ComEd Ex. 14.0

STATE OF ILLINOIS

ILLINOIS COMMERCE COMMISSION

COMMONWEALTH EDISON COMPANY	:	
	:	No. 12-0298
Petition for Statutory Approval of a Smart Grid	:	
Advanced Metering Infrastructure Deployment	:	
Plan pursuant to Section 16-108.6 of the Public	:	
Utilities Act	:	

Rebuttal Testimony of

PETER A. VALBERG, PH.D.

Principal, Environmental Health

Gradient

on behalf of

Commonwealth Edison Company

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I. Introduction

A. Witness Identification

Q. **What is your name and business address?**

A. My name is Peter A. Valberg. My business address is Gradient, 20 University Road, Cambridge, Massachusetts 02138-5156.

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

A. I am a Principal for Environmental Health at Gradient, an environmental consulting firm.

B. Summary of Rebuttal Testimony

Q. **What is the purpose your rebuttal testimony?**

A. Based on my review of the relevant science, I confirm that the radio frequency ("RF") transmissions from the proposed advanced metering infrastructure ("AMI") meters are not hazardous to health. The RF levels emitted by AMI meters such as those proposed in ComEd's Smart Grid Advanced Metering Infrastructure Deployment Plan ("AMI Plan") comply with guidelines developed to assure RF safety. No public health agency has identified the RF from AMI meters as causing human disease, and the RF emissions from AMI meters are far below health-protective standards and guidelines developed for public exposure to RF. In fact, a large number of scientific groups have reviewed research findings on potential health effects of RF emissions without finding credible evidence that they pose a health threat at exposure levels below safety guidelines. The Commission should not be deterred from approving a beneficial AMI deployment because of concerns over radio frequency signals from AMI meters.

C. Background and Qualifications

Q. **In what areas of science and public policy do you specialize?**

A. My scientific work concentrates on quantitative assessment of environmental impact and human health risk. In particular, I specialize in the quantitative analysis of exposure and toxicology of environmental agents, including ionizing and non-ionizing radiation. I have extensively researched and studied the links between human health and people's exposure to specific agents such as radio-wave frequencies and electric and magnetic fields ("EMF").

Q. **What background and experience do you have in the area of EMF and radio frequency fields?**

A. In-depth study of these areas was part of my training at both Taylor University and Harvard University. I also taught electromagnetism at Amherst College and Harvard University. Among the research grants that I directed at Harvard SPH (funded by the National Cancer Institute) was one on "Magnetic Fields Effects on Macrophages" (macrophages are lung cells that clean the lung of dust and other particles deposited there from the air we breathe). I also served on the "Harvard Advisory Committee on EMF and Human Health" and the "Peer Review Board on Cellular Technology and Human Health" committees during the period of time when Harvard University (Center for Risk Analysis) had those as active committees. Additionally, I assisted the Health Effects Institute (Boston, MA) in determining the feasibility of launching an EMF research program, and published a summary document on "EMF Mechanisms" in the peer-reviewed journal *Radiation Research*.

I have made numerous presentations on health effects at RF- and EMF-related conferences. At the request of the International Congress on Radiation Research ("ICRR"), I organized and chaired a symposium on "Physical aspects of RF effects on Biological Systems," at the 11th Annual ICRR meeting in Dublin, Ireland. I helped organize a conference in the Boston area on "Childhood Leukemia: Electric and Magnetic Fields as Possible Risk Factors." A summary of this workshop was published in the peer-reviewed journal *Environmental Health Perspectives*. In 2006, I was asked to present a lecture on how electric and magnetic fields interact with living organisms by the Cyprus International Institute for the Environment and Public Health in a symposium on "Electromagnetic Fields: Sources, Health Effects, and Regulations," which took place in Nicosia, Cyprus.

I worked with the World Health Organization (Geneva, Switzerland) on the health effects on EMF as they apply to cellular telephone technology. An article summarizing some of my WHO work was published in the peer-reviewed journal *Environmental Health Perspectives*, and a more complete discussion appeared in the book: "Base Stations and Wireless Networks: Exposures and Health Consequences. International Workshop on Base Stations and Wireless Networks: Exposures and Health Consequences." (Eds.: Repacholi, M; van Deventer, E; Ravazzani, P), WHO, Geneva, Switzerland (2007).

Q. **How do you continue to maintain your expertise in the area of health effects related to radiofrequency fields and EMF, in general?**

A. On a continuing basis, I review recently published articles related to health effects of non-ionizing radiation, especially those publications that are relevant to health risks

potentially attributed to RF and power-line EMF exposures. Also, I participate in professional societies that discuss matters related to EMF. I am a member of the Bioelectromagnetics Society ("BEMS") and read the society's peer-reviewed journal "*Bioelectromagnetics*," which publishes articles relevant to RF / EMF health effects. I am a member of the Health Physics Society, read their newsletter, and subscribe to their peer-reviewed journal "*Health Physics*." Important RF and EMF articles are published in this journal, and I review them as they appear. I am also a full member of the Society of Toxicology ("SOT"), and at each annual meeting, I identify and attend any talks or abstracts dealing with RF and EMF. I subscribe to the SOT's peer-reviewed journal, "*Toxicological Sciences*," and review those articles relevant to RF / EMF. I, thereby, remain current with both the results reported in peer reviewed scientific journals as well as with proceedings of symposia and the like where new study designs and studies in progress are informally discussed and/or where policy debates may occur.

Q. **What is your educational background?**

A. My educational background includes an A.B. degree, *summa cum laude*, in Physics and Mathematics from Taylor University, both an M.A. and Ph.D. degree in Physics from Harvard University, and an M.S. degree in Human Physiology from the Harvard University School of Public Health ("Harvard SPH"). My Ph.D. thesis work at Harvard University was carried out in the laboratories of Dr. Norman F. Ramsey, winner of the 1989 Nobel Prize in Physics.

Q. **Are any exhibits attached to your direct testimony?**

A. Yes. My complete resume is attached to this direct testimony as ComEd Ex. 14.01. A list of references, many of which I cite in this testimony, is attached as ComEd Ex. 14.02.

II. Response to the Questions Concerning RF Exposure

Q. **Have you reviewed the testimony of Dr. Megan Sandel (AG/AARP Ex. 2.0) and the attachments thereto (AG/AARP Exs. 2.1-2.3) submitted in this Docket?**

A. Yes. They almost exclusively focus on issues far removed from RF exposure. However, as is sometimes the case in such documents, they touch on the subject of RF emissions with little discussion and no analysis. For example, while Dr. Sandel refers to "hypothesized impacts" of EMF as a "potential" "pathway" for health effects in her narrative testimony,[1] and characterizes the issue of health impacts as "uncertain"[2], she includes "non-ionizing radiation from the digital meter's radio transmitters" in the category of "housing adequacy" without any analysis.[3] Although she does not mention RF emissions in her narrative conclusions, they appear in the summary table (AG/AARP Ex. 2.1) she sponsors as well as in several locations the body of the "Health Impact Assessment" ("HIA") (AG/AARP Ex. 2.3),[4] also without analysis or discussion. And, despite her expressions of uncertainty, the HIA "scoring" table appears to claim, again without discussion or citation to evidence, that that there may be "adverse neurological effects, cancer related to non-ionizing rad exposure (childhood leukemia, miscarriage)."[5]

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[1] Sandel Dir., AG/AARP Ex. 2.0, 16:328-31, 345-46.

[2] *Id.*, 29:632-33.

[3] *Id.*, 17:358.

[4] AG/AARP Ex. 2.1; AG/AARP Ex. 2.3, pp. 20-21, 96, 97, 98, 121-22.

[5] AG/AARP Ex. 2.3, p. 100.

Q. **Does Dr. Sandel's testimony, or the documents attached thereto, either conclude or support a conclusion that ComEd's proposed AMI meters' RF transmissions pose any public health threat?**

A. No. Dr. Sandel's narrative appears to admit frankly her personal uncertainty, and the objective evidence does not support the claims of health effects.

A. <u>AMI Meter Radio Transmissions</u>

Q. **How, why, and from where does an AMI meter transmit data by radio to other ComEd equipment?**

A. Just like thousands of other modern devices that communicate wirelessly, the Silver Spring Network ("SSN") module installed in ComEd's proposed AMI meters periodically "calls in" data *via* radio. It does this from the location where the meter itself is installed.

Q. **Is it unusual for people in the United States and other developed countries to be living in an environment where radios operate and radio transmissions are ubiquitous?**

A. No. In our ordinary activities, we become exposed to RF as a matter of going about our daily routines. It is important to recognize that our environment has a multitude of radio-wave sources that surround us every day, including:

- Commercial radio (AM & FM) and commercial TV (VHF & UHF & digital)
- Marine and aviation radio services, military and weather radar, police radar
- Public emergency, fire, and police dispatch services
- Amateur (ham) radio operators, wireless paging services, remote-control devices

- Cell phones, "Personal Communications Systems" (PCS), "Smartphones," iPads
- Cordless telephones, baby monitors, wireless toys, walkie-talkies, Internet routers
- Computers (and game controllers), TV sets, CD players, DVD players, iPods
- Microwave ovens (RF leakage)
- Microwave links for computers, radio, television, and telephones
- Satellite radio / television / communications, global positioning system (GPS)
- Medical procedures such as diathermy, magnetic resonance imaging (MRI)

That list is, of course, illustrative and far from exhaustive.

Q. **Are you familiar with the radio mesh communications network used by the Silver Spring Networks ("SSN") advanced metering infrastructure that ComEd proposes to install?**

A. Yes, I am.

Q. **How do radio transmissions from the SSN-equipped AMI meters ComEd proposes to install compare to RF exposure from other common devices used by most consumers?**

A. Common sources of electromagnetic energy can be characterized according to the power they emit into our electromagnetic spectrum environment. The list below is mostly for RF, but, for perspective, I have included some sources in the "heat" and "light" part of the spectrum. In fact, the energy waves (photons) from heat and light are <u>more</u> energetic than for RF waves.

- Utility AMI meters: 1watt or less , typically ¼ watt
- Handheld cell phones, cordless phones: below 2 watts

- Remote control toys & nursery monitors: about 3 watts
- Flashlight: about 5 watts (light + heat)
- "Walkie-talkies": about 10 watts
- Cellular telephone base stations: about 80 watts
- Standard light bulb: about 100 watts (light + heat)
- The human body: about 100 watts (infrared)
- Microwave oven: about 1,500 watts (heat + RF)
- Electric space heater: about 1,500 watts (light + heat)
- Radio and television stations: about 50,000 to 1,000,000 watts

The importance of this list is to demonstrate that radio waves have been used in highly populated regions for over a hundred years, and health statistics show no indication that our increasing use of RF communications has been adverse to human health.

Moreover, the radio-frequency emission levels from AMI meters are very low. First of all, a useful reference point is to realize that the smart-meter integrated RF dose over a day is far lower than that from using a cellular phone for, say, 15 minutes throughout a day. RF doses can be expressed either as a fraction of "maximum permissible exposure" (MPE) limits or as a fraction of "specific absorption rate" (SAR) limits. These two biologically-based benchmarks can be used to rank the RF doses of different devices relative to each other and to Federal Communication Commission ("FCC") guidelines. ""

Q. **But, aren't AMI meters always on and, therefore, constantly exposing people to RF energy?**

A. No. Smart meters transmit at a very low duty cycle (that is, the devices transmit for a very small fraction of the time) and the duration of RF exposure from AMI meters is very short, *i.e.*, the meters transmit data on electricity consumption several times per day, for periods on the order of 0.1 seconds, with a mean "duty cycle" of 0.14%, giving a total transmit time of about 2 minutes per day (Tell *et al*., 2012; EPRI 2011). As calculated above, the approximate, full-day RF dose to a resident of a house who stands constantly in front of his / her AMI meter is comparable to that produced by use of a cellular telephone for about 10 seconds. Typically, the AMI meter transmits less than about 2 minutes a day on average, and less than about 16 minutes a day for 99.9% of meters.

Q. **How would you describe overall exposure to RF energy from an AMI meter, considering both the strength and periods of operation?**

A. In terms of RF intensity, at a 10-ft distance in front of the AMI meter, the RF intensity of AMI meters (when on) is below 1% of the FCC MPE limit (see the table below, of course, behind the meter, *i.e.*, inside the home, the levels are far lower),[6] whereas, for a cell phone held at the head (and being used), the RF doses are below the FCC SAR,[7] but the tissue doses range from 25 to 90% of the FCC SAR limit.[8] Thus, for cell phone use of 15 minutes per day, the integrated RF daily dose (900 seconds × 0.50 SAR) is about 375 times greater than the RF exposure from one day of standing continuously within 10 feet of a AMI meter (120 seconds × 0.01 MPE). Put another way, you would have to be

[6] The less than 1% of the MPE (~ 4 $\mu W/cm^2$) for the smart meter is at 10 feet in front of it. Behind the meter (*i.e.*, inside the residence), the RF levels would be considerably lower (Tell *et al*., 2012).

[7] The Federal Communications Commission (FCC) requires that phones sold in the US have a SAR level at or below 1.6 watts per kilogram (W/kg), averaged over a volume containing a mass of 1 gram of tissue that is most highly exposed.

[8] For background see: http://en.wikipedia.org/wiki/Specific_absorption_rate

exposed to the RF from a AMI meter for 375 years to get a dose equivalent to that of one year of 15-minutes-per-day cell phone use.[9]

B. <u>Evidence Regarding Health Effects</u>

Q. **Are radio transmissions from the proposed AMI meters a threat to health?**

A. No. Sometimes the RF is called "radiation," which people may confuse with the "ionizing radiation" associated with X-rays, CAT scans, and nuclear medicine. But, this is an incorrect association. The electromagnetic spectrum encompasses frequencies from the kilohertz[10] range up through microwaves and on into infrared, light, ultraviolet, and X-rays. Visible light is the major source of electromagnetic energy in our environment. The human body, by virtue of being alive and warm, generates heat energy (electromagnetic energy in the infrared portion of the spectrum), which can be seen by an "infrared" or "night-vision" camera, *i.e.*, in complete darkness. Importantly, those electromagnetic waves with a frequency below that of visible light (including RF), cannot damage molecules, and hence are called "non-ionizing," unlike X-rays, which are "ionizing radiation." There is no credible evidence that the RF transmissions from AMI meters are hazardous.

Q. **Does Dr. Sandel's testimony, or the documents attached thereto, either conclude or support a conclusion that ComEd's proposed AMI meters' radio frequency (RF) transmissions pose any public health threat?**

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[9] The mathematics is straightforward. (900 seconds × 0.50) / (120 seconds × 0.01) = 375.

[10] Radio-wave frequencies are expressed in "Hertz" (Hz), a term which is equivalent to "cycles per second." For example, voice frequencies (i.e., sound waves in the air) cover the range from about 50 Hz to 15,000 Hz. Radio-wave frequencies cover the range from about 300,000 Hz (i.e., 0.3 megahertz, or 0.3 MHz) to 30,000,000,000 Hz (i.e., 30 gigahertz, or 30 GHz). For AMI meters, the RF frequencies are in the range 900 to 920 MHz.

A. No. Nothing in the testimony of, attachments to, or documents relied on by Dr. Sandel demonstrates the existence of any health risk.

Q. **How does the exposure from an SSN AMI mesh network component compare to any applicable exposure regulations, standards, or limits?**

A. For AMI meters, the RF levels are far below health-protective standards and guidelines developed for public exposure to RF. For the AMI meter RF band around 910 MHz, the allowable, safe RF level is 610 $\mu W/cm^2$. By comparison, summertime sunlight at noon bathes us with about 150,000 $\mu W/cm^2$ of electromagnetic energy. These energy comparisons are shown in the following Table:[11]

Electromagnetic energy in sunlight at the earth's surface (noon, summer day)	Applicable FCC standard for 910 MHz RF wave energy (public and residential areas)	Typical RF levels measured near (at 10 feet) AMI meters that are actually transmitting
150,000 $\mu W/cm^2$	610 $\mu W/cm^2$	~ 4 $\mu W/cm^2$

The ~ 4 $\mu W/cm^2$ for the AMI meter is at 10 feet in front of it. Away from the meter (*i.e.*, inside the residence, or elsewhere in the multifamily dwelling, or elsewhere on the property), the RF levels would be considerably lower.

No public health agency has identified the RF emissions from AMI meters as hazardous to health. In fact, a large number of scientific groups have reviewed research findings on potential health effects of RF waves. These independent scientific consensus groups, composed of research, engineering, medical, and public health scientists, have produced "blue-ribbon" reports that have examined all aspects of RF safety, for example:

- American National Standards Institute (ANSI / IEEE, 2003, 2006),

[11] Figure 1 (page 5) of CCST, 2011.

230 • Federal Communications Commission (FCC, 1999, 2007),[12]

231 • Health Canada, Safety Code 6 (2009)[13]

232 • International Agency for Research on Cancer (IARC, 2011)[14]

233 • International Commission on Non-Ionizing Radiation Protect. (ICNIRP, 1998,
234 2004, 2009, 2011)[15]

235 • National Council on Radiation Protection and Measurements (NCRP, 2002)[16]

236 • National Radiation Protection Board [Health Protection Agency], UK (NRPB,
237 HPA, 2000, 2004)

238 • Netherlands Health Council (NHC, 2002, 2003, 2007)

239 • World Health Organization (WHO, 1993, 2000, 2007)

240 • President's Cancer Panel (PCP, 2010), "Reducing Environmental Cancer
241 Risk"[17]

242 The reports of these groups, written by researchers, medical doctors, biologists,
243 engineers, and toxicologists, are voluminous, thorough, and even-handed. These blue-
244 ribbon panels, in general, concur that the current guidelines for RF exposure protect the
245 safety of the public and of residents living in our present-day RF environment.

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[12] Federal Communications Commission (FCC) http://transition.fcc.gov/Bureaus/Engineering_Technology/Documents/bulletins/oet56/oet56e4.pdf (p. 15).

[13] Health Canada, March, 2010: http://www.hc-sc.gc.ca/ewh-semt/pubs/radiation/radio_guide-lignes_direct-eng.php"

[14] IARC: In May 2011, the International Agency for Research on Cancer (IARC) classified radiofrequency fields (RF) as Group 2B (possibly carcinogenic) on the IARC scale of carcinogenic risk to humans. http://www.iarc.fr/en/media-centre/pr/2011/pdfs/pr208_E.pdf

IARC uses the "possibly carcinogenic" category when talking about both cell phones and power-line magnetic fields ("EMF"), and the IARC category 2B includes "possible carcinogens" such as coconut oil, gasoline, diesel fuel, fuel oil, "carpentry and joinery," coffee, carbon black (car tires), car-engine exhaust, surgical implants, iron supplement pills, mothballs, nickels, pickled vegetables, talc-based body powder, safrole (sassafras) tea, titanium dioxide, *etc.* http://monographs.iarc.fr/ENG/Classification/ClassificationsGroupOrder.pdf

[15] ICNIRP: http://www.icnirp.de/documents/StatementEMF.pdf; http://www.icnirp.de/documents/RFReview.pdf ; http://www.icnirp.de/documents/SCIreview2011.pdf

[16] NCRP: http://www.ncrppublications.org/Reports/119

[17] President's Cancer Panel, http://deainfo.nci.nih.gov/advisory/pcp/annualReports/pcp08-09rpt/PCP_Report_08-09_508.pdf

Q. **Do Federal Communications Commission ("FCC") regulations only address the thermal effects of "AMI meters" and neglect "non-thermal" effects that may be dangerous?**

A. No. RF exposure limits were developed by the FCC specifically to protect against all known hazards and dangers of RF energy. These limits were established after a thorough review and evaluation of the scientific literature, and after ample opportunity for comment by all interested parties. They have been adopted by federal health agencies, have withstood repeated scrutiny, and are similar to European regulations. For example, the World Health Organization has endorsed health-protective guidelines: "The main conclusion from the WHO reviews [of RF bioeffects data] is that EMF exposures below the limits recommended in the ICNIRP international guidelines do not appear to have any known consequence on health"[18] and the Health Council of the Netherlands has endorsed this viewpoint as well.[19] The level of RF exposure from AMI meters is a tiny fraction of FCC, IEEE, ICES, and ICNIRP guidelines. It is also small or comparable relative to other exposures to RF energy that we experience over the course of a day from other technologies that emit RF energy, as listed above. There are no regulations for "non-thermal" effects, because these remain speculative and have not been demonstrated to lead to adverse health effects.

Q. **How should we interpret the World Health Organization's (WHO) report stating that RF exposure from cell phones is a "possible" carcinogen?**

[18] http://www.who.int/peh-emf/standards/en/

[19] http://www.ncbi.nlm.nih.gov/pubmed/21591902

266 A. It should not be interpreted as evidence that AMI meters are dangerous to anyone. First
267 of all, it should be noted that the WHO endorses the same international guidelines for
268 safe public RF exposure that are recognized by ICNIRP as safe. The WHO states: "To
269 date, all expert reviews on the health effects of exposure to RF fields have reached the
270 same conclusion: There have been no adverse health consequences established from
271 exposure to RF fields at levels below the international guidelines on exposure limits
272 published by the International Commission on Non-Ionizing Radiation Protection."[20]

273 In an abundance of precaution, in May of 2011, the International Agency for
274 Research on Cancer (IARC) classified RF electromagnetic fields as "possibly"
275 carcinogenic to humans (Group 2B).[21] The classification assigned to RF by IARC was
276 one of the lowest on IARC's scale of "possible" risk. The IARC category 2B includes
277 "possible" carcinogens that we all encounter, such as coconut oil (which we ingest),
278 gasoline, diesel fuel, fuel oil, "carpentry and joinery," coffee (which we drink), carbon
279 black (our car tires), car-engine exhaust, surgical implants, talc-based body powder, iron
280 supplement pills, mothballs, nickels, pickled vegetables (which many regard as healthy),
281 safrole tea, titanium dioxide, chloroform, and many other substances.[22] Moreover, IARC
282 classifications are made with no reference to the quantity of exposure, *i.e.*, no quantitative
283 comparison as to how the various societal uses of RF contribute to people's exposure. As
284 shown above, AMI meters are among the weakest sources of RF.

[20] http://www.who.int/mediacentre/factsheets/fs193/en/ and http://www.who.int/peh-emf/meetings/ottawa_june05/en/index4.html

[21] http://www.iarc.fr/en/media-centre/pr/2011/pdfs/pr208_E.pdf

[22] http://monographs.iarc.fr/ENG/Classification/ClassificationsGroupOrder.pdf

Q. **To those who might claim that the SSN radio mesh network technology has not been "proven to be safe," and therefore cannot be installed before more study is completed, what would you say?**

A. This question is often phrased as "We didn't know that smoking and asbestos was bad, now look!" While having seeming surface appeal, this analogy is neither scientifically valid nor useful, for several reasons.

First of all, the study of radio waves and people's use of the RF spectrum for communication predate the widespread use of asbestos and commercial cigarettes. Research on RF, and implementation of RF for communication, for more than 100 years has not demonstrated any health risks to society.

Second, no parallel can be drawn between the development of medical and health-effects understanding in these two areas. For RF, extensive biological and medical research has been used to identify intensity levels, *i.e.*, standards and guidelines, below which no adverse health effects are anticipated. And, as I have already noted, these safety guidelines allow RF levels much higher than those associated with AMI meters.

While some may call for reductions in exposure limits to levels far below ICNIRP limits, due to fears that some as-yet undemonstrated hazard may exist from exposure to RF energy at low levels, this is simply a response to fear. But, such an approach ignores the extensive body of science that supports the ICNIRP limits and ignores the characteristics of transmissions from an AMI meter. In fact, the WHO strongly

discourages "arbitrary adjustments to the limit values to account for the extent of scientific uncertainty,"[23] which this approach exemplifies.

III. Conclusion

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

A. Yes, it does.

[23] http://www.who.int/docstore/peh-emf/publications/facts_press/EMF-Precaution.htm

ComEd Ex. 14.01

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Areas of Expertise

Public health, inhalation toxicology, epidemiology, human health risk assessment, risk communication, indoor / outdoor air quality, comparative toxicology, modeling of human exposure and retained dose, health effects of ionizing and non-ionizing radiation.

Education

M.S., Human Physiology and Inhalation Toxicology, Harvard School of Public Health.

Ph.D., Physics, Harvard University, Graduate School of Arts and Sciences.

M.A., Physics, Harvard University.

A.B., Physics and Mathematics, *summa cum laude*, Taylor University.

Professional Experience

2001 – Present (and 1990 – 1998) GRADIENT, Cambridge, MA
Principal. Environmental consulting practice includes inhalation toxicology, environmental health, human health risk assessment, use of epidemiology in public health decisions, health effects of airborne gases and particles, and health effects of ionizing and non-ionizing radiation.

1998 – 2000 CAMBRIDGE ENVIRONMENTAL, INC., Cambridge, MA
Senior Scientist.

1985 – 2000 HARVARD SCHOOL OF PUBLIC HEALTH, Boston, MA
Associate Professor of Human Physiology. (Adjunct, after 1990) Research work included: (1) human health effects of air toxics, (2) lung macrophage function measured with magnetic particles, and (3) lung deposition and clearance of radioactive tracer particles.

1987 INSTITUTE OF OCCUPATIONAL HEALTH, Helsinki, Finland
Visiting Researcher. Developed a magnetometric assay to be used for studying pulmonary macrophage function for lung cells lavaged from human subjects.

1984 INHALATION TOXICOLOGY RESEARCH INSTITUTE, Albuquerque, NM
Visiting Scientist. Examined the effect of exercise and hypercapnia on deposition, lung clearance, and lung distribution of inhaled radioactive aerosol.

1976 – 1985 HARVARD SCHOOL OF PUBLIC HEALTH, Boston, MA
Assistant Professor of Respiratory Physiology.

1970 – 1976 AMHERST COLLEGE, Amherst, MA
Assistant Professor of Physics.

Professional Activities

- National Academy of Sciences and National Research Council, Evaluating Health-Risk-Reduction Benefits of US EPA Regulations (2001 – 2003).
- Harvard School of Public Health: Research Advisory Committee Member for NIH-Sponsored Research on "Mechanisms of mortality/morbidity due to air particulate" (1997 – 2005).
- Member of the Committee on Man and Radiation (COMAR) (1999 – 2006).
- Health Effects Institute, Cambridge, MA, *ad hoc* reviewer (1984 – 1994).
- National Research Council, Commission on Life Sciences: Committee on Passive Smoking (1986 – 1988).
- Editorial Board, *Journal of Aerosol Medicine* (1987 – 2000).
- Center for Indoor Air Research, grant-application reviewer (1989 – present).
- NIOSH: Environmental Center Grants, Site Visit Delegation (1990).
- NIH Reviewer: Cardiovascular and Pulmonary Study Section, Radiation Study Section, and Health of the Population Study Section.
- DOE: Office of Health and Environmental Research, reviewer.
- Harvard Center for Risk Analysis: Review of Cellular Telephones (1994 – 1999).
- Physical and Biological Sciences Study Committee, Town of Needham Planning Board.

Professional Affiliations

Fellow of the Academy of Toxicological Sciences • Society of Toxicology (full member) • International Society for Environmental Epidemiology • Society for Risk Analysis • Health Physics Society (full member) • Sigma Xi • American Association for the Advancement of Science • American Conference of Governmental Industrial Hygienists (associate member)

Projects *(abbreviated)*

Carbon Black Manufacturers: Evaluated the toxicology and epidemiology of carbon black inhalation and ingestion.

Charter School in Washington, DC: Prepared a health risk assessment for the school board on the health risks of handling asbestos-containing materials that might release fibers.

City of Newton Health Department: Measured RF levels from a local transmitting antenna, reviewed RF field calculations, and provided scientific literature critique on RF health effects.

Confidential Client: Prepared a risk assessment for a Massachusetts landfill containing both chemical and radioactive waste and including multiple pathways of contaminant uptake by a trespasser.

Confidential Client: Prepared a model predictive of asbestos fiber drift and inhalation health hazard applicable to industrial processes where asbestos-containing materials are used.

Confidential Clients: Prepared an analysis of relative risks of TCE in drinking water *versus* health hazards from background levels of chemicals in air, water, and soil, as well as other routine risks to life and health.

Electric-Power Generating Companies: Prepared and delivered expert reports and public testimony on the potential health effects of airborne emissions from coal fired, gas-fired, oil-fired, and wood-fired electric utility power generating plants.

Electric Power Research Institute: Reviewed and analyzed the mechanisms by which biological systems may be affected by environmental electric and magnetic fields (EMFs). Organized a public workshop on the causes and characteristics of childhood leukemia.

Engine Manufacturers Association: Evaluated US EPA and California EPA health assessment documents on the potential carcinogenicity of diesel exhaust and ambient air particulate matter.

Harvard School of Public Health: Continuing Education for Professionals: Prepared material on special topics on inhalation toxicology for graduate students and health professionals. Presented lectures on risk assessment and risk communication.

Health Effects Institute: Prepared an analysis entitled "Ozone Molecular Dosimetry and Interaction with Biological Macromolecules."

Health Effects Institute: Organized, supervised, and documented a feasibility study for the Health Effects Institute initiating a national research program on the health effects of electric and magnetic fields.

Manufacturing Company: Analyzed multi-pathway human health risk for a site contaminated with polychlorinated biphenyls (PCBs) and chlorinated organic solvents. Analyzed experimental data to derive a fraction of PCBs that are picked up from concrete when touching the concrete.

Manufacturing Company/FUSRAP Site: Prepared a radionuclide health risk assessment and site management plan for site contaminated by nearby storage of uranium ore.

Massachusetts Department of Public Health: Prepared a public communications essays on what citizens can do to support improved air quality.

Medical Product Manufacturer: Prepared a risk assessment for air toxics produced during malfunction of a medical device used to assist breathing.

Michigan Occupational and Environmental Medical Association (MOEMA): Prepared and delivered a risk assessment tutorial for MOEMA's Continuing Education program.

Mining Company: Evaluated the epidemiological basis for the toxicity of arsenic in soils. Evaluated metals toxicity factors and site-specific bioavailability of metals.

National Institute of Environmental Health Sciences – Division of Research Grants: Reviewed grant applications for the Radiation Study Section Panel on Health-Effects Research.

National Institute of Environmental Health Sciences / Environmental Protection Agency: Asbestos Workshop, assisted in the review of the summary publication, "A Science-Based Examination of Asbestos and Related Mineral Fibers".

Navy Occupational Health and Preventive Medicine Program: Prepared and delivered seminars and workshops to US Navy medical personnel on the current research on EMFs.

New Mexico Environmental Department: Prepared a health risk assessment for measured and modeled concentrations of 80 airborne chemicals in Albuquerque, NM.

Refineries in US and Canada: Prepared a multi-pathway human health risk assessment for air emissions from petroleum refineries. The risk assessment process was monitored by task forces composed of regulators, educators, union members, and local officials.

School District on Long Island: Assessed possible environmental, occupational, and lifestyle risk factors for early-term miscarriage.

University of Denver: Analyzed the potential health impact of uranium disposal from munitions testing ("depleted uranium") as it was practiced in the 1960s and 1970s.

Uranium Mill: Evaluated the health implications of radioactive substance migration as predicted by different US EPA and DOE models.

US Department of Energy: Prepared a risk communication strategy for a nuclear test site where detonation of underground atomic devices had the potential to contaminate groundwater.

US Department of Justice: Prepared an analysis of the health hazards of the Love Canal Superfund site (Niagara Falls, NY).

US Department of Justice: Prepared a report and provided expert testimony on human toxicology with regard to soil contamination at a RCRA site.

US Department of Justice: Prepared reports and provided expert testimony in several different cases on asbestos, sulfuric acid, and airborne particulate inhalation toxicology.

US Environmental Protection Agency: Provided US EPA with a peer review (scientific critique) of the agency's draft guidance on risk assessment for VOC's present in household water..

US Environmental Protection Agency: Provided US EPA with a peer review (scientific critique) of the agency's draft reference concentration (RfC) methodology for risk assessment.

US Environmental Protection Agency: Analyzed the health risks of a remediation alternative at the Bloody Run Creek section of the Hyde Park Landfill superfund site (Niagara Falls, NY).

US Environmental Protection Agency, Health Effects Research Laboratory: Assisted in preparing a database of non-cancer health effects for 189 Hazardous Air Pollutants.

US Environmental Protection Agency, Environmental Criteria and Assessment Office: Evaluated research proposals on "Indoor and Ambient Air Risk Assessment Methodologies."

Utility: Analyzed the relationship between inhaled carbon monoxide concentration and blood carboxyhemoglobin. Performed sensitivity analysis on all the variables involved.

Waste Management Company: Evaluated health risks for a medical waste incinerator, including a multiple-pathway (ingestion, inhalation, dermal, mothers' milk) health risk assessment.

World Health Organization: Helped prepare a WHO research report on EMF health effects. Presented a lecture on EMF health effects at a WHO workshop in Geneva, Switzerland. Published review article on RF health effects.

Academic Research Projects *(abbreviated)*

National Heart, Lung, and Blood Inst.:	"Physical Determinants of Lung Function and Dysfunction."
National Heart, Lung, and Blood Inst.:	"Pulmonary SCOR: Chronic Diseases of the Airways."
National Cancer Institute:	"Magnetic Field Effects on Macrophages."
National Inst. of Environ. Health Sci.:	"Inhaled Particle Retention in Normal and Diseased Lungs."
National Heart, Lung, and Blood Inst.:	"Particle Location and Ingestion by Lung Macrophages."
National Inst. of Environ. Health Sci.:	"Factors Influencing Deposition of Inhaled Aerosols."

Publications – *Articles*

Hesterberg, TW; Long, CM; Bunn, WB; Lapin, CA; McClellan, RO; Valberg, PA. 2012. "Research and regulation of diesel exhaust emissions and health effects: A historical overview focused on lung cancer risk." *Inhalation Toxicology*, In Press.

Hesterberg, TW; Bunn, WB; Valberg, PA; Long, CM. 2012. "Potential health effects of exposure to diesel engine exhausts." In *The Praeger Handbook of Environmental Health: Water, Air, and Solid Waste.* (Ed: Friis, RH), Praeger, ABC-CLIO, LLC, Santa Barbara, CA, p185-212.

Brain, JD; Kavet, R; Valberg, PA. 2012. "Observations on power-line magnetic fields associated with asthma in children." *Arch Pediatr Adolesc Med*. 166(1):97-8.

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Hesterberg, TW; Long, CM; Valberg, PA. 2011. Letter to the editor, "The Mounting Evidence Differentiating the Health Risks of New Technology Diesel Exhaust (NTDE) versus Traditional Diesel Exhaust (TDE)." *European Heart Journal.* 32(18).

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Hesterberg, TW; Long, CM; Bunn, WB; Sax, SN; Lapin, CA; Valberg, PA. 2009. "Non-cancer health effects of diesel exhaust (DE): A critical assessment of recent human and animal toxicological literature." *Critical Reviews in Toxicology* 39(3):195-227.

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Abstracts & Reports *(list available on request)*

Invited Lectures *(past 10 years)*

6/11/12 "Portals of Entry: Pulmonary Deposition and Clearance of Particles.*"* To be presented in the course "*Comprehensive Industrial Hygiene"* Harvard School of Public Health, Boston, MA.

3/19/12 "Epidemiology of Diesel Exhaust: An Overview.*"* Presented at the "*International Congress of Occupational Health"* Cancun, Mexico.

6/14/10 "Portals of Entry for Workplace Chemicals / Lung Deposition and Clearance of Inhaled Particles.*"* Presented in the course "*Comprehensive Industrial Hygiene: The Applications of Basic Principles"* Harvard School of Public Health, Boston, MA.

3/24/10 "Do Brain Cancer Rates Correlate with Ambient PM-Levels or with Hazardous Air Pollutant (HAP) Concentrations ?*"* Presented at the AAAR Specialty Conference "*Air Pollution and Health: Bridging the Gap from Sources to Health Outcomes*," San Diego, CA.

6/23/08 "Routes of Entry into the Body: Pulmonary Deposition and Clearance of Particles." Presented in the course "Comprehensive Industrial Hygiene: Practical Applications of Basic Principles," Harvard School of Public Health, Boston, MA.

6/25/07 "Routes of Entry into the Body: Pulmonary Deposition and Clearance of Particles." Presented in the course "Comprehensive Industrial Hygiene: Practical Applications of Basic Principles," Harvard School of Public Health, Boston, MA.

3/29/07 "Non-linear Exposure-Response Relationships between Ambient PM_{10} and Daily Mortality." Presentation with Dr. T. Bowers at the Society of Toxicology Annual Meeting, Charlotte, NC. This presentation was selected as one of the *Top 12 Risk Assessment Abstracts at the SOT Meeting.*

11/7/06 "What is EMF? How EMF Interacts with Organisms." Presented at the Cyprus International Institute for the Environment and Public Health symposium on "Electromagnetic Fields: Sources, Health Effects, and Regulations, Nicosia, Cyprus.

6/19/06 "Pulmonary Deposition and Clearance of Particles." Presented in the course "Comprehensive Industrial Hygiene: Practical Applications of Basic Principles," Harvard School of Public Health, Boston, MA.

5/18/06 "Health Hazards of Nanoparticles." Presented at "A Mock Hearing: Environment, Health & Safety" at the NanoBusiness Alliance Meeting, New York City, NY.

4/25/06 "Inhalation Risk Assessment: Extrapolating from Macro-materials to Nano-materials." Overcoming Obstacles to Effective Research Design in Nanotoxicology, Cambridge, MA.

10/6/05 Panelist for: "A Reevaluation of the Association Between Diesel Exhaust Exposure and Lung Cancer." Air & Waste Management Association (AWMA) Specialty Workshop on "Diesel Exhaust," Chicago, IL.

6/20/05 "The Respiratory Tract as a Portal of Entry for Airborne Chemicals in the Work Environment." Lecture at the Harvard School of Public Health course on "Comprehensive Industrial Hygiene," Boston, MA.

6/16/05 "Electromagnetic Fields, Base Stations, and Wireless Networks: Exposures & Health Consequences." WHO Workshop, 15-16 June 2005, at the World Health Organization, Geneva, Switzerland.

2/11/05 "Generation of Charged Aerosols by High-Voltage Electric-Power Lines." American Association for Aerosol Research, Specialty Conference on Particulate Matter, Atlanta, GA.

2/4/05 "Magnetic Microparticles Detect and Probe Cytoplasmic Motions." Bioelectromagnetics Society Winter Workshop, Phoenix, AZ.

6/21/04 "Pulmonary Deposition and Clearance of Particles." Harvard School of Public Health Continuing Education course on "Fundamentals of Industrial Hygiene," Boston, MA.

1/27/04 "Quantitative and Qualitative Factors that Determine Health Risk: Explaining Risk to Judges, Juries, and Communities." Mealey's Water Contamination Conference, Pasadena, CA.

9/14/02 "Health Effects of Air Pollutants." Annual Scientific Meeting of the Michigan Occupational and Environmental Medicine Association "Current Topics in Occupational and Environmental Medicine," Frankenmuth, MI.

6/18/01 "Pulmonary Physiology, and Lung Deposition and Clearance of Particles." Harvard School of Public Health Continuing Education course on "Fundamentals of Industrial Hygiene," Boston, MA.

11/14/00 "Effects of Air Pollution on the Human Lung." Lecture in Tufts University course CEE 136, "Air Pollution," Medford, MA.

7/26/00 "Review of Ambient Air Quality as it Relates to Proposed Emission Standards for Massachusetts Power Plants." Testimony before the Massachusetts Department of Environmental Protection, Boston, MA.

1/10/00 "Useful Concepts in the Physics of RF." RF Safety: Science, Compliance and Communication, Electromagnetic Energy Association and the University of Texas Health Science Center, San Antonio, TX.

Manuscript Peer Reviewer for the Following Research Journals

American Industrial Hygiene Journal; American Journal of Physics; American Journal of Respiratory Cell and Molecular Biology; American Review of Respiratory Disease; Atmospheric Environment; Bioelectromagnetics; Biophysical Journal; Biorheology; Cell Biophysics; Chemical Research in Toxicology; Critical Reviews in Toxicology; Environmental Geochemistry and Health; Environmental Health Perspectives; Environment International; Environmental Science & Technology; Epidemiology; Experimental Lung Research; Fundamental and Applied Toxicology; Hepatology; Human and Ecological Risk Assessment; Human and Experimental Toxicology; IEEE Biomedical Engineering; IEEE Transactions on Plasma Science; International Journal of Radiation Biology; Journal of Aerosol Medicine and Pulmonary Drug Delivery; Journal of Applied Physiology; Journal of Applied Toxicology; Journal of Occupational and Environmental Hygiene; Journal of Occupational and Environmental Medicine; Journal of Occupational Medicine and Toxicology; Journal of the Royal Society Interface; Journal of Toxicology and Environmental Health; Nature; Nonlinearity in Biology, Toxicology, and Medicine; Radiation Research; Risk Analysis: An International Journal; Regulatory Toxicology & Pharmacology; Science; Tissue & Cell; Toxicology and Applied Pharmacology; Toxicological Sciences; USGS Environmental Geochemistry of Mineral Deposits (Reviews in Economic Geology series).

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