

**THE STATE OF NEW HAMPSHIRE
BEFORE THE
SITE EVALUATION COMMITTEE
DOCKET NO. 2015-04**

PRE-FILED DIRECT TESTIMONY OF WILLIAM H. BAILEY

**APPLICATION OF PUBLIC SERVICE COMPANY OF NEW HAMPSHIRE
D/B/A EVERSOURCE ENERGY
FOR A CERTIFICATE OF SITE AND FACILITY FOR CONSTRUCTION OF A
NEW 115 kV TRANSMISSION LINE**

THE SEACOAST RELIABILITY PROJECT

April 12, 2016

1 **Qualifications and Purpose of Testimony**

2 **Q. Please state your name and business address.**

3 A. My name is William H. Bailey. I am employed by Exponent, Inc.
4 (Exponent), a scientific and engineering firm, located in the Maryland Science and
5 Technology Center at 17000 Science Drive, Suite 200, Bowie, Maryland, 20715.

6 **Q. What is your position at Exponent?**

7 A. I am a Principal Scientist in the Center for Occupational and
8 Environmental Health Risk Assessment.

9 **Q. Please describe your current responsibilities.**

10 A. My practice specializes in the health sciences and, more specifically, in
11 human exposure and risk assessment. My work involves reviewing, analyzing, and
12 conducting health research. Much of my work relates to the exposures and potential
13 biological, environmental, and health effects associated with electrical facilities, such as
14 transmission lines and substations, and with electrified railroad lines, including the
15 possible effects of electric and magnetic fields (“EMF”). In the course of this work, I
16 work with and supervise professionals in diverse health, engineering, and environmental
17 practices, mentor junior scientists and engineers, and direct scientific research and data
18 collection.

19 **Education and Experience**

20 **Q. Please summarize your education and academic research and**
21 **teaching experience.**

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

1 Rockefeller University in New York City. My *curriculum vitae* is attached as Attachment
2 A.

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

4 A. Yes. I am a member of the Rockefeller University Chapter of Sigma XI, a
5 national scientific honor society; the Health Physics Society; the International Committee
6 on Electromagnetic Safety (ICES), Subcommittees 3 and 4 – Safety Levels with Respect
7 to Human Exposure to Fields; the Bioelectromagnetics Society; the Engineering in
8 Medicine and Biology Society of the Institute of Electrical and Electronics Engineers
9 (IEEE); the Conseil International des Grands Reseaux Electriques; the American
10 Association for the Advancement of Science; the New York Academy of Sciences; the
11 Society for Neuroscience; the Society for Risk Analysis; and the International Society for
12 Exposure Analysis.

13 **Q. Have you served as a reviewer and scientific advisor on health-related
14 issues for state and federal agencies or scientific organizations?**

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

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

30 I worked with scientists from 10 countries to evaluate possible hazards from
31 exposures to static and extremely low frequency (ELF) EMF for the International Agency

1 for Research in Cancer (IARC), a division of the World Health Organization (WHO)
2 located in Lyon, France. I also was an invited participant in the workshop convened by
3 the International Committee on Non-Ionizing Radiation Protection (ICNIRP) to update
4 guidelines for human exposures to alternating current (AC) EMF. I have participated in
5 peer reviews of ICNIRP's draft guidelines for direct current and AC magnetic fields that
6 were submitted by the ICES.

7 Most recently, I have served as an advisor to government agencies in Canada and
8 the Netherlands on topics relating to scientific research on EMF health and safety and
9 have peer reviewed a "Preliminary Opinion on Potential Health Effects of Exposure to
10 Electromagnetic Fields" that was submitted by a committee of the European Commission
11 for comment prior to issuing its final opinion in 2015.

12 **Q. Have you published or presented your research in**
13 **bioelectromagnetics and other areas to the scientific community?**

14 A. I have published or presented more than 50 scientific papers on EMF and
15 related subjects. These publications and presentations are listed in my *curriculum vitae*,
16 attached as Attachment A.

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

18 A. Yes. I have appeared before state, provincial, and national regulatory
19 agencies to summarize the status of research on EMF at the request of applicants as well
20 as these agencies. I have also submitted pre-filed testimony in two proceedings presently
21 before the NH Site Evaluation Committee, the Merrimack Valley Reliability Project and
22 the Northern Pass Transmission Project.

23 **Purpose of Direct Testimony**

24 **Q. What is the purpose of your direct testimony?**

25 A. The purpose of my direct testimony is to provide the Site Evaluation
26 Committee with an assessment of the EMF associated with the operation of the proposed
27 Seacoast Reliability Project ("SRP" or the "Project") and to offer the opinion that, to a
28 reasonable degree of scientific certainty, the EMF associated with the operation of the
29 Project will not be harmful to human health and, therefore, will not result in an
30 unreasonable adverse effect on public health and safety.

1 **Q. What is the scope of your assessment?**

2 A. I reviewed the levels of EMF on the proposed route as described in the
3 *Electric and Magnetic Field Summary, Seacoast Reliability Project*, as prepared by
4 Eversource, Appendix 41. The sources of EMF are the 115-kilovolt (kV) AC
5 transmission line between the Madbury Substation in Madbury, New Hampshire, and the
6 Portsmouth substation in Newington, New Hampshire, as well as the reconfigured 34.5-
7 kV AC distribution lines along the Project route. I evaluated the levels identified in the
8 *Electric and Magnetic Field Summary* in light of current health research, the consensus
9 evaluations of the scientific evidence by authoritative scientific and health agencies, and
10 relevant health and safety guidelines. My assessment includes the review and evaluation
11 of current research as summarized in the technical report, “Current Status of Research on
12 Extremely Low Frequency Electric and Magnetic Fields and Health – Seacoast
13 Reliability Project,” which is included in Appendix 40.

14 **Summary of Assessment Relevant to Proposed Transmission Lines**

15 **Q. What methods did you use to conduct your assessment?**

16 A. The assessment included the review of the relevant scientific literature and
17 considered several streams of evidence. To begin, I identified and reviewed health risk
18 assessments and evaluations conducted by authoritative national and international health
19 and scientific agencies. These agencies have commissioned multidisciplinary panels of
20 scientists to review the scientific evidence on potential health effects of EMF. These
21 authoritative reviews provide reliable summaries of the current scientific knowledge and
22 serve as guidance to policy making and standard setting bodies. I also identified and
23 reviewed standards and scientifically-based exposure guidelines relevant to 60 Hertz (Hz)
24 EMF. I evaluated the predicted change in potential exposure to the population and
25 environment adjacent to the new Project that may be attributable to the new transmission
26 lines, and compared these levels to existing scientifically-based exposure guidelines.
27 Finally, I reviewed the results of a search of the relevant scientific literature to identify
28 recent research publications that may contribute new information to a weight-of-evidence
29 evaluation of potential effects of EMF.

30

1 **Q. What are electric and magnetic fields?**

2 A. Electric and magnetic fields are properties of a location in space where
3 electric charges can be influenced. The type of fields associated with the existing and
4 proposed power lines on the Project route oscillate at a frequency of 60 Hz as do the
5 fields produced by the operation of most other components of our electrical power grid.
6 EMF associated with electricity is often referred to as extremely low frequency (ELF) or
7 power-frequency EMF.

8 Electric fields are associated with voltage and are measured in volts per
9 meter (V/m) or kilovolts per meter (kV/m). Magnetic fields are associated with the flow
10 of electric current and are measured in milligauss (mG).¹ Both fields rapidly diminish
11 with distance from the source; however, while electric fields are easily blocked by
12 common objects (e.g., trees, bushes, buildings), magnetic fields are not.

13 **Q. What are sources of these fields, and what field levels may be**
14 **encountered in our daily environment?**

15 A. Anything that generates, transmits, or uses electricity is a source of EMF.
16 Common EMF sources in our homes, schools, workplaces and other locations (e.g.,
17 stores) include electrical appliances and tools, and the electrical wiring inside our
18 buildings. Outside sources include transportation equipment (e.g., trains and subways
19 operated by electricity) and electric transmission and distribution lines. Indoors, typical
20 magnetic-field levels in close proximity to appliances may reach several hundreds or
21 even thousands of mG. For example, median magnetic field values 6 inches from copy
22 machines, hair dryers, and electric can openers were reported as 90, 300, and 600 mG,
23 respectively, while the highest values measured from these appliances at the same
24 distance were 200, 700, and 1,500 mG, respectively.² Our daily exposure to EMF is
25 determined by the sources we encounter during the day, the duration of time we spend
26 near these sources, and our distance from the various sources. A systematic survey of the
27 general population in the United States indicated that, while there are big variations in

¹ Another commonly used unit for measuring magnetic fields is the microtesla; where 1 microtesla is equal to 10 mG.

² National Institute of Environmental Health Sciences (NIEHS). EMF Questions & Answers (NIH Publication 02-4493). Research Triangle Park, NC: NIEHS, 2002.

1 exposure during the day, the average daily magnetic-field exposure is approximately 1
2 mG.³

3 **Q. How does ELF EMF interact with the body?**

4 A. There are well established mechanisms that describe physical interactions
5 between ELF EMF and objects, including the human body. The tissues of the body are
6 well shielded from external ELF electric fields such that the electric field induced inside
7 the body is 100,000 to 1,000,000 smaller than the external electric field. Charges on the
8 surface of an ungrounded body from very strong external electric fields may result in
9 electric discharges, or micro-shocks when contacting grounded objects.

10 In contrast, ELF magnetic fields are not blocked by the body, but the voltages and
11 currents they induce in the body are very small. Stimulation of nerves is known to occur
12 by this process, but the level of magnetic field required is far higher than those produced
13 by electrical sources in our community or even by high-strength sources in workplaces.

14 Scientifically-established exposure guidelines have been developed to protect the
15 general public and workers from these effects of ELF EMF.

16 **Q. What are the exposure guidelines for ELF EMF?**

17 A. There are no federal guidelines or standards in the United States for 60-Hz
18 EMF. There is no guideline limiting levels of EMF from transmission lines or other
19 sources in New Hampshire. A handful of other states require that the levels of electric
20 fields from new transmission lines be below specified levels, and two states (Florida and
21 New York) require this for magnetic fields. The electric-field levels were set to minimize
22 the potential for electric discharges, and the magnetic-field levels were set to keep
23 magnetic fields from new lines at levels no higher than were produced by existing
24 transmission lines.

25 In contrast to the EMF limits administered by state agencies that regulate
26 transmission lines, two internationally-recognized agencies: ICNIRP and ICES (a
27 committee of the IEEE), have developed scientifically-based exposure guidelines from

³ Zaffanella LE and Kalton GW. Survey of Personal Magnetic Field Exposures. Phase II: 1,000-person Survey. EMF RAPID Engineering Project #6. Oak Ridge, TN: Lockheed Martin Energy Systems, Inc., 1998.

1 comprehensive reviews of the relevant literature.⁴ The guidelines developed by ICNIRP
2 for non-ionizing radiation are formally recognized by the WHO and recommended for
3 adoption by national authorities. The reviews performed by these organizations identified
4 potential adverse effects and then determined the exposure level at which these effects
5 are reported. Exposure guideline limits were set well below the exposure level where an
6 adverse effect was confirmed.

7 The ICNIRP limits were updated in 2010. For the general population, the
8 reference level for 60-Hz fields to ensure that the Basic Restriction (i.e., ceiling limit
9 values) is met is 4.2 kV/m for electric fields and 2,000 mG for magnetic fields. The
10 corresponding ICES limits, set in 2002, are 5 kV/m⁵ and 9,040 mG, which were
11 reaffirmed in 2007.

12 **Q. Have you reviewed the methods and EMF calculations provided by**
13 **Eversource for this Project? How do the calculated ELF EMF values for this**
14 **Project compare to these guideline values?**

15 A. I reviewed the Eversource methods and calculations for my assessment.
16 The magnetic-fields produced by the new and rebuilt lines at annual average load and
17 peak load are calculated to be well below the ICNIRP and ICES guideline EMF levels
18 corresponding to Basic Restrictions for exposure of the general public. The electric-fields
19 are also below the ICNIRP and ICES guideline values. At the edges of the transmission
20 right-of-way (“ROW”) above ground, the magnetic field along the route will vary
21 between 0.48 and 22.74 mG and the electric field will vary between 0.03 and 0.91 kV/m.
22 For the submarine cable, the calculated magnetic field 50 feet from the center submarine
23 cable is 31.43 mG.

⁴ International Committee on Electromagnetic Safety (ICES). IEEE Standard for Safety Levels with Respect to Human Exposure to Electromagnetic Fields 0 to 3 kHz. Piscataway, NJ: IEEE, 2002 (reaffirmed 2007); International Commission on Non-ionizing Radiation Protection (ICNIRP). Guidelines for limiting exposure to time-varying electric and magnetic fields (1 Hz to 100 kHz). Health Phys 99: 818-836, 2010.

⁵ An exception of 10 kV/m applies within transmission line rights of way because people do not spend a substantial amount of time there and very specific conditions are needed before a response is likely to occur (i.e., a person must be well insulated from ground and must contact a grounded conductor) (ICES, 2002, p. 27).

1 **Q. Have potential effects of ELF EMF been studied and considered at**
2 **levels below these guideline limits as well?**

3 A. Yes. A large amount of scientific research has been conducted since 1979
4 to examine potential long-term effects of ELF EMF on human health at levels below the
5 guideline limits. As the WHO expresses in its website “[d]espite the feeling of some
6 people that more research needs to be done, scientific knowledge in this area is now more
7 extensive than for most chemicals.”⁶ Thousands of scientific studies have been published
8 since 1979 in several scientific disciplines. These research studies include epidemiologic
9 studies (i.e., studies of human populations), laboratory studies of animals (*in vivo*
10 studies), and laboratory studies of tissues and cells (*in vitro*). The studies investigated the
11 potential effects of ELF EMF exposures from various sources (including both
12 occupational and residential sources) on both cancer and non-cancer outcomes among
13 children and adults. The proper scientific process for evaluating whether the scientific
14 evidence overall suggests the existence of any potential effects from any exposure
15 requires identification and evaluation of the relevant scientific literature. No scientifically
16 valid conclusions may be drawn from an individual study or a selected group of studies.
17 Individual studies may be subject to various sources of systematic (bias) and random
18 (chance) errors, and potential confounding due to limitations in the study design, conduct
19 of the study, or in the analyses and interpretation of the results. To account for the large
20 volume and complexity of the existing scientific literature, health risk evaluations are
21 conducted by multi-disciplinary expert panels on behalf of health, scientific, and
22 government agencies, a number of which have been conducted on potential EMF effects.

23 **Q. What are the conclusions and evaluations of EMF research conducted**
24 **by authoritative health and scientific agencies?**

25 A. A number of scientific, health, and government agencies have regularly
26 and repeatedly reviewed the available cumulative scientific evidence, and none has
27 confirmed the existence of adverse health effects. Some of the agencies that conducted
28 reviews of the scientific evidence include the U.S. National Institute of Environmental
29 Health in 1998, the IARC in 2002, the National Radiological Protection Board of the
30 United Kingdom in 2004, the WHO in 2007, ICNIRP in 2010, and the European Union’s

⁶ <http://who.int/peh-emf/about/WhatisEMF/en/index1.html>

1 Scientific Committee on Emerging and Newly Identified Health Risks in 2015.⁷ None of
2 these agencies concluded that the evidence, overall, confirms the existence of any adverse
3 long-term health effects from environmental exposure to ELF EMF at levels below
4 scientifically-established exposure guidelines. While the limited evidence based on a
5 statistical association in some of the childhood leukemia epidemiologic studies is
6 recognized by these organizations, they all concluded that chance, bias, and confounding
7 could not be excluded as an explanation for these findings. They also concluded that
8 results from lifetime exposure studies of laboratory animals that have not identified an
9 excess of cancer development in association with exposure to ELF magnetic fields are
10 not in support of a potential carcinogenic effect. In addition, no biophysical mechanism is
11 currently known that may explain a carcinogenic effect.

12 With respect to the overall evidence on potential long-term effects, the WHO
13 currently states on its website that “[b]ased on a recent in-depth review of the scientific
14 literature, the WHO concluded that current evidence does not confirm the existence of
15 any health consequences from exposure to low level electromagnetic fields.”⁸ ICNIRP
16 has also considered the scientific literature on potential long-term effects and stated that
17 “[i]t is the view of ICNIRP that the currently existing scientific evidence that prolonged
18 exposure to low frequency magnetic fields is causally related with an increased risk of
19 childhood leukemia is too weak to form the basis for exposure guidelines. In particular, if
20 the relationship is not causal, then no benefit to health will accrue from reducing
21 exposure.”⁹

⁷ National Institute of Environmental Health Sciences (NIEHS). Assessment of Health Effects from Exposure to Power-line Frequency Electric and Magnetic Fields: Working Group Report. Research Triangle Park, NC: National Institute of Environmental Health Sciences of the U.S. National Institutes of Health, 1998; International Agency for Research on Cancer (IARC). IARC Monographs on the Evaluation of Carcinogenic Risks to Humans. Volume 80: Static and Extremely Low-Frequency (ELF) Electric and Magnetic Fields. Lyon, France: IARC Press, 2002; National Radiological Protection Board (NRPB). Review of the scientific evidence for limiting exposure to electromagnetic fields (0-300 GHz). National Radiological Protection Board (NRPB). Volume 15, No 3, Chilton, Oxfordshire: NRPB, 2004; World Health Organization (WHO). Environmental Health Criteria 238: Extremely Low Frequency (ELF) Fields. Geneva, Switzerland: World Health Organization, 2007; International Commission on Non-ionizing Radiation Protection (ICNIRP). Guidelines for limiting exposure to time-varying electric and magnetic fields (1 Hz to 100 kHz). Health Phys 99: 818-836, 2010; Scientific Committee on Emerging and Newly Identified Health Risks (SCENIHR). Opinion on Potential Health Effects of Exposure to Electromagnetic Fields (EMF). Brussels, Belgium: European Commission, 2015.

⁸ <http://who.int/peh-emf/about/WhatisEMF/en/index1.html>

⁹ ICNIRP, 2010, p. 824.

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Conclusion

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Q. Please summarize your conclusion regarding whether the EMF levels modeled for the Project will pose an unreasonable adverse effect on public health.

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A. The modeled EMF levels associated with the operation of the Project are below limits on public exposure recommended by two international agencies derived from their assessments of health research studies. The WHO and other scientific and health agencies also have thoroughly considered research on EMF and have concluded that, on balance, the scientific weight of evidence does not support the conclusion that EMF causes any long-term adverse health effects. Our review of recent research does not provide evidence to alter this overall conclusion. The conclusions of the WHO and other agencies apply to all sources of ELF EMF in our environment, including power distribution lines, transmission lines, and electrical appliances. Thus, based on all of the information I have evaluated, my conclusion, to a reasonable degree of scientific certainty, is that the EMF associated with the operation of the Project will not be harmful to human health and, therefore, will not result in an unreasonable adverse effect on public health and safety.

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Q. Does this conclude your testimony?

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A. Yes, it does.