13 **A.** No.

14 **Q. Why did the WHO and other reviewers not regard statistical associations**  
15 **between estimates of magnetic field exposure and childhood leukemia as**  
16 **evidence confirming a causal link?**

17 **A.** Like most cancers, childhood leukemia is a complicated disease that appears to  
18 have diverse origins, which are largely unknown to scientists. A lot of research  
19 on childhood leukemia is being conducted worldwide on many exposures –  
20 genetic, environmental, and infectious – with varying amounts of strength in  
21 support of an association or causality. Magnetic field exposure is one exposure  
22 that has been studied extensively in approximately 35 studies conducted

1 throughout the world. The quality of these studies varies considerably, with later  
2 studies generally having higher quality. While the largest, most methodologically  
3 sound studies did not support a clear statistical association, a pooled analysis of  
4 all of the studies reported a statistical association between average exposure to  
5 greater than 3 – 4 mG and childhood leukemia. This finding has not been  
6 interpreted as causal in nature because of the many limitations of the underlying  
7 studies and the pooled analysis itself. In addition, the panels of scientists who  
8 have reviewed the research noted that there is little supportive data from *in vivo*  
9 and *in vitro* studies for a causal relationship between magnetic fields and  
10 childhood leukemia (NRPB, 2001; IARC, 2002; ICNIRP, 2003; HCN, 2004,  
11 WHO, 2007b).

12 **Q. What are the results of experimental studies in which animals have been**  
13 **exposed to EMF?**

14 **A.** The WHO report (2007b) concluded that large-scale, long-term studies in rodents  
15 have not shown any consistent increases in any type of cancer, including  
16 leukemia, lymphoma, mammary, brain, and skin tumors. The WHO did not  
17 conclude that *in vivo* studies provide evidence that exposure to ELF-EMF causes  
18 tumors.

19 These conclusions were based on a number of *in vivo* studies, including two large-  
20 scale studies that the National Toxicology Program (NTP) completed (Boorman,  
21 et al. 1999 a, b; McCormick et al. 1999). In these studies, lifetime magnetic field

1 exposure did not increase leukemia or lymphoma rates, or cancers of the breast,  
2 brain, or cancers in general.

3 **Q. In some of these studies, were animals tested that already had a higher risk**  
4 **of developing leukemia or related types of cancer?**

5 **A.** Studies specifically designed to test cancer promotion have not found evidence  
6 that magnetic field exposure promotes cancer. These studies utilized specific  
7 exposures frequently used to initiate cancer including ionizing radiation, a  
8 chemical such as ethylnitrosourea (ENU), and 7,12-dimethylbenz[a]anthracene  
9 (DMBA) or used a strain of mice with a virus that predisposes them to cancer  
10 (Babbitt et al., 2000; Sommer and Lerchl, 2006, Chung et al., 2008, Fedrowitz  
11 and Löscher, 2008; Negishi et al., 2008). These studies are consistent with and  
12 reinforce previous conclusions that exposure to magnetic fields does not increase  
13 the incidence of cancer, even in animals predisposed to cancer.

14 **Q. Please summarize the evaluations of the overall evidence presented by**  
15 **scientific agencies.**

16 The conclusions of the multidisciplinary scientific review panels have been  
17 consistent. None of the panels concluded that long-term exposure to magnetic  
18 fields is a known or likely cause of any adverse health effect and, as a result, no  
19 standards or guidelines have been recommended for magnetic fields at the  
20 strengths normally encountered in our environment. The IARC (2002) and  
21 ICNIRP (1998; 2003) concluded that the evidence does not support a cause-and-  
22 effect relationship between magnetic fields and any adverse health effect,

1 including adult leukemia/lymphoma or brain cancer. They classified magnetic  
2 fields as a possible carcinogen only because of the epidemiologic evidence related  
3 to childhood leukemia. In IARC’s classification the term “possible” denotes an  
4 exposure for which epidemiologic data provides limited evidence for a  
5 relationship with cancer, and experimental evidence does not support a cause-and-  
6 effect relationship. Later reviews conducted for the European Commission, the  
7 Swedish Radiation Protection Institute, and the World Health Organization noted  
8 that more recent studies have not provided evidence to alter IARC’s conclusion  
9 (SCENIHR, 2007; SSI, 2007; WHO, 2007b).

10 **Q. Is this a summary of the consensus of the multidisciplinary reviews up to the**  
11 **present?**

12 **A.** Yes. My colleagues and I also review newly published research on a regular basis  
13 to evaluate whether recent findings alter the conclusions of the scientific review  
14 panels. The research published after the June 2007 review by the WHO does not  
15 alter the conclusions of these review panels.

16 **Q. Have health agencies recommended limits for exposures that are in the range**  
17 **that people encounter every-day in their communities (i.e., below health-**  
18 **based limits recommended by ICNIRP and ICES)?**

19 **A.** No. The conclusions reached by national and international scientific and health  
20 agencies from their evaluation of EMF research, and the guidelines for exposure  
21 they have recommended above, make clear that exposures to EMF that people  
22 encounter in their daily life, including those from transmission lines like the one

1 considered here, do not pose any recognized long-term health risks. For example,  
2 the NIEHS states “No regulatory action was recommended by or taken based on  
3 the NIEHS report....it suggested that power companies and utilities ‘continue  
4 siting power lines to reduce exposures and ... explore ways to reduce the creation  
5 of magnetic fields around transmission and distribution lines without creating new  
6 hazards.’” (p. 52, NIEHS, 2002). Similarly, the WHO recommends in a recent  
7 fact sheet, “When constructing new facilities ... low-cost ways of reducing  
8 exposures may be explored. Appropriate exposure reduction measures will vary  
9 from one country to another. However, policies based on the adoption of  
10 arbitrary low exposure limits are not warranted” (WHO, 2007a).

11 **Q. Has PSE&G taken steps in the siting and design of the proposed Project that**  
12 **are consistent with the above recommendations?**

13 **A.** Yes, PSE&G has sited the Project on an existing right-of-way instead of locating  
14 the line on a new right-of-way, which limits the geographic spread of sources in  
15 the area. In addition, because the 500kV line would be co-located on a double-  
16 circuit tower and the phasing of the 500-kV line would be ‘reversed’ with respect  
17 to the 230-kV line, the magnetic fields from the 230-kV line and the 500-kV line  
18 would tend to cancel.

19 **Q. If EMF at levels typically found in our communities is not harmful, why is**  
20 **research still ongoing?**

21 **A.** As in other areas of science, research on EMF is an ongoing activity. Although  
22 no adverse effects of EMF exposure at the levels found in our communities have

1           been confirmed, research continues to explore new questions that arise, to attempt  
2           to replicate previous studies, and to ensure that even the smallest possibility of a  
3           risk has not been overlooked. Since essentially everyone in developed countries  
4           like the United States is exposed to EMF throughout the day from a variety of  
5           sources, even a very small risk applied to these large populations would be of  
6           public health importance.

7   **IV. CONCLUSION**

8   **Q. Does scientific research show that electric and magnetic fields at levels**  
9           **described in the testimony of PSE&G witness Kyle G. King are harmful to**  
10           **human health?**

11   **A.** No. The WHO, as well as the numerous other scientific and health agencies that  
12           have considered this issue have concluded that on balance, the weight of the  
13           scientific evidence does not support the conclusion that power-frequency EMF  
14           causes any long-term adverse health effects. Recent research does not provide  
15           evidence to alter this conclusion. The conclusions of the WHO and other  
16           agencies apply to all sources of ELF-EMF in our environment, including power  
17           distribution lines, transmission lines, electrical appliances, and electrically-  
18           powered transportation.

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20   **Q. Does this conclude your testimony?**

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22   **A.** Yes it does.  
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**V. REFERENCES**

Babbitt JT, Kharazi AI, Taylor JMG, 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* 21: 1379-89, 2000.

Boorman GA, Anderson LE, Morris JE, Sasser LB, Mann PC, Grumbein SL, Hailey JR, McNally A, Sills RC, Haseman JK. Effects of 26-week magnetic field exposure in a DMBA initiation-promotion mammary glands model in Sprague-Dawley rats. *Carcinogenesis* 20:899-904, 1999a.

Boorman GA, McCormick DL, Findlay JC, Hailey JR, Gauger JR, Johnson TR, Kovatch RM, Sills RC, Haseman JK. Chronic toxicity/oncogenicity evaluation of 60 Hz (power frequency) magnetic fields in F344/N rats. *Toxicologic Pathology* 27:267-78, 1999b.

Chung M-K, Kim Y-B, Ha C-S, Myung S-H. Lack of a co-promotion effect of 60 Hz rotating magnetic fields on n-ethyl-n-nitrosourea induced neurogenic tumors in F344 rats. *Bioelectromagnetics* 29:539-48, 2008.

Council of the European Union (CEU). Council Recommendation of 12 July 1999 on the Limitation of Exposure of the General Public to Electromagnetic Fields (0 Hz To 300 GHz). *Official Journal of The European Communities*. L199: 59-65, 1999.

Fedrowitz M and Löscher W. Exposure of Fischer 344 rats to a weak power frequency magnetic field facilitates mammary tumorigenesis in the DMBA model of breast cancer. *Carcinogenesis* 29: 186-93, 2008.

Florida Department of Environmental Regulation (FDER). Electric and Magnetic fields. Chapter 17-274. Department of Environmental Regulation Rules, March, 1989.

Florida Department of Environmental Protection (FDEP). Chapter 62-814 Electric and Magnetic Fields, 1996.

Health Canada. Human Health Risk Assessment for Priority Substances. Environmental Health Directorate. Canadian Environmental Protection Act. Health Canada, Ottawa, 1994.

Health Council of the Netherlands (HCN). ELF Electromagnetic Fields Committee. Electromagnetic fields: Annual Update 2003. The Hague: Health Council of the Netherlands. Publication No. 2004/1, 2004.

International Agency for Research on Cancer (IARC). IARC Monographs on the Evaluation of Carcinogenic Risks to Humans. Volume 46: Diesel and Gasoline Engine Exhausts and some Nitroarenes. IARC Press, Lyon, France, 1989.

- 1 International Agency for Research on Cancer (IARC). IARC Monographs on the  
2 Evaluation of Carcinogenic Risks to Humans. Volume 51: Coffee, Tea, Mate,  
3 Methylxanthines and Methylglyoxal. IARC Press, Lyon, France, 1991.
- 4 International Agency for Research on Cancer (IARC). Mechanisms of Carcinogenesis in  
5 Risk Identification. No. 116. IARC Press, Lyon, France, 1992.
- 6 International Agency for Research on Cancer (IARC). IARC Monographs on the  
7 Evaluation of Carcinogenic Risks to Humans. Volume 56: Some Naturally Occurring  
8 Substances: Food items and Constituents, Heterocyclic Aromatic Amines and  
9 Mycotoxins. IARC Press, Lyon, France, 1993.
- 10 International Agency for Research on Cancer (IARC). IARC Monographs on the  
11 Evaluation of Carcinogenic Risks to Humans. Volume 80: Static and Extremely Low-  
12 Frequency (ELF) Electric and Magnetic fields. IARC Press, Lyon, France, 2002.
- 13 International Agency for Research on Cancer (IARC). IARC Monographs on the  
14 Evaluation of Carcinogenic Risks to Humans. Preamble. IARC Press, Lyon, France,  
15 2006.
- 16 International Commission on Non-Ionizing Radiation Protection (ICNIRP). Guidelines  
17 for limiting exposure to time-varying electric, magnetic, and electromagnetic fields (up to  
18 300 GHz). Health Phys. 74:494-522, 1998.
- 19 International Commission on Non-Ionizing Radiation Protection (ICNIRP). Exposure to  
20 Static and Low Frequency Electromagnetic Fields, Biological Effects and Health  
21 Consequences (0-100 kHz) – Review of the Scientific Evidence on Dosimetry, Biological  
22 Effects, Epidemiological Observations, and Health Consequences Concerning Exposure  
23 to Static and Low Frequency Electromagnetic Fields (0-100 kHz). Matthes R, McKinlay  
24 AF, Bernhardt JH, Vecchia P, Beyret B (eds.). International Commission on Non-  
25 Ionizing Radiation Protection, 2003.
- 26 International Committee on Electromagnetic Safety (ICES). IEEE Standard for Safety  
27 Levels with Respect to Human Exposure to Electromagnetic Fields 0 to 3 kHz C95. 6-  
28 2002. Piscataway, NJ: IEEE, 2002.
- 29 McCormick DL, Boorman GA, Findlay JC, Hailey JR, Johnson TR, Gauger JR, Pletcher  
30 JM, Sills RC, Haseman JK. Chronic toxicity/oncogenicity evaluation of 60 Hz (power  
31 frequency) magnetic fields in B6C3F1 mice. Toxicol Pathol 27:279-85, 1999.
- 32 National Institute of Environmental Health (NIEHS). Health effects from Exposure to  
33 Power Line Frequency Electric and Magnetic Fields. NIH Publication No. 99-4493.  
34 Research Triangle Park, NC: National Institute of Environmental Health Sciences of the  
35 U.S. National Institutes of Health, 1999.
- 36 National Institute of Environmental Health (NIEHS). EMF – Electric and Magnetic  
37 Fields Associated with the Use of Electric Power: Questions and Answers. Research

1 Triangle Park, NC: National Institute of Environmental Health Sciences of the U.S.  
2 National Institutes of Health, 2002.

3 National Radiological Protection Board (NRPB). ELF Electromagnetic Fields and the  
4 Risk of Cancer: Report of an Advisory Group on Non-ionising Radiation. National  
5 Radiological Protection Board. Volume 12, No 1, 2001.

6 National Radiological Protection Board (NRPB). Review of the Scientific Evidence for  
7 Limiting Exposure to Electromagnetic Fields (0-300 GHz). National Radiological  
8 Protection Board (NRPB). Volume 15, No 3, 2004.

9 Negishi T, Imai S, Shibuya K, Nishimura I, Shigemitsu T. Lack of promotion effects of  
10 50 Hz magnetic fields on 7,12-dimethylbenz(a)anthracene-induced malignant  
11 lymphoma/lymphatic leukemia in mice. *Bioelectromagnetics* 29: 29-38, 2008.

12 New York Public Service Commission (NYPSC). Opinion No. 78-13. Opinion and  
13 Order Determining Health and Safety Issues, Imposing Operating Conditions, and  
14 Authorizing, in Case 26529, Operation Pursuant to Those Conditions. Issued June 19,  
15 1978.

16 New York Public Service Commission (NYPSC). Statement of Interim Policy on  
17 Magnetic Fields of Major Transmission Facilities. Cases 26529 and 26559 Proceeding  
18 on Motion of the Commission. Issued and Effective: September 11, 1990.

19 Scientific Committee on Emerging and Newly Identified Health Risks (SCENIHR).  
20 Possible Effects of Electromagnetic Fields (EMF) on Human Health. European  
21 Commission. Directorate C – Public Health and Risk Assessment, 2007.

22 Sommer AM, Lerchl A. 50 Hz magnetic fields of 1 mT do not promote lymphoma  
23 development in AKR/J mice. *Radiat Res.* 165:343-349, 2006.

24 Swedish Radiation Protection Authority (SSI). Fourth Annual Report from SSI's  
25 Independent Expert Group on Electromagnetic Fields, 2006: Recent Research on EMF  
26 and Health Risks. SSI Rapport 2007:04.

27 US Environmental Protection Agency (USEPA). A Review of the Reference Dose and  
28 Reference Concentration Process. EPA/630/P-02/002F, 2002.

29 US Environmental Protection Agency (USEPA). Guidelines for Carcinogen Risk  
30 Assessment and Supplemental Guidance for Assessing Susceptibility from Early-Life  
31 Exposure to Carcinogens. EPA/630/P-03/001F, 2005.

32 World Health Organization (WHO). International Programme on Chemical Safety  
33 (IPCS). Environmental Health Criteria 170: Assessing Human Health Risks of  
34 Chemicals: Derivation of Guidance Values for Health-Based Exposure Limits. World  
35 Health Organization, 1994.

- 1 World Health Organization (WHO). Fact sheet No. 322: Electromagnetic Fields and  
2 Public Health – Exposure to Extremely Low Frequency Fields. World Health  
3 Organization, 2007a.
- 4 World Health Organization (WHO). Environmental Health Criteria 238: Extremely Low  
5 Frequency (ELF) Fields. WHO, Geneva, Switzerland, ISBN 978-92-4-157238-5, 2007b.