STATE OF RHODE ISLAND AND PROVIDENCE PLANTATIONS
ENERGY FACILITY SITING BOARD

In re The Narragansett Electric Company	:	
d/b/a National Grid	:	Docket No. SB-2008-02
(Rhode Island Reliability Project)	:	

Testimony of

William H. Bailey, Ph.D.

June 29, 2009

TESTIMONY OF WILLIAM H. BAILEY, Ph.D.

Introduction

Q. Please state your full name and business address.

A. My name is William H. Bailey. My address is 17000 Science Drive, Suite 200, Bowie, MD.

Q. By whom are you employed and in what capacity?

A. I am a Principal Scientist in the Health Sciences practice and Director of the Center for Exposure Assessment & Dose Reconstruction at Exponent. I also am a visiting research scientist at the Cornell University Medical College in New York.

Q. What is Exponent?

A. Exponent is a scientific and engineering firm comprised of scientists, physicians, engineers, and regulatory professionals that performs in-depth scientific research and analysis in over 90 scientific and engineering disciplines.

Within Exponent, the scientists of the Health Sciences practice have training and expertise in epidemiology, cell and cancer biology, medicine, public health, physiology and pharmacology, and toxicology.

Q. Please describe your current responsibilities.

A. I work primarily in the assessment of environmental and occupational exposures and their relationship to health. My work involves reviewing, analyzing, and conducting research. One of the areas in which I have done a great deal of work relates to assessments of the

electric and magnetic fields (EMF) associated with electrical facilities, such as transmission lines, substations, and electrified railroad lines.

Educational Background and Experience

Q. Please describe your educational background, research experience, and professional degrees you have been awarded.

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

Q. Have you served as a reviewer and scientific advisor on health-related issues for government or scientific agencies? If so, please describe.

A. Yes. I review research for the National Institutes of Health, the National Science Foundation, and other government agencies. Regarding transmission lines specifically, I served on a Scientific Advisory Panel convened by the Minnesota Environmental Quality Board to review health aspects of a high-voltage transmission line. In addition, I have served as a consultant on transmission line health and safety issues to the Vermont

Department of Public Service, the New York State Department of Environmental Conservation, the staffs of the Maryland Public Service Commission and the Maryland Department of Natural Resources, and the province of Prince Edward Island, Canada. I also have worked with the National Institute of Occupational Health and Safety, 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. What are electric and magnetic fields?

A. Electric and magnetic fields associated with the operation of alternating current (AC) power lines or devices are often referred to as EMF. Voltage, which is similar to 'pressure,' moves the electricity through wires and produces an electric field. The standard unit for measuring the strength of an electric field is "volts per meter," abbreviated as V/m. Current, which is a measure of how much electricity is flowing,

produces a magnetic field. The unit in which magnetic field levels are measured is "milligauss," abbreviated as mG. Electric and magnetic fields are characterized by the frequency at which their direction and magnitude oscillate each second. The fields produced by the use of electricity in North America oscillate at a frequency of 60 cycles per second (60 Hertz [Hz]). Both electric and magnetic fields decrease relatively quickly with distance from their source.

Q. What are typical sources of 60-Hz electric and magnetic fields?

A. Typical sources of these fields include power lines (both transmission and distribution lines), home and office appliances, tools, building wiring, and current flowing on water pipes. The contribution of these sources to overall exposure varies considerably. For example, if a residence is very close to a transmission line, or even a distribution line (which runs near most everyone's residence), these sources could be the dominant, but not necessarily the only, source of magnetic fields in the home. Depending on the circumstances, other sources may be of equal or greater importance. For example, a random survey of nearly 1,000 residences in the U.S. reported that currents flowing on water pipes and on other components of grounding systems are twice as likely as outside power lines to be the source of the highest magnetic fields measured in homes (Zaffanella, 1993).

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 over 25 years. My research has included laboratory, exposure assessment and dosimetry, and epidemiologic studies of EMF across a range of frequencies, including those associated with power systems.

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

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

Q. Are you a member of any professional organizations?

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

Q. Is your educational and professional experience summarized elsewhere?

A. Yes. Additional details of my educational and professional experience are summarized in my curriculum vitae, which is attached as WHB-1.

Q. Have you previously testified before Rhode Island's Energy Facility Siting Board (EFSB) or the Public Utilities Commission?

A. Yes, on several occasions. Most recently, I testified before the EFSB on electric and magnetic field issues relating to the Southern Rhode Island Transmission Project.

Scope of Testimony

Q. What is the purpose of your testimony?

A. The primary purpose of my testimony is to introduce our review and summary of the status of health research regarding EMF exposure (Exponent, 2008)[1] and our calculations of EMF and audible noise (AN) associated with the operation of existing and proposed transmission lines along the route of the Rhode Island Reliability Project (Exponent, 2008a,b)[2], which are attachments WHB-2 and WHB-3 to this testimony. As before, EMF refers to fields with frequencies in the extremely low frequency range (60 Hz), produced by appliances, devices and power lines connected to utility power sources.

Q. How will the addition of a 345-kV line and the reconfiguration of existing 115-kV lines that are part of the Rhode Island Reliability Project affect EMF levels?

A. EMF levels associated with the 115-kV and 345-kV lines along the right-of-way between the West Farnum Substation and the Kent County Substation were modeled for eight representative cross sections. The field levels will be highest on the right-of-way and diminish with distance from the conductors. Because the new 345-kV line will be constructed at the center of the right-of-way it will produce only marginal increases or decreases in the EMF levels produced by the 115-kV and 345-kV existing lines.

[1] Exponent. Electric and Magnetic Field Research Update: Rhode Island Reliability Project, August 8, 2008 *(Appendix B to Environmental Report – Volume 1).*

[2] Exponent. Rhode Island Reliability Project: Electric and Magnetic Field Modeling, May 19, 2009; Addendum, May 26, 2009.

The highest electric field levels at the edge of the right-of-way are found on a short segment of the route from mile 18.31 to 18.44 just north of Providence Street.[3] The electric field associated with the operation of the existing transmission lines on the west edge of this section of right-of-way is 3.84 kV/m; the electric field associated with the proposed condition is 3.80 kV/m. The electric field levels at the edges of other cross sections are lower—less than 1.94 kV/m under existing or future conditions.

Magnetic field levels were calculated at expected annual average loading (AAL) and annual peak loading (APL) in 2012 (pre-NEEWS) and 2012 and 2017 (post-NEEWS). The AAL is emphasized here because it provides the best estimate of 'typical' potential magnetic field exposures.

Again, the highest field levels at the edge of the right-of-way are expected just north of Providence Street.[3] The magnetic field level associated with the existing lines in 2012 pre-NEEWS under AAL conditions at the western edge of the right-of-way is modeled to be 47.9 mG; following completion of the Project in 2012 (post-NEEWS) and 2017 it will be less than 34.7 mG. For a limited period of time during the year (a few hours on a few days) when peak load demand occurs, the modeled magnetic fields are higher. For the same cross section near Providence Street, the pre-NEEWS magnetic fields at APL would be 17.1 mG higher than than at AAL and the post-NEEWS magnetic fields would be less than 10.8 mG higher than at AAL. The magnetic field levels on other cross

[3] Figure 4-2, Sheet 3 of 5 in Application and identified as Cross section 5 [XS-5] in Exponent's reports.

sections are lower than this cross section at both AAL or APL, and the differences between pre- and post-NEEWS values are smaller.

Q. Will the new 345-kV line and the reconfiguration of existing 115-kV lines lead to an increase in noise?

A. The partial electrical breakdown of the air surrounding the conductors of higher voltage overhead transmission lines may be perceived as AN. This AN can be characterized as a hissing, crackling sound that may be accompanied by a 120-Hz hum during times of heavy precipitation. Transmission line conductors are designed to be free of AN during fair weather but wetting of the conductors during periods of rain, fog, snow, or ice, and debris increase AN. The change in AN levels associated with the addition of the 345-kV line was calculated to be very low in fair weather (with levels well below quiet ambient background) and higher during foul weather. However, background noise levels also increase during foul weather (rain hitting the ground, trees rustling, etc.), which likely masks the increase in AN from the lines.

Q. National Grid has proposed some minor changes to the configuration of the 23-kV circuits 2227 and 2230. Does this materially affect the levels of EMF and AN presented in the Application?

A. No, but Exponent updated calculations for those cross sections affected by the design changes (XS-3, XS-5, XS-6, XS-7) in the May 26, 2009 Addendum (Attachment WHB-3). On the eastern side of the right-of-way closest to these circuits, the magnetic field levels will be lower on XS-3, XS-5, and XS-7 but higher for XS-6, where the post-

NEEWS levels in 2012 and 2017 will be ~12 mG above the previous estimates. The electric field levels on the eastern side of the right-of-way post-NEEWS will all be slightly lower, and electric field levels unchanged on the western side as a result of the design changes. The design changes will not change the calculated EMF values at the western edge of the right-of-way or AN values on either side of the right-of-way from those presented in the Application.

Q. Are there any Rhode Island or federal standards that address EMF from transmission lines based on health considerations?

A. No state or federal standards have been enacted to limit exposure to EMF based on health effects. Two states, Florida and New York, have enacted standards to limit magnetic fields from transmission lines at the edge of the right of way to maintain the "status quo" so that fields from new transmission lines would be no higher than fields produced by existing transmission lines. These limits are 200 mG (for 500-kV lines) and 2 kV/m in Florida, and 200 mG and 1.6 kV/m in New York (FDER, 1989; FDEP, 1996; NYPSC, 1978; NYPSC, 1990).

Q. Have any international agencies or other organizations recommended EMF exposure limits based on established effects on human health and safety?

A. Yes, like anything else, as the level of exposure increases, adverse effects can be observed. At very high field levels, acute stimulation of nerves and muscles can result. Two international scientific organizations have published guidelines for exposure to EMF

to protect against such effects. The ICNIRP recommends screening values[4] of 833 mG and 4.2 kV/m for the public (ICNIRP, 1998). The 27 member countries of the European Union apply the ICNIRP recommendation "to relevant areas where members of the public spend significant time" (CEU, 1999).

The International Committee on Electromagnetic Safety (ICES) also recommends limiting magnetic and electric field exposures at high levels because of the risk of acute effects, although their guidelines are higher than ICNIRP's guidelines at 60 Hz. The ICES recommends public exposure screening values[4] of 9,040 mG and 5 kV/m, respectively (ICES, 2002). These agencies have set the screening values and basic restrictions far below exposure levels at which neurostimulatory effects might occur to account for uncertainty and variation in possible responses.

Q. Will the modeled EMF levels outside the right-of-way be below the exposure guidelines recommended by these international organizations?

A. Yes. Additional discussion of standards and guidelines is provided in section 4 of Appendix B to the Environmental Report – Volume 1.

Q. Some Internet sites and scientific publications discuss the possibility that long-term exposures to magnetic fields might be associated with health risks, including cancer. Have scientists also evaluated this possibility?

A. Yes. Because EMF exposure is so ubiquitous, this possibility has been the subject of considerable research over the past 30 years. The results of this research have been

[4] Exposures above screening values are permitted if the underlying current density or electric field within critical tissues, i.e., the basic restriction, is not exceeded.

comprehensively evaluated by national and international scientific and health agencies using weight-of-evidence methods.[5] Quite a number of weight-of-evidence evaluations have been published over the past ten years by national and international scientific health agencies. Four of these reviews deserve special mention because they are relatively recent and comprehensive. The National Institute of Environmental Health Sciences (NIEHS) published, "Health Effects from Exposure to Power-Line Frequency Electric and Magnetic Fields," in 1999. This was followed in 2002 by the publication of "Static and Extremely Low Frequency (ELF) Electric and Magnetic Fields," by the International Agency for Cancer Research (IARC) and, in 2004, the publication of "Review of the Scientific Evidence for Limiting Exposure to Electromagnetic Fields (0-300 Hz)," by the National Radiological Protection Board (NRPB) of Great Britain. Most recently, the World Health Organization (WHO) released an evaluation of the research literature through 2005 in the publication "Extremely Low Frequency Fields Environmental Health Criteria Monograph No. 238," released in 2007. The conclusions of these agencies are all quite similar.

Q. What was the WHO's conclusion regarding EMF and health?

A. In particular, the WHO states:

> Acute biological effects [i.e., short-term, transient health effects such as a small shock] have been established for exposure to ELF electric and magnetic fields in the frequency range up to 100 kHz that may have adverse consequences on health. Therefore, exposure limits are

[5] A weight-of-evidence evaluation is based on a comprehensive assessment of all the relevant scientific research, which includes epidemiologic and experimental studies of humans, experimental studies in animals (*in vivo*) and experimental studies in isolated cells and tissues (*in vitro*) and takes into account the strengths and weaknesses of the research.

> needed. International guidelines exist that have addressed this issue. Compliance with these guidelines provides adequate protection. Consistent epidemiological evidence suggests that chronic low-intensity ELF magnetic field exposure is associated with an increased risk of childhood leukaemia. However, the evidence for a causal relationship is limited, therefore exposure limits based upon epidemiological evidence are not recommended, but some precautionary measures are warranted (p. 355, WHO 2007b).

Q. Are the WHO and other agencies suggesting that there is a confirmed cancer risk from magnetic field exposure?

A. No, just the possibility of a risk. The overall conclusion of the 446-page WHO report was that the scientific evidence was inadequate to conclude that there is a statistical association between EMF and any cancer, with the exception of childhood leukemia, where a statistical association has been observed with higher levels of estimated time-weighted average (TWA) magnetic field exposure, i.e., > 3-4 mG. The current scientific consensus, however, is that the cumulative body of research does not support the conclusion that the statistical association observed in these epidemiologic studies is causal in nature.

Q. Does additional EMF research published after the WHO report suggest that the WHO conclusions should be changed?

A. This possibility was evaluated in Exponent's review of new human health epidemiology studies published through June 2008, as summarized in Appendix B to the Environmental Report - Volume 1. In addition, consideration was given to subsequent studies published in the past year. Altogether, a cumulative assessment of the scientific evidence published prior to and since the WHO report still just provides limited evidence for the statistical

association noted by the WHO in its review and inadequate evidence from experimental research. Recent epidemiologic research continues to observe an association with estimated high exposures to magnetic fields and childhood leukemia, but experimental research has not identified any clear supporting evidence for a risk of cancer (including leukemia) associated with very high and continuous magnetic field exposures. More recent reviews from other scientific agencies have arrived at similar conclusions (HCN, 2008; SSI, 2008). Research will continue to clarify the meaning of the observed statistical association with childhood leukemia.

Q. Did the WHO or other heath agencies make any policy recommendations that are relevant to this project?

A. Yes. The NIEHS, for example, states "No regulatory action was recommended by or taken based on the NIEHS report….it suggested that power companies and utilities 'continue siting power lines to reduce exposures and … explore ways to reduce the creation of magnetic fields around transmission and distribution lines without creating new hazards'" (p. 52, NIEHS, 2002). Similarly, the WHO recommends in a recent fact sheet, "When constructing new facilities … low-cost ways of reducing exposures may be explored. Appropriate exposure reduction measures will vary from one country to another. However, policies based on the adoption of arbitrary low exposure limits are not warranted" (WHO, 2007a).

Q. Did the WHO provide additional guidance as to its recommendations?

A. Yes. The three most relevant recommendations are:

- Provided that the health, social and economic benefits of electric power are not compromised, implementing very low-cost precautionary procedures to reduce exposures is reasonable and warranted.
- Policy-makers and community planners should implement very low-cost measures when constructing new facilities and designing new equipment including appliances.
- Changes to engineering practice to reduce ELF exposure from equipment or devices should be considered, provided that they yield other additional benefits, such as greater safety, or involve little or no cost (WHO, 2007b, p. 372).

Q. Is National Grid's approach of minimizing the potential for greater EMF exposure from this project consistent with the above recommendations?

A. Yes. National Grid has proposed to construct the 345-kV lineat the center of an existing right-of-way, which increases the distance to the edge of the right-of-way and reduces the possibility of measuring higher EMF in new areas. National Grid has also proposed to optimize the phasing configuration of the new 345-kV and rebuilt 115-kV lines so as to minimize the fields outside the right-of-way by promoting the mutual cancellation of fields from all of the lines.

Q. Does this conclude your testimony?

A. Yes.

References

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ATTACHMENTS

WHB-1 Curriculum Vitae of William H. Bailey, Ph.D.

WHB-2 Rhode Island Reliability Project: Electric and Magnetic Field Modeling (May 19, 2009)

WHB-3 Rhode Island Reliability Project: Electric and Magnetic Field Modeling, Addendum to Report (May 26, 2009)