STATE OF CONNECTICUT
CONNECTICUT SITING COUNCIL

Eversource Energy Application for a Certificate of Environmental Compatibility and Public Need for the construction, maintenance, and operation of a 115-kilovolt (kV) bulk substation located at 290 Railroad Avenue, Greenwich, Connecticut, and two 115-kV underground transmission circuits extending approximately 2.3 miles between the proposed substation and the existing Cos Cob Substation, Greenwich, Connecticut, and related substation improvements.	DOCKET NO. 461 September 29, 2015

DIRECT TESTIMONY OF GABOR MEZEI, M.D., Ph.D.

Q. PLEASE STATE YOUR NAME, POSITION, THE COMPANY YOU WORK FOR, AND YOUR BUSINESS ADDRESS.

A. My name is Gabor Mezei. I am a Senior Managing Scientist in the Center for Epidemiology and Computational Biology within the Health Sciences Practice of Exponent, Inc. (Exponent). Exponent is a multidisciplinary scientific and engineering firm. My business address is 149 Commonwealth Drive, Menlo Park, California, 94025.

Q. PLEASE DESCRIBE YOUR EDUCATION, QUALIFICATIONS AND PROFESSIONAL EXPERIENCE.

A. I trained as a medical doctor earning my M.D. degree at the Semmelweis University of Medicine in Budapest, Hungary, and as an epidemiologist earning my Ph.D. degree at the UCLA School of Public Health in Los Angeles, California. I have over 25 years of experience in health research including the

conduct of epidemiologic studies of both clinical outcomes and environmental and occupational health issues. In my current role at Exponent, I review, analyze, and conduct health research in collaboration with other professionals with diverse expertise in the field of health, engineering and environmental sciences. Much of my current work and expertise relates to health research related to electric and magnetic fields (EMF). Prior to joining Exponent, I led the multidisciplinary EMF Health Assessment Research Program at the Electric Power Research Institute, where the scientific work focused on potential health effects associated with residential and occupational exposure to EMF. I have published more than 60 peer-reviewed scientific papers and book chapters. The subject of many of these publications was health and exposure assessment research related to EMF. A list of these publications and further details on my professional experience are included in my submitted *curriculum vitae*. (See Eversource Exhibit 10i)

Q. HAVE YOU SERVED AS AN EXPERT IN OTHER COMMISSION PROCEEDINGS?

A. Yes. I served as an expert witness in proceedings before the Alberta Utilities Commission and the Kentucky Public Service Commission. I also appeared before a Joint Committee for Transport and Communications of the Parliament of Ireland and before the staff of the California Public Utilities Commission.

Q. WHAT IS THE PURPOSE OF YOUR DIRECT TESTIMONY?

A. The purpose of my direct testimony is to assess health research related to extremely low frequency (ELF)[1] EMF as it relates to exposures to ELF EMF associated with the operation of the proposed Greenwich Substation and Line Project. Our summary of current research on this topic is provided in the technical report, "Update of Research on Extremely Low Frequency Electric and Magnetic Fields and Health, August 1, 2012 – July 31, 2014, Greenwich Substation and Line Project" which was submitted to the Council as Attachment G-3 to the Application. An additional purpose of my direct testimony is to address EMF-

[1] The ELF frequency range includes 60-Hz EMF that is associated with electricity used in the United States.

related concerns that were raised during the evening session of the first day of this hearing on September 1, 2015.

Q. WHAT METHODS DID YOU USE TO CONDUCT YOUR ASSESSMENT?

A. I identified and reviewed the relevant weight-of-evidence consensus evaluations of the scientific evidence on EMF and health conducted by authoritative scientific and health agencies. These authoritative reviews provide reliable summaries and evaluations of current scientific knowledge and also serve as guidance to policy making and standard setting organizations. I also identified and reviewed relevant exposure guidelines, and I searched the scientific literature for recent relevant research publications that may contribute new information to a weight-of-evidence assessment of potential EMF effects.

Q. WHAT ARE THE STANDARDS AND GUIDELINES FOR PUBLIC EXPOSURE TO ELECTRIC AND MAGNETIC FIELDS?

A. There are no federal standards in the United States for 60-Hz EMF exposure. There is no guideline limiting levels of EMF from substations in Connecticut. While the State of Connecticut has no numerical limits on EMF produced by transmission lines, project applicants are required to follow EMF Best Management Practices (BMPs) adopted by the Connecticut Siting Council to minimize public exposure to magnetic fields. The latest BMPs are dated February 20, 2014.[2]

In addition, there are scientifically-based exposure guidelines that were developed by two international scientific agencies to protect workers and members of the public from established effects of EMF. These agencies are the International Commission on Non-Ionizing Radiation Protection (ICNIRP) and the International Committee of Electromagnetic Safety (ICES), a committee of the

---

[2] Connecticut Siting Council (CSC). Electric and Magnetic Fields Best Management Practices for the Construction of Electric Transmission Lines in Connecticut. February 20, 2014. (See Appendix G-1 to Application).

Institute of Electrical and Electronics Engineers. The World Health Organization (WHO) has formally recognized and recommended the ICNIRP guidelines for adoption by national authorities. The scientific basis of exposure guideline development is a thorough and comprehensive review of the relevant scientific literature with the aim to identify any potential adverse effects and determine the exposure level at which any of these effects are reported. Once the exposure level is determined where an adverse effect is identified, exposure guideline limits are set well below this level. A reduction in exposure levels of up to 10-fold is implemented to account for scientific uncertainty and any potential variability in sensitivity within the human population. This reduction in exposure level is also termed "safety factor." EMF exposure at sufficiently high levels may result in visual phosphenes and in nerve and muscle stimulation. These effects are immediate and reversible and only occur at very high levels. Scientifically established exposure guidelines are developed to protect from these effects.

The ICNIRP limits were updated in 2010.[3] For the general population, the reference level at 60-Hz is 4.2 kV/m for electric fields and 2,000 mG for magnetic fields. The corresponding ICES limits[4] are 5 kV/m[5] and 9,040 mG. Both of these exposure guidelines are referenced in the BMPs.

Q. HOW DO THE ELF ELECTRIC AND MAGNETIC FIELDS CALCULATED FOR THIS PROJECT COMPARE TO THESE GUIDELINE VALUES?

A. The magnetic field levels for annual average load and peak load that were calculated for the Project's proposed 115-kV underground transmission line by Eversource are well below the ICNIRP and ICES guideline reference values for the general public. Due to underground construction, no electric-field from the

[3] International Commission on Non-ionizing Radiation Protection (ICNIRP). ICNIRP Statement—Guidelines for limiting exposure to time-varying electric and magnetic fields (1 Hz to 100 kHz). Health Physics 99:818-836, 2010.

[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.

[5] An exception of 10 kV/m applies within transmission line rights of ways because people do not spend a substantial amount of time there and very specific conditions are needed before a response is likely to

proposed line would be present above ground, as electric fields are easily shielded by the conductors' metallic sheath and the earth. The calculated EMF values are described in Section M and Appendix G-2 of the Application. With respect to EMF from substations, the IEEE Standard 1127 provides guidance on design, construction and operation of safe and reliable substations. The standard states "In a substation, the strongest fields near the perimeter fence come from the transmission and distribution lines entering and leaving the substation. The strength of fields from equipment inside the fence decreases rapidly with distance, reaching very low levels at relatively short distances beyond substation fences."[6]

Q. HAVE POTENTIAL LONG-TERM EFFECTS OF ELF ELECTRIC AND MAGNETIC FIELDS BEEN STUDIED AND CONSIDERED AS WELL?

A. Yes. A large amount of scientific research has been conducted since 1979 to examine potential long-term effects of ELF EMF on human health. As the WHO currently states on its website "[d]espite the feeling of some people that more research needs to be done, scientific knowledge in this area is now more extensive than for most chemicals."[7] Hundreds, if not thousands, of scientific studies have been published over the more than 35 years in several scientific disciplines. These research studies include epidemiologic studies (i.e., studies of human populations), laboratory studies of animals (*in vivo* studies), and laboratory studies of tissues and cells (*in vitro*). The studies investigated the potential effects of ELF EMF exposures from various sources (including both occupational and residential sources) on both cancer and non-cancer outcomes among children and adults. The proper scientific process for evaluating whether the scientific evidence overall suggests the existence of any potential long-term effects from any exposure requires identification and evaluation of the entire relevant scientific literature. No scientifically valid conclusions may be drawn from an individual study or a selected group of studies. Individual studies may be subject to various sources of systematic (bias) and random (chance) errors, and potential

---

occur (i.e., a person must be well insulated from ground and must contact a grounded conductor) (ICES, 2002, p. 27).

[6] IEEE Guide for the Design, Construction, and Operation of Electric Power Substations for Community Acceptance and Environmental Compatibility. New York: IEEE. IEEE Std 1127-2013, p. 26.

[7] http://who.int/peh-emf/about/WhatisEMF/en/index1.html

confounding due to limitations in the study design, conduct of the study, or in the analyses and interpretation of the results. To account for the large volume and complexity of the existing scientific literature, health risk evaluations are conducted by multidisciplinary expert panels on behalf of health, scientific, and government agencies, a number of which have been conducted on potential EMF effects.

Q. WHAT AUTHORITATIVE HEALTH AND SCIENTIFIC AGENCIES HAVE CONDUCTED EVALUATIONS OF THE SCIENTIFIC EVIDENCE ON POTENTIAL HEALTH EFFECTS OF EMF?

A. A number of scientific, health, and government agencies have reviewed the available cumulative scientific evidence over the past several years. These include, for example, the National Institute of Environmental Health Sciences (NIEHS) of the United States in 1998, the International Agency for Research on Cancer (IARC) in 2002, the National Radiological Protection Board (NRPB) of the United Kingdom in 2004, the WHO in 2007, ICNIRP in 2010, and the European Union's Scientific Committee on Emerging and Newly Identified Health Risks (SCENIHR) in 2009 and 2015.

Q. COULD YOU BRIEFLY DESCRIBE THE WORK COMPLETED BY THE NATIONAL INSTITUTE OF ENVIRONMENTAL HEALTH SCIENCES (NIEHS)?

A. Yes. As part of the 1992 Energy Policy Act, the United States Congress authorized the Electric and Magnetic Fields Research and Public Information Dissemination Program (EMF-RAPID Program) and instructed the NIEHS and the Department of Energy "to direct and manage a program of research and analysis aimed at providing scientific evidence to clarify the potential for health risks from exposure to ELF-EMF" (NIEHS, 1999, p. 2). As part of this program, the Director of the NIEHS was mandated "to provide a report outlining the possible human health risks associated with exposure to ELF-EMF" (NIEHS, 1999, p. 2). To fulfill this mandate, the NIEHS assembled a Working Group of 32 scientists representing a number of relevant scientific disciplines to review the

available scientific evidence on ELF EMF and potential health effects. The NIEHS Working Group conducted a weight-of-evidence evaluation of the potential effects of exposure to ELF EMF on cancer and non-cancer health end-points. They identified and reviewed epidemiologic, *in vivo*, and *in vitro* studies relevant to cancer and non-cancer health outcomes and biological and biophysical processes, along with studies of exposure assessment, related to ELF EMF. The NIEHS evaluation followed the guidelines developed by IARC, with minor modifications. The Working Group issued its report in 1998[8] and the Director of the NIEHS issued his report to Congress in 1999.[9]

Q. WHAT WERE THE CONCLUSIONS OF THE NIEHS EVALUATION?

A. The overall NIEHS conclusion states that "[t]he scientific evidence suggesting the ELF-EMF exposure pose any health risk is weak," and that in their opinion, "this finding is insufficient to warrant aggressive regulatory concern" (NIEHS, 1999, p. ii-iii). According to the 1998 NIEHS Working Group report, the evidence from epidemiologic studies on residential exposure and childhood leukemia and on occupational exposure and one type of adult leukemia was classified as "limited" by the majority of the Working Group members (the limited classification implies that the association observed in epidemiologic studies is considered credible but chance, bias, and confounding cannot be excluded as explanation for the association). Epidemiologic evidence on all other cancers, including brain cancer, and all non-cancer outcomes was considered as "inadequate." Evidence from *in vivo* animal studies was also classified as "inadequate" by the majority of the Working Group members. With respect to the overall findings, the NIEHS Conclusion in 1999 NIEHS report summarizes the evidence as follows.

> Epidemiological studies have serious limitations in their ability to demonstrate a cause and effect relationship whereas laboratory studies, by design, can clearly show that cause and effect are possible. Virtually all of the laboratory evidence in animals and humans and most of the

[8] NIEHS Working Group Report. Assessment of Health Effects from Exposure to Power-Line Frequency Electric and Magnetic Fields. NIH Publication No. 98-3981. Research Triangle Park, NC, 1998.

[9] NIEHS Report on Health Effects from Exposure to Power-Line Frequency Electric and Magnetic Fields. NIH Publication No. 99-4493. Research Triangle Park, NC, 1999.

> mechanistic work done in cells fail to support a causal relationship between exposure to ELF-EMF at environmental levels and changes in biological function or disease status. The lack of consistent, positive findings in animal or mechanistic studies weakens the belief that this association is actually due to ELF-EMF, but it cannot completely discount the epidemiological findings (NIEHS, 1999, p. ii-iii).

In summary, the NIEHS review did not conclude that the scientific evidence confirms the existence of any cancer or non-cancer adverse health effects and the overall evidence was considered weak.

Q. WHAT WERE THE CONCLUSIONS OF THE MORE RECENT EVALUATIONS CONDUCTED BY AUTHORITATIVE HEALTH AND SCIENTIFIC AGENCIES FOLLOWING THE NIEHS REVIEW?

A. None of the agencies mentioned earlier (IARC, NRPB, WHO, ICNIRP, SCENIHR) that conducted a weight-of-evidence evaluation of the available scientific evidence concluded that the evidence, overall, confirms the existence of any adverse long-term health effects from environmental exposure to ELF EMF at levels below scientifically-established exposure guidelines. While the limited evidence based on a statistical association in some of the childhood leukemia epidemiologic studies is also recognized by these organizations, they all concluded that chance, bias, and confounding could not be excluded as an explanation for these findings (the epidemiologic evidence for all other cancer and non-cancer health outcomes among children or adults were considered inadequate by all recent reviews).

These reviews also concluded that results from lifetime exposure studies of laboratory animals have not identified an excess of cancer development in association with exposure to ELF magnetic fields and thus do not support a potential carcinogenic effect. In addition, no biophysical mechanism has been confirmed that could explain a carcinogenic effect. Because the weight-of-evidence evaluation conducted by the WHO represents one of the most comprehensive and most widely referenced reviews, further details of its methods

and the specific conclusions are discussed in the technical report (Appendix G-3 of Application).

With respect to the overall evidence on potential long-term effects, the WHO currently states on its website that "[b]ased on a recent in-depth review of the scientific literature, the WHO concluded that current evidence does not confirm the existence of any health consequences from exposure to low level electromagnetic fields." ICNIRP has also considered the scientific literature on potential long-term effects and stated that "[i]t is the view of ICNIRP that the currently existing scientific evidence that prolonged exposure to low frequency magnetic fields is causally related with an increased risk of childhood leukemia is too weak to form the basis for exposure guidelines. In particular, if the relationship is not causal, then no benefit to health will accrue from reducing exposure" (ICNIRP, 2010, p. 824).

The most recent comprehensive evaluation of the relevant scientific literature was conducted by SCENIHR in 2015. The 2015 SCENIHR report updates the earlier report issued by SCENIHR in 2009. Similar to the earlier report, the 2015 SCENIHR report did not conclude that the scientific evidence confirms any adverse health effects. This conclusion is consistent with conclusions of evaluations completed by other organizations mentioned earlier. With respect to the statistical association observed in some of the childhood leukemia epidemiologic studies, the 2015 SCENIHR report states that "no mechanisms have been identified and no support is existing from experimental studies that could explain these findings, which, together with shortcomings of the epidemiological studies prevent a causal interpretation" (SCENIHR, 2015, p. 16).

Q. DR. MEZEI, ON THE BASIS OF YOUR ASSESSMENT, PLEASE SUMMARIZE YOUR CONCLUSIONS REGARDING THE POTENTIAL FOR ADVERSE HEALTH EFFECTS FROM THE PROPOSED PROJECT.

A. The ELF magnetic field associated with the operation of the proposed substations and transmission lines in the Greenwich Substation and Line Project, at the edges of the right-of-way and beyond, and at the boundaries of the substations is

expected to be within the range commonly encountered from other sources, and below applicable limits in guidelines designed to protect public health. Neither Exponent's review of the relevant scientific literature nor the health risk assessments and evaluations conducted by expert panels on behalf of scientific and health agencies confirmed the existence of any adverse effects at exposure levels that are expected to be associated with the Greenwich Substation and Line Project and that would predict any likely adverse impact on public health.

Q. AND IN YOUR OPINION IS THE DESIGN OF THE PROPOSED PROJECT CONSISTENT WITH THE CONNECTICUT SITING COUNCIL'S BMPS?

A. Yes. As specified in the 2014 BMPs, compliance is demonstrated by providing reference to new developments in EMF scientific research, calculations of electric and magnetic fields, consideration of buffer zones, and engineering controls. Our report on the status of scientific research on EMF and health serves as the current reference to new developments in EMF scientific research. Eversource has provided calculations of magnetic fields, and the project design as an underground line is the engineering control on the magnetic field.

The expected magnetic field calculated by Eversource is about 1 mG or less directly over the underground line and the magnetic field further diminishes in intensity with distance from the line such that any measureable increase in the background magnetic field at nearby Statutory Facilities would be unlikely. The particularly low magnetic field calculated by Eversource for this underground transmission line results from the close proximity of the transmission phase conductors within each of the two 8-inch diameter steel pipe in the proposed installation. Because the conductors are insulated, they can be in direct contact with each other; this design has the effect of enhancing the mutual cancelation of the magnetic field produced by each phase conductor, and the encapsulation of the conductors inside the steel pipe also contributes to shielding of the magnetic fields resulting in the very low field levels.

Q. DOES THIS CONCLUDE YOUR TESTIMONY?

A. Yes.