STATE OF RHODE ISLAND AND PROVIDENCE PLANTATIONS
ENERGY FACILITY SITING BOARD

In re The Narragansett Electric Company	:	
d/b/a National Grid and Clear River Energy LLC	:	Docket No. SB 2017-01
(Burrillville Interconnection Project)	:	

Pre-Filed Testimony of

William H. Bailey, Ph.D.

In support of the Joint Application of

The Narragansett Electric Company d/b/a National Grid

and

Clear River Energy LLC

August 24, 2018

EXECUTIVE SUMMARY

William Bailey, Ph.D. is a Principal Scientist in the Center for Occupational and Environmental Health Risk Assessment Department at Exponent, Inc. (“Exponent”) and testifies regarding the electric and magnetic field (“EMF”) analysis conducted for the Burrillville Interconnection Project (“Project”). Specifically, he testifies regarding Exponent’s modeling of the EMF associated with the new 345 kV transmission line. Mr. Bailey, relying on his experience and expertise, the application, the relevant literature and national health agency reviews, and EMF modeling prepared by Exponent, opines that the EMF levels from the Project are well below international guideline limits.

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 business 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 at Exponent, Inc. ("Exponent").

Q. What is Exponent?

A. Exponent is a scientific and engineering firm comprised of scientists, physicians, engineers, and regulatory professionals who perform 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 extremely low frequency ("ELF") electric and magnetic fields ("EMF") associated with electrical facilities, such as transmission lines, substations, and electrified railroad lines.

<u>Educational Background and Experience</u>

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 M.B.A. from the University of Chicago, awarded in 1969. From 1986 to 2012 I was a visiting scientist at the Cornell University Medical College. I also lectured on topics in the field of bioelectromagnetics 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 have reviewed research for the National Institutes of Health, the National Science Foundation, and other federal 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 EMF 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.

Internationally, I have worked with scientists from the World Health Organization ("WHO") on EMF risk assessment and the International Agency for Research in Cancer, a division of the WHO located in Lyon, France, in the review of possible hazards from exposures to static and ELF EMF. Most recently, I was an advisor to the Federal Office for Radiation Protection in Germany on health and safety issues relating to EMF from new proposed transmission lines.

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

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

A. Yes. I have published more than 60 scientific papers and technical reports 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 (ELF and Radiofrequency 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 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 to this testimony as Attachment WHB-1.

Q. Have you previously testified before Rhode Island's Energy Facility Siting Board ("EFSB")?

A. Yes, on a number of occasions. Most recently, I submitted testimony to the EFSB regarding the Clear River Energy Center in Docket SB 2015-06 that also relates to the transmission lines proposed in this docket and I testified before the EFSB on EMF issues

relating to the Aquidneck Island Reliability Project (Docket SB 2016-01), Interstate Reliability Project (Docket SB 2012-01), and Rhode Island Reliability Project (Docket SB 2008-02).

Q. What are electric and magnetic fields?

A. Electric and magnetic fields associated with the operation of alternating current 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 (V/m) or kilovolts per meter (kV/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 (mG). Both electric fields 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”]). The strength of both electric fields 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 contributors to, but

not necessarily the only, sources of magnetic fields in the home. Depending on the circumstances, other sources may be of equal or greater importance. For example, a survey of nearly 1,000 randomly selected residences in the United States 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).

Scope of Testimony

Q. What is the purpose of your testimony?

A. The primary purposes of my testimony are to present the calculations of EMF associated with the operation of existing and proposed transmission lines along the route of the Burrillville Interconnection Project ("Project") and to introduce Exponent's review and summary of the status of health research regarding EMF exposure as required by EFSB Rules. The calculations of electric fields and magnetic fields before and after the Project are included in Tables 8-3 through 8-7 of the Environmental Report. Exponent's summary of the current status of research on EMF health effects was filed as Appendix A in Volume 3 of National Grid's Environmental Report filed with the EFSB.

Q. What changes to the transmission system were modeled?

A. Exponent modeled the magnetic-field levels and electric-field levels associated with the proposed 3052 Line and the existing 341 and 347 345-kilovolt ("kV") transmission lines. Magnetic-field levels were calculated for the existing and proposed conditions for the three segments of the Project route.

Q. Please identify the specific route segments of the Project route for which pre-construction EMF levels from existing transmission lines were compared to post-construction EMF levels after Project completion.

A. EMF levels were modeled for pre- and post-Project conditions for the 250-foot wide CREC ROW (XS-1), the 300-foot wide section of the TNEC ROW (XS-2), and the 500-foot wide section of the TNEC ROW (XS-3).

Q. For what loading of the proposed 3052 transmission line were magnetic-field levels calculated?

A. The modeling assumed that the proposed 3052 Line was operating at full capacity which is 1046 Mega Volt Amperes for all route sections. In sections XS-2 and XS-3 on the TNEC ROW, the direction of load flows on the transmission lines affects the interaction of the magnetic fields between adjacent transmission lines and so magnetic fields were modeled for power flow on the 341 and 347 Lines from east to west and west to east as may occur during certain times of the year. For both modeling scenarios, the power on the 3052 Line was modeled going west to east (from CREC to the Sherman Road Switching Station).

Q. What loadings were assumed for the 341 and 347 Lines on the TNEC ROW?

Magnetic-field levels from these lines on the TNEC ROW were calculated at expected annual average loading ("AAL") pre-construction and post-construction. The AAL is emphasized here because it provides the best estimate of typical potential magnetic-field exposures on any randomly selected day of the year. Magnetic-field levels were also

calculated at expected annual peak loading ("APL") pre-construction and post-construction. When peak load demand occurs, for a limited time during the year (a few hours on a few days), the modeled magnetic fields are typically higher.

Q. Did Exponent analyze the effect of different phasings of the proposed 3052 Line on the magnetic-field levels at the edges of the TNEC ROW?

A. Yes. Exponent identified a phasing that would minimize magnetic field levels at the edges of the ROW and National Grid and CREC selected that phasing for their conceptual design of the proposed 3052 Line on the sections of the TNEC ROW where it is adjacent to other transmission lines. The optimal phasing for the 3052 Line was determined to be A-B-C (from south to north).

Q. What will be the effect of the Project on magnetic field levels compared to pre-construction values?

A. The greatest increase in the magnetic field can be expected on section XS-1 within the CREC property because there are no existing power lines on the property. On the TNEC ROW for power flows from west to east or vice versa, the increase in the magnetic field is greater in section XS-2 where Line 3052 is closer to the southern edge[1] of the ROW and the ROW is narrower than section XS-3. At peak loading for power flows in either direction, increases or decreases (mostly) in the magnetic field at ROW edges from levels calculated at AAL were quite small in both sections XS-2 and XS-3. All magnetic-field levels at the edges of the ROW, both pre- and post-construction, are calculated to be far

[1] Labeled as the (-) ROW edge in Tables 8.3 through 8.7.

below the magnetic-field Reference Levels recommended by the International Committee on Electromagnetic Safety ("ICES") and the International Commission on Non-ionizing Radiation Protection ("ICNIRP").

Q. Will the Project lead to an increase in the electric fields?

A. Yes, there is an increase along the edges of the new CREC ROW. On the TNEC ROW the electric fields post-construction will be similar to those produced by the existing 345-kV lines. All calculated electric-field levels at the edges of the ROW are well below the screening values recommended by ICES and ICNIRP.

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

A. No state or federal standards have been enacted to limit exposure to EMF based on any finding that either electric fields or magnetic fields have adverse health effects. Specifically, Rhode Island has not implemented any EMF exposure limits and has not made a determination that EMF is a cause of any adverse health effects. Decades ago, two states, Florida and New York, enacted standards to limit magnetic fields from transmission lines at the edge of the ROW to maintain the status quo so that fields from new transmission lines would be no higher than fields produced by existing transmission lines. The magnetic-field limits in Florida are 200 mG (for 500-kV lines) and 150 mG (for ≤230-kV lines), and the electric field limit is 2 kV/m (for ≤500-kV lines) (FDEP, 1993). In New York the electric-field and magnetic-field limits are 1.6 kV/m and 200 mG, respectively (NYPSC, 1978; NYPSC, 1990).

Q. Have any internationally-recognized expert organizations recommended EMF exposure limits based on established effects on human health and safety?

A. Two international scientific organizations, which are noted above, have published guidelines for exposure to EMF. They conducted comprehensive reviews of the literature to determine the lowest biological thresholds at which any adverse effects have been established. They determined that the adverse effects with the lowest biological thresholds are acute stimulation of nerves and muscles. Then, they set limits at levels of exposure far below those thresholds. ICNIRP recommends screening values[2] for the public of 2,000 mG for magnetic fields and 4.2 kV/m for electric fields (ICNIRP, 2010). The 28 member countries of the European Union apply the ICNIRP recommendation "to relevant areas where members of the public spend significant time" (CEU, 1999). ICES also recommends limiting EMF exposures at high levels to prevent acute effects, although their screening values are higher than ICNIRP's at 60 Hz. The ICES recommends public exposure screening values of 9,040 mG for magnetic fields and 5 kV/m (10 kV/m on ROWs) for electric fields (ICES, 2002/2007). These agencies have set these screening values and the underlying basic restrictions on internal electric fields far below exposure levels at which neurostimulatory effects might occur to account for uncertainty and variation in possible responses. Compliance with these screening values, called Reference Levels by ICNIRP and maximum permissible exposure ("MPE") levels by ICES, assure compliance with the underlying exposure limits known as Basic

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

Restrictions. Exposures to field levels above these screening levels are permitted if calculations for the exposure scenario of interest show that the Basic Restrictions are not exceeded. No adverse health effects were confirmed below these values.

Q. Please summarize the conclusions of the survey of current health research which Exponent prepared (Appendix A of Volume 3 of the Environmental Report and Attachment WHB-2 hereto).

A. Our 2015 report presented a systematic literature review and a critical evaluation of epidemiology and *in vivo* studies published after the WHO report in 2007. The studies reviewed did not provide sufficient evidence to alter the basic conclusion of the WHO that the research overall does not indicate that electric fields or magnetic fields are a cause of cancer or any other disease. The WHO, however, does recommend that nations adopt the science-based limits of ICNIRP and ICES to prevent short-term neurostimulatory effects, as previously described, that might occur at levels far higher than we encounter in our everyday environments.

Q. Since the date of the Exponent review in 2015, have there been major new studies or reviews published that would prompt you to revise its conclusions?

A. The most recent review of the literature is still the 2015 review by the Scientific Committee on Emerging and Newly Identified Health Risks that was discussed in Exponent's 2015 review (SCENIHR, 2015). As in other areas of science, research in this field is ongoing, but there have been no major new developments. A 2016 evaluation by a research consortium (ARIMMORA) funded by the European Union concluded that

recent research results have not provided new evidence that would change the overall conclusions of the IARC in 2001 (Schüz et al., 2016). Some notable recent studies that have appeared since the 2015 Exponent review include epidemiologic studies of childhood cancer published from the United States (Crespi et al., 2016; Amoon et al., 2018), China (Zhang et al., 2016), Denmark (Pedersen et al., 2015), Italy (Magnani et al., 2014; Salvan et al., 2015), and the United Kingdom (Bunch et al., 2015, 2016; Swanson and Bunch 2018); as well as a Nordic study of adult leukemia (Talibov et al., 2015); studies of neurodegenerative diseases from Sweden (Fischer et al., 2015), the United States (Vergara et al., 2015), the Netherlands (Koeman et al., 2015; Brouwer et al., 2015), and Switzerland (Huss et al., 2015); and a study of reproductive and developmental effects from Finland (Eskelinen et al., 2016).

The large epidemiologic study of childhood cancer in California reported by Crespi et al. (2016) included 5,788 childhood leukemia cases and 3,308 childhood brain cancer cases. The authors reported no statistically significant associations for any of the cancer outcomes with residential proximity to high-voltage overhead power lines (60 kV to 500 kV). A pooled analysis by Amoon et al. (2018) combined data from 11 international epidemiology studies to assess the association between childhood leukemia and distance to overhead power lines. The analysis found no material association with distance to the nearest overhead power line of any voltage, and no association with calculated magnetic fields. A meta-analysis by Zhang et al. (2016) combined epidemiologic studies of all types of cancer, including studies of adult and childhood cancers; however, since various

adult and childhood cancers have very different etiologies and biological mechanisms, it is scientifically not defensible to expect that any specific exposure will have an identical effect on the risk of all types of cancers. This renders the study's main results mostly meaningless, or difficult to interpret at best. The Danish study of childhood cancers by Pedersen et al. (2015) included 1,536 leukemia, 1,324 central nervous system, and 417 malignant lymphoma cases. The authors reported statistically non-significant associations between the three types of cancers, separately and combined, and estimated exposures greater than 0.4 microtesla (μT) [4 mG] compared to less than 0.1 μT [1mG]. A study of childhood leukemia from Italy that included 412 cases (Magnani et al., 2014; Salvan et al., 2015) found no consistent exposure-response patterns across multiple analyses evaluating various metrics for magnetic-field exposure. The British researchers provided updated analyses to their earlier studies discussed in the Exponent report (Bunch et al., 2015, 2016; Swanson and Bunch 2018). The new analyses provided no support for an association for any of the investigated childhood cancers with either distance from transmission lines or estimated magnetic-field levels, including when the analyses were repeated with finer distance categories (Swanson and Bunch 2018). The Nordic study on acute myeloid leukemia ("AML") and occupational exposure to ELF EMF and electric shocks included 5,409 cases from Finland, Iceland, Norway, and Sweden (Talibov et al., 2015). The study found no association between AML and exposure either in men or women. The Swedish (Fischer et al., 2015) and United States (Vergara et al., 2015) studies reported results of a population-based case-control study of

occupational exposure to electric shocks and magnetic fields and amyotrophic lateral sclerosis ("ALS"). Overall, neither of the two studies reported an association between EMF and ALS. Brouwer et al. (2015) and Koeman et al. (2015) examined the occurrence of Parkinson's disease and dementia in a cohort of 120,000 followed for almost 30 years. No statistically significant trends or consistent associations were reported for any of the reported outcomes in association with estimated occupational EMF exposure. A meta-analysis by Huss et al. (2015) combined the results from 11 studies reporting risk estimates of Parkinson's disease in workers' exposure to ELF magnetic fields and found that overall, there was no evidence that exposure increased the risk of Parkinson's disease. The Finnish study of residential exposure to magnetic fields and reproductive and developmental effects found that none of the metrics used to assess EMF exposure were statistically associated with measures of fetal growth or time to pregnancy (Eskelinen et al., 2016).

In summary, the results of these and other recently published studies do not change the overall assessment and conclusions expressed in the WHO and SCENIHR reports.

Q. Has National Grid continued its approach to minimize the potential for EMF exposure from this Project consistent with recommendations of the National Institute of Environmental Health Sciences (NIEHS, 2002) and the WHO (2007a, 2007b)?

A. Yes. National Grid has proposed to construct the proposed 3052 Line with an optimized phasing configuration to minimize the fields outside the ROW by promoting the mutual cancellation of fields from the lines.

Q. Are you familiar with the advisory opinion to the EFSB from the Rhode Island Department of Health on March 15, 2018 that commented on Exponent's report?

A. Yes, I am.

Q. Did the Department of Health make any recommendations in this Advisory Opinion to minimize magnetic fields in addition to those already incorporated by National Grid into the Project's siting and design?

A. No, it did not. The Rhode Island Department of Health concluded that the "electromagnetic fields associated with the proposed Project will have negligible or no impact on public health."

Q. Did the Department of Health note that the maximum electric field on the ROW would be higher than the ICNIRP Reference Level?

A. Yes.

Q. Does this mean that the recommended limit for exposure of general public to electric fields would be exceeded on the Project ROW?

A. No. As ICNIRP's guideline states:

> If the measured or calculated value exceeds the reference level, it does not necessarily follow that the basic restriction will be exceeded. However, whenever a reference level is exceeded it is necessary to test

> compliance with the relevant basic restriction and to determine whether additional protective measures are necessary (ICNIRP, 2010, p. 825).

Q. Would exposures to electric fields on the ROW exceed ICNIRP's recommended limit for exposure of the general public to electric fields?

A. No. The recommended limit is the Basic Restriction. According to calculations published by Kavet et al. (2012) based on current dosimetry, the external electric field that would produce an electric field within the central nervous system equal to the Basic Restriction when the external exposure is 36.4 kV/m. And ICNIRP states "the electric field reference levels for general public exposure up to 50 Hz include a sufficient margin to prevent surface electric-charge effects such as perception in most people." (ICNIRP, 2010, p. 827). Moreover, the International Committee for Electromagnetic Safety's MPE which is its term for Reference Level, explicitly allows electric field exposures of the general public up to 10 kV/m on transmission line rights-of-way (ICES, 2002/2007).

Q. So, do you have a concern about public access to the TNEC ROW?

A. No. The EMF levels on the TNEC ROW are well below those that would cause the Basic Restrictions in these standards to be exceeded.

Q. Does this conclude your testimony?

A. Yes.

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ATTACHMENTS

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

WHB-2 Current Status of Research on Extremely Low Frequency Electric and Magnetic Fields and Health: Rhode Island Transmission Projects – The Narragansett Electric Company d/b/a National Grid. March 9, 2015 (Appendix A to Environmental Report).