Testimony of Barbara D. Beck, Ph.D., DABT

Regarding "Discussion Draft of H.R.___, a Bill that would Revise the Consumer Product Safety Improvement Act"

Prepared for the
Subcommittee on Commerce, Manufacturing, and Trade Hearing
April 7, 2011
at the
Committee on Energy and Commerce
2125 Rayburn HOB/316 Ford HOB
Washington, DC 20515

Prepared by
Barbara D. Beck, Ph.D., DABT, FATS, ERT
Gradient
20 University Road
Cambridge, MA 02138

April 7, 2011

Table of Contents

Page

Executive Summary ES-1
1 Introduction 1
2 Consumer Product Safety Improvement Act (CPSIA) of 2008 2
3 Lead Standards and Permissible Intake 3
4 Proposed Change to the CPSIA: *De Minimis* Exemption 4
5 Consideration of Exposure: Risk-Based Approach 5
5.1 Dose Response 5
5.2 Exposure Duration and Frequency 6
5.3 Exposure Route 6
5.4 Lead Intake *versus* Uptake 7
5.5 Blood Lead Modeling 8
5.6 Consideration of Age of Child 8
6 Appropriate Extraction Methods 8
7 Use of Blood Lead Modeling in Developing Permissible Lead Limits 9
8 Recommendation 11
References 12

Executive Summary

The lead limits stipulated by the Consumer Product Safety Improvement Act (CPSIA) of 2008 have forced many manufacturers to stop selling certain products, because the products contain components exceeding the current 300 ppm total lead standard of the Act. The difficulty with this approach to regulating lead in products is that it does not consider the *actual* exposure of children to lead. This is because the presence of lead in a product, as reflected by the concentration of lead, does not necessarily mean that there will be a significant exposure to lead. If the exposure to lead is very small, there will not be any health effects. Unfortunately, the present version of the CPSIA does not support consideration of exposure. Risk-based analyses that take into consideration age of child, exposure frequency and duration, exposure route, and dose represent a scientifically supportable approach to determine exclusions from the lead standard. In 2009, I recommended at a Congressional Briefing that that such risk-based analysis be allowed under the auspices of the Act. The "Discussion Draft H.R.____," dated March 29, 2011, proposed by the Subcommittee on Commerce, Manufacturing, and Trade to amend the Act, suggests just such an approach. Although details need to be worked out with respect to the testing method and specific criteria (*e.g.*, allowable lead exposure limits), conceptually the proposal, by focusing on *actual* exposure of young children to lead from a product, rather than concentration of lead in the product, represents an improvement over the present version of the CPSIA, while remaining health protective.

1 Introduction

Good morning and thank you for this opportunity to testify regarding the CPSIA and the need for a risk-based approach for lead in children's products. I am Barbara D. Beck, Ph.D., diplomate of the American Board of Toxicology (DABT), and fellow of the Academy of Toxicological Sciences. For 24 years I have been a toxicologist and Principal with Gradient, a firm specializing in human health exposure and risk assessment, and located in Cambridge, Massachusetts. Prior to Gradient, I held positions at the Harvard School of Public Health, US EPA Region I, and Tufts University School of Medicine. I am past president of the Academy of Toxicologists, and have been a DABT for 20 years.

Over my 30+ year career in toxicology and public health, I have worked extensively on projects involving lead. More than 20 years ago, while at US EPA Region I, I developed the first target action level for lead in soil. During my tenure at Gradient, I have worked for the private and the public sector on many projects involving lead exposure, toxicology and risk. These projects have included refinery and mining sites, children's toys, consumer products, and automotive vehicles. I was also significantly involved in providing regulatory comment for the lead National Air Quality Standard (NAAQS). On April 1, 2009, I testified at the CPSIA Rally and Congressional Briefing regarding lead and the CPSIA.

I would also like to emphasize that I am presenting my testimony this morning on my own behalf as an independent scientist. I am not being compensated for my travel expenses or any of the time I have spent preparing for today's testimony. In addition, I am not representing myself under any Federal contract or grant.

2 Consumer Product Safety Improvement Act (CPSIA) of 2008

The Consumer Product Safety Improvement Act (CPSIA) of 2008 stipulates that, as of August 14, 2009, children's products that contain more than 300 ppm (mg/kg) lead may no longer be sold in the United States (US Congress, 2008). The limit will be reduced to 100 ppm on August 14, 2011, unless the Commission determines that this lower limit is not technically feasible. Based on the current language, while manufacturers may petition for exclusion from these standards, exclusions are allowed only if the manufacturers can demonstrate that no lead can be absorbed by children.

The scientific community understands that, based on multiple lead-related recalls occurring in 2007, Congress was motivated to write the Act to be protective of our children's health, and, in the case of lead, to eliminate lead risk to children. However, there have been untoward consequences of the Act, as some manufacturers and businesses have suspended sales of their existing inventory. The act has been particularly burdensome for manufacturers of steel, copper, and aluminum alloys, as components made from these materials typically contain fairly high concentrations lead. The end result is that certain individual components in the products exceed the current lead standard – even though exposure to lead in those components is, because of the nature of the way children come into such components, unlikely, and would not result in health effects. Thus, the Subcommittee on Commerce, Manufacturing, and Trade has responded with a proposed bill that would amend the CPSIA to allow for a risk-based approach, that is protective of public health, and to relieve the burden to manufacturers.

As I explained during my testimony at the Congressional Briefing in 2009, a risk-based approach focuses on *actual* exposure and the health significance of that exposure. Such an approach can be extremely effective in protecting a child's health. Consider, for example, how average blood lead levels in children have been reduced by nearly 10-fold, from 15 μg/dL in 1976 to 1.5 μg/dL in 2007-2008 (CDC,

2011), an important public health success story. This was accomplished by focusing on *important* sources of lead exposure (*i.e.*, sources that had a significant impact on blood lead levels), specifically lead in air (from leaded gasoline), in food (primarily from lead solder in cans), and in paint, to the general population of children. Indeed, risk-based approaches are widely used and considered appropriate in other sectors, for example, in human health risk assessment for lead in soil performed for Superfund sites (US EPA, 1997).

3 Lead Standards and Permissible Intake

Regulatory agencies develop standards to prevent harmful health effects. In general, the agencies purposely over-estimate exposures to and the toxicity of chemicals in order to be certain that human health is protected. This means that standards have a margin of safety (*i.e.*, the permissible dose of a chemical is well below the dose that causes harmful health effects). This provides confidence that regulatory limits will be sufficiently protective for all individuals, even those who might especially sensitive to the chemicals of interest. In the case of lead, children are typically considered to be more susceptible than adults.

A permissible level of lead in a toy or another children's product must be based on an understanding of how lead is released from a toy, the amount of lead potentially ingested by a child, and the quantitative impact of that ingested lead on blood lead. Lead that cannot be released from a toy or other product because the lead is in an inaccessible location or bound in a matrix would not constitute a risk potential because the lead would not be ingested by the child. Thus, to be meaningful, a standard should be linked to the amount of lead released from the toy. A standard based on soluble lead [*e.g.*, the 90 ppm standard specified for soluble lead in ASTM F963-07e1 (ASTM, 2007)] would, in general, be

preferable to a standard based on total lead (unless a robust relationship between total lead and soluble lead has been determined).

Thus, a standard could be developed by setting a target blood lead increment and then calculating the amount of lead released from a toy or other product that would result in an impact at or below the target blood lead increment. Conceptually, health-based limits for lead in other media, such as air, water, or soil, have been developed in this manner, using exposure parameters specific to that medium (see, for example, CPSC, 1977; US EPA, 2001, 2002).

4 Proposed Change to the CPSIA: *De Minimis* Exemption

The new bill proposed by the Subcommittee on Manufacturing, Trade, and Commerce proposes a *de minimis* exemption for lead released from children's products, specifically stating that:

> The limits established under subsection (a) shall not apply to any component part of a children's product if, under reasonably foreseeable conditions of use and abuse, it is unlikely that a child who is exposed to the product would ingest more than a *de minimis* amount of lead. (Subcommittee on Manufacturing, Trade, and Commerce, 2011)

In terms of implementation, the proposed amendments state:

> The Commission shall, by regulation, establish a methodology for estimating the amount of lead a child would likely ingest from exposure to a component part. Such methodology shall distinguish, at a minimum, between parts that can be placed in the mouth and parts that cannot be placed in the mouth. (Subcommittee on Manufacturing, Trade, and Commerce, 2011)

Moreover, until such methodology is defined by the US Consumer Product Safety Commission (CPSC):

> [A] manufacturer may use any reasonable methodology to estimate the amount of lead a child would ingest from exposure to a component part. (Subcommittee on Manufacturing, Trade, and Commerce, 2011)

Although details on implementation (*e.g.*, testing method and definition of the *de minimis* lead exposure limit) need to be worked out, the proposal focuses on *actual* exposure of young children to lead from a product, and considers the impact of that exposure in terms of health. This is an important improvement over the present version of the CPSIA.

The following sections provide scientific support for the use of a risk-based approach, including a hypothetical example that describes an approach to assist in the definition of a *de minimis* level. The sections also contain information on application of such a risk-based approach to children's products, including a discussion of possible extraction methods for product testing and the use of blood lead modeling.

5 Consideration of Exposure: Risk-Based Approach

The mere presence of lead in a children's product or component does not mean that there is an exposure hazard to a child. Moreover, a component with a high concentration of lead does not necessarily mean that a child will subsequently be exposed to a high concentration of lead. Several exposure factors, described below, must be considered to determine whether the lead in a particular product constitutes a health risk to a child contacting that product.

5.1 Dose Response

The most fundamental concept in toxicology is the dose-response relationship, commonly summarized as "the dose makes the poison" (Eaton and Gilbert, 2008). All substances show a dose-response relationship. For example, small amounts of salt may be consumed without adverse effects, but ingestion of much larger quantities can result in adverse effects, such as elevated blood pressure (Braunwald *et al.*, 2001, p. 1415). As another example, at the recommended dose of two tablets,

aspirin yields pain relief from headaches or other minor aches, and even lower doses can be used to prevent and manage cardiovascular disease. However, taking more than the recommended dose can lead to increasing levels of toxicity, including death (Roberts and Morrow, 2001). Similarly, lead exhibits a dose-response relationship, with the likelihood and nature of effects being greater with increasing dose, typically expressed as blood lead levels.

5.2 Exposure Duration and Frequency

The dose of a chemical is affected by a number of factors. For example, how long and how often someone comes into contact with a chemical will affect the dose. In the case of a children's consumer product, it is important to know whether the child comes into contact with the product every day, or only occasionally. It is also important to know how many hours or minutes of each day a child contacts the product. For example, daily or infrequent contact with the product may be possible. With less time of contact, exposure will generally be less. One-time acute exposure (*i.e.*, accidential ingestion) is also possible; appropriate science-based assessments are available to account for such potential acute exposure, if that is a plausible exposure scenario.

5.3 Exposure Route

The manner in which a person comes into contact with the chemical (for example, through the skin *versus* taking the chemical in through the mouth) is also important. The chemical also must be accessible to the child in order for an exposure to occur. While some chemicals can be taken in through the skin, others are not taken in through the skin very well, if at all. In the case of children's products, a young child might possibly chip or bite paint off a painted product, or, if the paint is loose, take paint off by sucking on the children's product. If the paint contains lead, these activities could result in some lead taken into the body through the mouth; this is termed "ingestion." Because lead is not taken up through

the skin, just handling the children's product will not result in a dose of lead. Another possible exposure scenario is surface-to-hand transfer and subsequent transfer from hand to mouth. Considerations for this scenario include the surface area of the hand/fingers touching a component, the transfer of lead to the hand/fingers, the frequency and duration of the contact, the transfer of lead from hand/fingers to mouth, and subsequent intake of the lead into the body. Methods are available to quantify the transfer of metals, such as lead, from components to hands *via* use of wipe tests (see, for example, Dubé *et al*., 2004).

5.4 Lead Intake *versus* Uptake

Intake is generally expressed as the amount of a chemical at the skin, lungs, gastro-intestinal tract that is available for absorption. Intake, while necessary to yield a "dose," is not equivalent to absorbed dose (uptake), the amount of a chemical absorbed into the blood stream. Lead intake (particularly from children's products) is primarily through ingestion (*e.g.*, through direct mouthing of a children's product or through hand-to-mouth contact).

How much lead a child actually absorbs, after lead is ingested, is an important consideration in a risk-based approach. Bioavailability (*i.e.*, the fraction of ingested lead that is solubilized in the gastro-intestinal tract) determines the amount of lead that can be absorbed into the body (uptake). Bioavailability <u>should</u> be considered when evaluating exposure using a risk-based approach. The bioavailability of lead in the digestive tract depends on the physical (*i.e.*, particle size) and chemical form of lead, and can vary by more than 10-fold. This is clearly an important determinant of the amount of lead uptake into the body.

5.5 Blood Lead Modeling

In order to evaluate the impact of lead exposure to the body, the amount of lead absorbed must be converted to a blood lead value. Models such as the *Integrated Exposure Uptake Biokinetic (IEUBK) Model for Lead in Children* (US EPA, 1994), or the O'Flaherty model (1997) are widely accepted risk-based approaches that have been used in a number of circumstances to quantify the impact of lead uptake on blood lead. These models can be and have been applied in risk-based approaches to evaluate the impact on blood lead of different types of exposures of lead, from soil, air and products.

5.6 Consideration of Age of Child

The Act considers products manufactured for children up to age 12. However, it is important to note that there is a significant difference between a 2- to 3-year-old toddler and a 12-year-old, and how they will interact with a children's product. The 2- to 3-year-old will have much more frequent hand-to-mouth contact than the 12-year-old and will contact products in a different manner than a 12-year-old (US EPA, 2006; RIVM, 2008). The 2- to 3-year-old absorbs more ingested lead and is more susceptible to the developmental effects of lead than older children (US EPA, 2006; O'Flaherty, 1998). Recognition of the important behavioral and physiological differences between the young child and older children would represent a significant improvement in the CPSIA. Although the proposed amendment does not specify the age group under consideration, it appears to be reducing the target group to younger children (*versus* as old as 12 years).

6 Appropriate Extraction Methods

The new amendment is written in such a way that approaches beyond the testing procedures defined in ASTM Method F963-7e1 (ASTM, 2007) toy safety standard might be considered appropriate

for evaluating lead exposure. The use of extraction methods is one accepted approach to evaluating exposure of lead and other constituents from products. Some of the methods evaluate chemicals leaching in acidic solutions that mimic gastric fluid [*i.e.*, the solubility extraction procedures in ASTM Method F963-7e1 (ASTM, 2007)]. As another example, CPSC recently released an updated 24-hour acid extraction test procedure to address acute exposure and mimic accidental ingestion of metal jewelry; the method was designed to evaluate cadmium leaching from swallowable small parts (CPSC, 2011). These methods, while appropriate for the scenario where a small part is likely to be swallowed whole, would potentially overestimate exposure in certain cases, such as mouthing or sucking scenarios. However, protocols have also been developed and used to assess chemical leaching in saliva. For example, CPSC developed a method to assess migration of diisononyl phthalate (DINP) from polyvinyl chloride (PVC) children's products (CPSC, 1998), a method that has also been adapted by CPSC to assess lead leaching from objects due to contact with saliva. This method involves shaking the sample for 6 hours in a simulated saliva solution at a neutral pH of approximately 7.2 and at a temperature of 37°C. A similar method was adapted and used by Duke University to evaluate lead leaching from brass ball point pen tips (Baker, 2009). CPSC has used a saline extraction method to evaluate cadmium leaching from metal jewelry during a mouthing scenario (CPSC, 2010). Depending on the nature of the product and how young children interact with that product, a saline extraction method would be more appropriate than an acid extraction method in a number of cases.

7 Use of Blood Lead Modeling in Developing Permissible Lead Limits

Blood-lead modeling is an important tool used to calculate the impact of exposure on blood lead. It has been used to set permissible limits for lead in other media, such as air, water, and soil (for example, US EPA, 2008, 1988, 1998, respectively). Various blood lead targets may be considered for determination of the *de minimis* amount of lead extracted from a product. For example, in developing the

National Ambient Air Quality Standard for Lead, US EPA used a 1-2 μg/dL increment in blood lead as the target to establish a permissible air lead limit (US EPA, 2008). In the case of lead in soil, US EPA (1998) focuses on a modeled distribution of blood lead for a hypothetical child. Another consideration is whether the modeled impact of the extractable lead could have a detectable incremental impact on blood lead.[1]

While the proposed amendment does not define a *de minimis* daily intake of lead, I provide here a hypothetical example using a value of 1 μg/day intake of lead, every day for a 2- to 3-year-old. Using blood modeling, specifically US EPA's IEUBK model, this amount of ingested lead would result in a mean blood lead change of 3.0 μg/dL to 3.1 μg/dL. As presented graphically below, such an increment would be negligible.[2]

Specifically, Figure 1 compares the blood lead impact based on a 1 μg/day intake of lead. In this example, I assumed that a 2- to 3-year-old child would take in this amount of lead in a soluble form, every day for two years.[3] Alternate assumptions may, depending upon the product and the plausible ways in which a child might interact with that product, also be appropriate. In this calculation, it can be seen that the contribution of lead from 1 μg is indiscernible as the blood level remains the same.

[1] It should be emphasized that my description of these approaches is meant to be illustrative. I am not proposing a specific increment to blood lead as a target under the CPSIA, but rather describe approaches whereby a permissible limit may be developed.

[2] An impact of approximately 2 μg/dL or less of a lead release would not be reliably and routinely detectable in an individual child, For example, in a study by Chandramouli *et al*. (2009), the majority of quality control results were within a range of +/- 2 μg/dL. These findings are generally consistent with recommendations from the US Centers for Disease Control that, for investigative actions, laboratories set their internal quality control limits to +/-2 μg/dL or ±10%, whichever is greater (Parsons and Chisolm, 1997).

[3] I do not provide these exposure assumptions as ones that ought to be used under amendments to the CPSIA, but to illustrate a process.

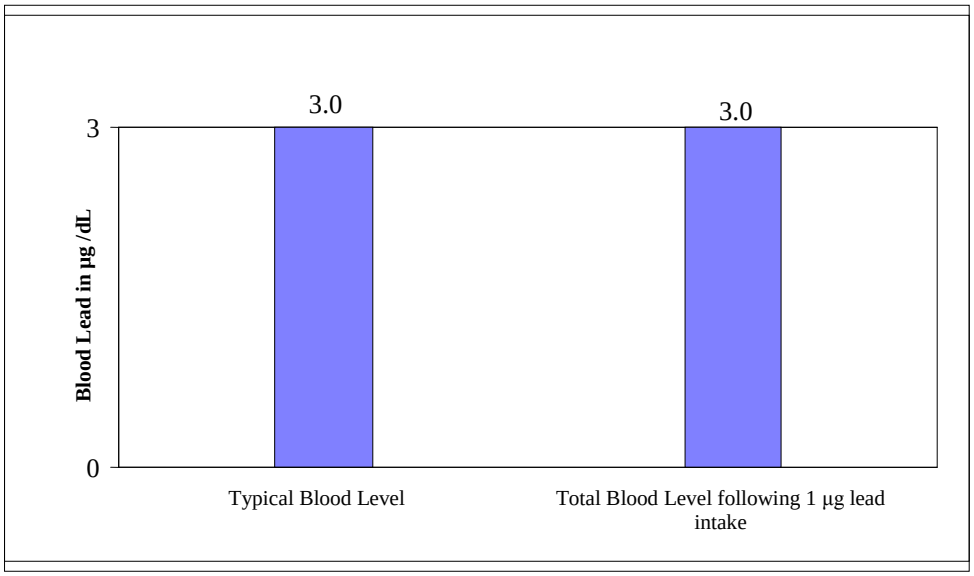

Figure 1. Comparison of Blood Lead Levels in µg/dL Before and After a 1 µg Intake by a 2- to 3-Year-Old Child

8 Recommendation

In conclusion, in order to appropriately evaluate exposure to lead in children's products, I recommend use of a risk-based approach that incorporates methods such as saliva extraction and blood lead modeling. This approach would reasonably mimic exposure scenarios relevant for a young child, while also emphasizing prevention of significant increases to blood lead. While many details remain to be worked out, I urge Congress and CPSC to seriously consider the new bill proposed by the Subcommittee on Manufacturing, Trade, and Commerce, which would amend the CPSIA to allow a health-protective risk-based approach.

References

American Society for Testing and Materials (ASTM). 2007. "ASTM F 963-07e1: Standard Consumer Safety Specification for Toy Safety."

Baker, D. 2009. "Section 101 Request for Lead Content Exclusion for Pen Point Components." Accessed on April 4, 2011 at http://www.cpsc.gov/library/foia/foia09/petition/wima_resp.pdf, February 9.

Braunwald, E; Fauci, AS; Kasper, DL; Hauser, SL; Longo, DL; Jameson, JL. 2001. *Harrison's Principles of Internal Medicine (15th Edition).* McGraw-Hill Medical Publishing Div., New York, 2800p.

Centers for Disease Control and Prevention (CDC). 2011. "Fourth National Report on Human Exposure to Environmental Chemicals [with Updated Tables, February 2011]." Accessed on March 3, 2011 at http://www.cdc.gov/exposurereport/, 655p.

Chandramouli, L; Steer, CD; Ellis, M; Emond, AM. 2009. "Effects of early childhood lead exposure on academic performance and behaviour of school age children." *Arch. Dis. Child*. doi:10.1136/adc.2008.149955.

Dubé, EM; Petito Boyce, C; Beck, BD; Lewandowski, TA; Schettler, S. 2004. "Assessment of potential human health risks from arsenic in CCA-treated wood." *Hum. Ecol. Risk Assess.* 10:1019-1067.

Eaton, DL; Gilbert, SG. 2008. "Principles of toxicology." In *Casarett and Doull's Toxicology: The Basic Science of Poisons (7th Edition).* (Ed.: Klaassen, CD), McGraw-Hill, New York, p11-44.

Netherlands, National Institute of Public Health and the Environment (RIVM). 2008. "Chemicals in Toys: A General Methodology for Assessment of Chemical Safety of Toys with a Focus on Elements." RIVM/SIR Revised Advisory Report 320003001/2008. Accessed on April 4, 2011 at http://www.rivm.nl/bibliotheek/rapporten/320003001.pdf, 234p.

O'Flaherty, EJ. 1997. "Manual for Physiologically-Based Pharmacokinetic Model for Lead."

O'Flaherty, EJ. 1998. "A physiologically based kinetic model for lead in children and adults." *Environ. Health Perspect.* 106(Suppl. 6):1495-1503.

Parsons, PJ; Chisolm, JJ Jr. 1997. "The lead laboratory." In *Screening Young Children for Lead Poisoning: Guidance for State and Local Public Health Officials*. Centers for Disease Control and Prevention (CDC). Accessed on October 15, 2010 at http://www.cdc.gov/nceh/lead/publications/1997/pdf/c1.pdf, 20p., November.

Roberts, LJ; Morrow, JD. 2001. "Analgesic-antipyretic and antiinflammatory agents." In *Goodman and Gilman's The Pharmacological Basis of Therapeutics (Tenth Edition).* (Eds.: Hardman, JG; Limbird, LE; Gilman, AG), McGraw Hill, New York, p697-703.

Subcommittee on Manufacturing, Trade, and Commerce. 2011. "Discussion Draft of H.R.___to Amend the Consumer Product Safety Laws." March 29.

US Congress. 2008. "Public Law 110-314: Consumer Product Safety Improvement Act of 2008." §101(a)(2). Accessed on January 21, 2009 at http://www.cpsc.gov/cpsia.pdf, August 14.

US Consumer Product Safety Commission (CPSC). 1977. "Title 16, Part 1303 - Lead-containing paint and certain consumer products bearing lead-containing paint." *Fed. Reg.* 42 :44199-44101, September 1.

US Consumer Product Safety Commission (CPSC). 1998. "Appendix A. Migration of DINP from polyvinyl chloride (PVC) children's products." In *The Risk of Chronic Toxicity Associated with Exposure to Diisononyl Phthalate (DINP) in Children's Products*. Accessed on December 3, 1998 at http://www.cpsc.gov, December.

US Consumer Product Safety Commission (CPSC). 2010. "Staff Report: Cadmium in Children's Metal Jewelry." Accessed on February 3, 2011 at http://www.cpsc.gov/LIBRARY/FOIA/FOIA11/os/cadmiumjewelry.pdf, 109p, October.

US Consumer Product Safety Commission (CPSC). 2011. "Test Method: CPSC-CH-E1004-11 Standard Operating Procedure for Determining Cadmium (Cd) Extractability from Children's Metal Jewelry." February 03.

US EPA. 1988. "Drinking water regulations: Maximum contaminant level goals and national primary drinking water regulations for lead and copper (Proposed)." *Fed. Reg.*53(160):31516-31578, August 18.

US EPA. 1994. "Guidance Manual for the Integrated Exposure Uptake Biokinetic Model for Lead in Children." Technical Review Workgroup for Lead, OERR Publication 9285.7-15-1, EPA 540-R-93-081, February.

US EPA. 1997. "Exposure Factors Handbook." EPA/600/P-95/002Fa, EPA/600/P-95/002Fb, EPA/600/P-96/002Fc, August.

US EPA. 1998. "Clarification to the 1994 Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities." Office of Solid Waste and Emergency Response, EPA/540/F-98-030, August.

US EPA. 2001. "Final Regulation: Residential Lead Hazards Standards - TSCA Section 403. Identification of Dangerous Levels of Lead. 40 CFR Part 745." Accessed at http://www.epa.gov/fedrgstr/EPA-TOX/2001/January/Day-05/t84.pdf.

US EPA. 2002. "National Primary Drinking Water Regulations." EPA 816F02013, http://www.epa.gov/safewater/mcl.html.

US EPA. 2006. "Air Quality Criteria for Lead. Volumes I and II (Final)." National Center for Environmental Assessment (NCEA), EPA/600/R- 5/144aF. Accessed on October 6, 2006 at http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=158823, 1856p., October.

US EPA. 2008. "National Ambient Air Quality Standards for Lead; Final Rule." *Fed. Reg.* 73:66964-67062, 40 CFR 50, 51, 53, 58, November 12.

Appendix A

Curriculum Vitae
Barbara D. Beck, Ph.D., DABT, FATS, ERT

Gradient

20 University Road
Cambridge, MA 02138
617-395-5000

Barbara D. Beck, Ph.D., DABT, FATS
Principal
bbeck@gradientcorp.com

Areas of Expertise

Risk assessment, exposure assessment, toxicology, metals, inhaled pollutants, soil contaminants, historical knowledge of toxicology.

Education & Certifications

Ph.D., Molecular Biology and Microbiology, Tufts University, 1976.

A.B., Biology, Bryn Mawr College, 1968.

Diplomate of the American Board of Toxicology, 1988; recertified 1994, 1999, 2004, 2009.

Fellow, Academy of Toxicological Sciences, 2002 to Present.

EU-registered toxicologist (ERT) *via* membership in the UK Register of Toxicologists, 2004; recertified 2007, 2009.

President, Academy of Toxicological Sciences, July 1, 2009 to June 30, 2010.

Professional Experience

1987 – Present GRADIENT, Cambridge, MA
Principal. Environmental consulting practice includes evaluation of chemical toxicity, health risk assessment for cancer and non-cancer endpoints, review of animal toxicology studies, and multi-media assessment of exposure to environmental chemicals. Special emphasis on metals and inhaled chemicals.

1985 – Present HARVARD SCHOOL OF PUBLIC HEALTH, Boston, MA
Visiting Scientist in Toxicology.

1985 – 1987 REGION I ENVIRONMENTAL PROTECTION AGENCY, Boston, MA
Regional Expert in Toxicology and Supervisory Scientist, Air Toxics Staff. Performed risk assessments for toxic air pollutants. General staff responsibilities included air impacts at waste sites, state air toxic programs, and US EPA radiation programs.

1979 – 1985 HARVARD SCHOOL OF PUBLIC HEALTH, Cambridge, MA
Research Associate in Environmental Science and Physiology and Fellow in Interdisciplinary Programs in Health. Developed short-term animal bioassay for pulmonary toxicants. Editor and author of monograph on variations in susceptibility to inhaled pollutants for both cancer and non-cancer endpoints.

1978 – 1979 TUFTS UNIVERSITY SCHOOL OF MEDICINE, Boston, MA
Instructor in Protein Chemistry. Isolated phagocytosis inhibiting factor from immunoglobulin of individuals with inherited susceptibility to bacterial infections.

1977 – 1978 HARVARD UNIVERSITY, Cambridge, MA
Postdoctoral Fellow in Biology. Researched novel properties of bacterial protein elongation factor, EF-Tu, relevant to possible role as a structural protein.

1975 – 1976 UNIVERSITY OF MASSACHUSETTS MEDICAL SCHOOL, Worcester, MA
Postdoctoral Fellow in Microbiology. Isolated and analyzed messenger RNA from slime molds. Initiated project on elongation factor, EF-Tu.

1968 – 1969 TUFTS UNIVERSITY SCHOOL OF MEDICINE, Boston, MA
Research Assistant in Molecular Biology and Microbiology. Performed genetic and biochemical studies on bacterial lipopolysaccharide.

Professional Activities

- Past President, Academy of Toxicological Sciences, June, 2010-June 20, 2011.
- President of the Academy of Toxicological Sciences, July 2009-June, 2010.
- Member of the National Research Council's Committee on the Future Operations for Management in the Nation's Subsurface Remediation Effort, November 2009-March 31, 2012.
- Visiting Scientist, Molecular and Integrative Physiological Sciences Program, Department of Environmental Health, Harvard School of Public Health, October 2008-Present.
- Member of Massachusetts Department of Public Health Advisory Committee, 2007.
- Member of Executive Committee of International Hormesis Society, 2006-Present.
- Councilor, Metals Specialty Section, Society of Toxicology, 2006-2007.
- Member of Board of Directors, Academy of Toxicological Sciences, 2005-Present.
- Member of Scientific Advisory Committee to the Manganese Health Research Program, 2004-Present.
- Peer Review Committee, US EPA National Health and Environmental Effects Research Laboratory, Experimental Toxicology Division, 2003.
- CIIT Science Advisory Committee, 2002-2004.
- Program Committee, Society of Toxicology, 2001-2005.
- American Chemistry Council Risk Assessment Methods Technical Implementation Panel, 1998-2001.
- International Life Sciences Institute Steering Committee on Cumulative Risk Assessment, 1998.
- American Water Works Association Research Foundation Peer Review Panel on Arsenic, 1997-1998.
- Membership Committee, Society of Toxicology, 1997-2000.
- Continuing Education Committee, Society of Toxicology, 1996-1997.
- Risk Assessment Task Force, Society of Toxicology, 1996 to 2000; chair 1999-2000.
- Advisory Committee to Public Health Program, Florida A & M University, 1996-2002.
- Chair of Session on Ecological and Human Health Protocols at GRI meeting on Environmentally Acceptable Endpoints in Soil, Arlington, VA, 1995.
- Session Chair, International Conference on Arsenic, San Diego, CA, 1995.
- Watertown, MA, Board of Health, 1995 - Present; chair, 2003.
- Rapporteur 1994. US EPA Meeting on Risk Assessment for Chemical Mixtures, Research Triangle Park, NC.
- Program Committee, Society of Toxicology, 1993 - 1996.
- Member of Arsenic Task Force, Society for Environmental Geochemistry and Health, 1993-1995.
- Work Group on Arsenic, Society for Environmental Geochemistry and Health, 1993.
- President, Society of Toxicology, Risk Assessment Specialty Section, 1994-1995.
- Vice President, Society of Toxicology, Risk Assessment Specialty Section, 1993-1994.
- President, Northeast Chapter of the Society of Toxicology, 1992-1993.
- Review Committee, US EPA Workshop on the Methodology for Deriving National Ambient Water Quality Criteria for the Protection of Human Health, 1992.
- Consultant to SAB Committee on Hazardous Air Pollutants, 1991.
- Member of Advisory Committee to US EPA on Metal Bioavailability, 1990.

- Member of Advisory Committee to Harvard Center for Risk Analysis, 1990-1993.
- Member of Committee on Public Communications, Society of Toxicology, 1990-1992.
- Councilor of Inhalation Specialty Section, Society of Toxicology, 1990-1992.
- Member of Technical Committee of Council for Health and Environmental Safety of Soils (CHESS), 1988-1990.
- President, Northeast Chapter of the Society for Risk Analysis, 1987-1988.
- US EPA Risk Assessment Forum, 1986-1987.
- Maine Science Advisory Panel, 1986-1990.
- Air Toxics Committee of Northeast States for Coordinated Air Use Management, 1985-1987.
- Rhode Island Air Toxics Advisory Committee, 1986-1987.
- Massachusetts Visibility/Public Health Index Peer Review Team, 1986.
- Massachusetts Air Toxics Guidelines Review Committee, 1985-1988.
- Peer Review Committee, US EPA Inhalation RfD Document, 1987.

Professional Affiliations

American Thoracic Society • Society of Toxicology • Northeast Chapter of the Society of Toxicology • Society for Risk Analysis • New England Chapter of the Society for Risk Analysis • American Association for the Advancement of Science • Society of Environmental Geochemistry and Health • International Society of Exposure Analysis • Academy of Toxicological Sciences

Projects

Law Firm: Provided expert support regarding health significance of releases to air from an oil refinery during upset conditions.

Law Firm: Evaluation of potential human health risks for metals, including arsenic, barium, lead and zinc, at a site used for manufacture of drilling muds.

Law Firm: Evaluation of potential risks from manganese into air and soil near manufacturing facility.

Engineering Company: Exposure to hexavalent chromium in outdoor air and soil. Evaluated toxicological causation and need for medical monitoring.

Health Canada: Peer review of exposure components of pilot program *Screening Assessment Document* for ethylbenzene. Peer review of toxicological analysis of aniline.

Perchlorate Study Group: Comments on scientific validity of US EPA RfD for perchlorate.

Gas Utility Companies: Analysis of exposures to and toxicological effects of elemental mercury in air.

Multiple Industrial Clients: Analysis of historical state of knowledge of asbestos exposure, toxicology, and risks.

Law Firm: Litigation support for lead- and arsenic-contaminated site in western US, including critique of risk assessments and assistance in design and interpretation of epidemiological study.

Industrial Client: Litigation support in multiple cases involving effects of lead on different health endpoints, including neurocognitive changes and behavioral effects in children.

Chemical Manufacturer: Analysis of toxicity of PCE and review of state risk assessments at dry cleaning sites.

Law Firm: Evaluation of risks associated with CCA-treated wood. Development of studies for CCA-treated wood.

Law Firm: Evaluation of health effects of ozone, including consideration of epidemiological, chamber, and animal studies.

Utility company: Evaluation of exposures and risks of coal fly ash.

Law Firm: Evaluation of potential short-term and long-term human health risks from metals including zinc and organics (including mineral oils) from possible medical exposures.

Environmental Engineering Company: Human health and ecological risk assessment for PAHs, dioxins, and other compounds at a former chemical R&D facility, including development and oversight of sampling.

EPRI: Synthesis report of arsenic research studies. Toxicological analysis of methylmercury and lead; development of research plan.

US EPA, Office of Research and Development: Development of toxicity data base for inhalation exposure to the Hazardous Air Pollutants listed under the 1990 Clean Air Act Amendments.

Law Firm: Risk communication and evaluation of toxicological causation for range of organic and inorganic compounds at landfill site. Also evaluated potential cancer cluster.

Law Firm: Analysis of exposures and risks of elemental mercury, including use of biomonitoring data.

Pesticide Registrant: Evaluation of carcinogenic mode-of-action and EU classification of a biocide.

Utility Research Organization: Analysis of toxicity of methylmercury and lead, and potential for interactions.

Trade Association: Evaluation of releases of lead into drinking water and potential health risks.

Wood Preservative Science Council: Evaluation of US EPA Stochastic Human Exposure Dose Simulation model.

Electronics Manufacturer: Risk communication to plant employees regarding exposures to TCE and DCE in groundwater.

Consumer Product Manufacturer: Evaluation of toxicity of hydrogen sulfide and risk communication on hydrogen sulfide at community meetings.

Consulting Company: Evaluation of health significance of metal exposures, especially iron, at historic mine site in New England.

New Mexico Environment Dept.: Risk assessment for metals at copper mining and smelting site.

Non-Governmental Organization: Evaluation of regulatory approaches regarding environmental releases of mercury.

Law Firm: Review of historic toxicological knowledge of PCBs for a case involving two manufacturing sites.

Law Firm: Exposure and risk assessment for vinyl chloride, ethylene dichloride, other solvents, and mercury at on-going chemical manufacturer.

Chemical Manufacturers Association: Review of US EPA land disposal regulations Phase IV. Review of ozone risk assessment in US EPA ozone staff paper.

Multinational Manufacturer: Risk assessment and risk communication for perchloroethylene in drinking water at operating facility in Asia.

Law Firm: Evaluation of risks and regulatory decisions associated with trichloroethylene in drinking water at site in southeastern US.

American Petroleum Institute: Role of risk assessment and potential cost savings in Superfund remedy selection process.

Law Firm: Evaluation of elemental mercury exposure in residences.

Pesticide Manufacturer: Evaluation of toxicity and environmental migration of organo-arsenicals. Probabilistic margin-of-exposure analysis for inorganic arsenic.

Law Firm: Evaluation of association between multiple pesticides and a birth defect. Multi-pathway dose reconstruction.

Utility Company: Risk assessment and risk communication support for TRI emissions from coal-fired power plants.

Industrial Client: Participation in advisory panel regarding health effects of inhaled and ingested hexavalent chromium.

Law Firm: Evaluation of medical monitoring claim in case involving exposure to arsenic, nickel, and antimony.

Law Firm: Evaluation of possible air exposures and health studies at former phosphorous manufacturer in Florida.

Law Firm: Toxicological evaluation of oil residuals on medical implants.

International Chemical Manufacturer: Evaluation of cancer classification systems and setting of occupational exposure limits in European countries and organizations.

Boston Medical Center: Coordination of study of potential effects of perchlorate in humans.

Zinc Corporation of America: Risk assessment using both environmental and epidemiological data for lead and cadmium in soil at a Superfund site.

Major Canadian Mining Company: Evaluation of arsenic exposure at mining/milling site using biological monitoring, risk assessment for arsenic, and communication with the public and regulatory agencies.

Law Firm: Evaluation of toxicological effects from acute exposures to ammonia.

Law Firm Representing Utility Company: Prepared report regarding historic knowledge of toxicity of simple and complex cyanides, and of oxide box waste materials at former MGP sites. Prepared risk assessment for site.

Law Firm: Evaluation of toxicology of mineral spirits.

US Dept. of Justice: Development of sampling plan and risk assessment for spray drift exposure to pesticides.

US Dept. of Navy: Risk assessment for volatiles released from waste water treatment plant.

Law Firm: Assessment of toxicity and risks of MTBE.

Law Firm Representing Smelter Owner: Evaluated health protectiveness of state cleanup levels for arsenic, lead, and cadmium in soil in class action case.

Law Firm Representing Municipality and Port Authority: Prepared risk assessment for proposed development at former MGP site, evaluating future exposures to construction workers and residents. Developed risk-based remedial targets.

Major Mining Company: Reviewed historical toxicological knowledge of lead.

Law Firms Representing Multiple PRPs at Site Involving Groundwater: Evaluation of historical uses, and standards and criteria for trichloroethylene.

Chemical Manufacturer: Development of risk screening process for evaluating potential hazards at international sites as part of property transfer.

Major Consumer Product Manufacturer: Development and application of adult blood lead model to predict blood lead levels from discontinuous exposures to lead released from a consumer product.

Engineering Firm: Evaluation of methodologies and assumptions used by US EPA and other investigators to estimate risks from polychlorinated biphenyls in soils and sediments, with particular emphasis on dermal absorption.

Health Effects Institute: Assessment of literature on carcinogenicity of inhaled diesel exhaust particulates, especially using urine mutagenicity. Review of literature on toxicity of carbon monoxide and effects on individuals with angina.

Massachusetts Attorney General: Expert witness testimony on the use of risk assessment for the siting of an energy facility.

Chemical Manufacturer: Review of toxicity of barium compounds in cost allocation project.

Lead Industries Association: Critique of HUD cost benefit analysis on apartment deleading.

Engineering Company: Risk assessment for lead, asbestos, PCBs, and other chemicals in soil and water at former brake lining manufacturing facility.

Law Firm: Risk support at multiple MGP sites, including evaluation of potential risks from VOCs in groundwater and evaluation of potential risks to workers from PAHs in soil.

Battery Manufacturing Company: Development and oversight on sample collection and analysis program for lead exposure, evaluation of existing blood lead and tooth lead data, and application of blood lead model.

Oil & Gas Company: Risk assessment support for several major mining-related Superfund sites in the western US. Evaluation of toxicology, epidemiology, and bioavailability of metals, including lead, arsenic, and cadmium.

International Lead Zinc Research and Organization: Development of probabilistic blood lead model.

Chemical Manufacturer: Toxicology assessment for organo-tin compounds.

Marine Shale Processors: Risk assessment of lead, other inorganics and organic compounds in aggregate produced by hazardous waste recycling. Evaluation of risks of air emissions during incineration process.

American Red Cross: Review of toxicity of new blood bag plasticizer and assessment of potential risks to blood product recipients.

Remedial Trust Representing Consortium of PRPs: Evaluation of university and agency research plans involving groundwater modeling and remedial approaches at former manufacturing site. Evaluation of biomonitoring approaches for metals. Evaluation of arsenic risk assessment for site.

Coalition for Clean Air Act Implementation: Evaluation of technical issues, including use of composite scores, in 112(g), trading of hazardous air pollutants. Quantification of uncertainty in the composite source.

Law Firm: Review of toxicology of atmospheric sulfuric acid.

Canadian Mining Company: Arsenic risk assessment at tailings site. Risk assessment for multiple metals associated with tailings release at mine in Southeast Asia.

American Chemistry Council: Evaluation of epidemiological studies used in ozone NAAQS.

Law Firm: Litigation support case involving alleged residential exposure to municipal landfill chemicals.

Mining/Smelting Company: Evaluation of multipathway risks associated with slag use. Critique of US EPA Hazardous Waste Identification Rule.

Oil & Gas Company: Preparation of technical comments on toxicological evaluation and risk assessment used for listing of lead by Cal EPA as toxic air pollutant.

Consortium of Massachusetts Utility Companies: Review of toxicological knowledge of chemicals at MGP sites over time for Massachusetts generic rate setting case.

Law Firm: Evaluation of non-cancer risks from alkylphenols in groundwater at a wood tar site, based on structure activity relationships. Evaluation of risks from polycyclic aromatic hydrocarbons.

US EPA Region I: Compilation and review of air toxics monitoring studies in Region I with respect to adequacy in reflecting human exposure and in identifying relevant sources from a risk perspective.

Engineering Firm: Risk assessment for volatile chemicals possibly entering a building due to site remediation.

Pharmaceutical Company: Critique of *Federal Register* notice on delisting of incinerator ash from RCRA regulations. Reviewed applicability of model to dioxin-contaminated ash.

Petroleum Company: Risk assessment for volatile compounds, polycyclic aromatic hydrocarbons, and metals in air, soil, and water associated with former refinery operations and with natural gas and petroleum formations.

American Lung Association of Maine: Technical advice on health effects of criteria and non-criteria air pollutants. Review of regulatory packages.

Northeast States for Coordinated Air Use Management: Technical assistance in organizing conference on use of bioassays in evaluating ambient air pollutants and presentation of report on use of short-term pulmonary bioassays in evaluation of toxicity and potential health effects of urban particulates.

Engineering Company: Risk assessment for metals in soil at US Navy shipyard for RCRA clean closure.

New Jersey Dept. of Environmental Protection: Site assessment and risk assessment for specialty chemical manufacturing site in New Jersey involving volatile organic chemicals and DDT.

US EPA/Engineering Company: Development of work plan to conduct morbidity or mortality study, using readily available databases, for high ozone levels experienced in summer of 1988.

Law Firm: Risk assessment for arsenic-contaminated soil. Assessed human health risks *via* inhalation and ingestion and ecological risks to deer populations.

Utility: Review of regulations regarding disposal of incinerator ash. Also reviewed air emissions from RDF facilities in comparison with emissions from traditional incinerators.

Oil Refinery: Ecological and human health risk assessment for solvent extracted soils originally contaminated with petroleum waste, based on potential to contaminate nearby harbor in New Jersey.

Gas Research Institute: Assistance in preparation of exposure manual for MGP sites.

Law Firm: Evaluation of lead releases from consumer household product into drinking water and recommendations for studies.

Law Firm: Regulatory analysis for perchlorate in drinking water well in Massachusetts.

State Agency: Impact analysis for a potential toxicological exposure of a biologic product related to manufacturing.

Publications – *Articles*

Beyer, LA; Beck, BD; Lewandowski, TA. 2011. "Historical perspective on the use of animal bioassays to predict carcinogenicity: Evolution in design and recognition of utility." *Crit. Rev. Toxicol.* DOI: 10.3109/10408444.2010.54122.

Greenberg, GI; Beck, BD. 2011. "Use of Years of Potential Life Lost (YPLL) for Risk Assessment at Hazardous Waste Sites." In *Encyclopedia of Environmental Health.* (Ed.: Nriagu JO), Elsevier Press, Burlington, MA, (5)602–607.

Petito Boyce, C; Lewis, AS; Sax, SN; Beck, BD; Eldan, M; Cohen, SM. 2010. Letter regarding "Probabilistic Modeling of Dietary Arsenic Exposure (Xue *et al*., 2010)." *Environ. Health Perspect.* 118(8):A331.

Lewis, AS; Beck, BD. 2010. "Nonlinear low-dose extrapolations." In *Cancer Risk Assessment: Chemical Carcinogenesis, Hazard Evaluation, and Risk Quantification,* (Eds.: Hsu, CH; Stedeford, T), Wiley Press, pp. 659-680.

Meek, ME (Bette); Levy, L; Beck, BD; Danzeisen, R; Donohue, JM; Arnold, IMF; Krewski, D. 2010. "Risk assessment practice for essential metals." *Journal of Toxicol. & Env. Health.* 73(2&3):253-260.

Prueitt, RL; Beck, BD. 2010. Commentary on "Toxicity Testing in the 21st Century: A Vision and Strategy." *Hum. Exp. Toxicol*. 29(1):7-9.

Prueitt, RL; Beck, BD. 2009. Commentary on "Toxicity Testing in the 21st Century: A Vision and Strategy." *Belle Newsletter.* 15(3):3-5.

Long, CM; Beck, BD. 2009. "Study of Chinese print workers claims to provide the first human evidence of the clinical toxicity of long-term nanoparticle exposures." *InterNano* [online newsletter]. Accessed from http://www.internano.org/content/view/306/1/, October 29.

Bailey, LA; Goodman, JE; Beck, BD. 2009. "Proposal for a revised Reference Concentration (RfC) for manganese based on recent epidemiological studies." *Regul. Toxicol. Pharmacol.* 55:330-339.

Nascarella, MA; Calabrese, EJ; Beck, BD. 2009. "Quantifying hormetic (biphasic) dose-responses in the assessment of nanoparticle toxicology." In *Conference Proceedings: International Conference on the Environmental Implications and Applications of Nanotechnology, University of Massachusetts Amherst.* (Ed: The Environmental Institute), p67-73.

Goodman, JE; Beyer, LA; Beck, BD. 2009. Comment on Caldwell *et al*. article, "Evaluation of evidence for infection as the mode of action for induction of rat lymphoma." *Environ. and Molecular Mutagenesis.* 50(1):4-5.

Petito Boyce, C; Lewis, AS; Sax, SN; Eldan, M; Cohen, SM; Beck, BD. 2008. "Probabilistic analysis of human health risks associated with background concentrations of inorganic arsenic: Use of a margin of exposure approach." *Hum. and Ecol. Risk Assess*. 14(6):1159-1201. ****Awarded HERA Paper of the Year 2008 in the category of Human Health Risk Assessment.**

Beck, BD; Lewis, AS; Slayton, TM. 2008. "Arsenic." In *Encyclopedia of Quantitative Risk Analysis and Assessment (Volumes 1-4).* (Eds: Melnick, EL; Everitt, BS), John Wiley & Sons, West Sussex, England.

Kenyon, EM; Klimecki, WT; El-Masri, H; Conolly, RB; Clewell, HJ; Beck, BD. 2008. "How can biologically-based modeling of arsenic kinetics and dynamics inform the risk assessment process? – A workshop review." *Toxicol. and Appl. Pharm.* 232:359-368.

Seeley, MR; Beck, BD. 2008. Commentary on "Hormesis and Toxic Torts." *Hum. and Exp. Tox.* 27(2):115-6.

Beck, B. 2008. Letter to the editor re: Effects of MTBE on Leydig cell tumors in Sprague-Dawley rats: Range of possible poly-3 results. *Regul. Toxicol. Pharmacol.* 50:430.

Saxe, JK; Wannamaker, EJ; Conklin, SW; Shupe, TF; Beck, BD. 2008. Reply to comment from Solo-Gabriele *et al.* on "Evaluating landfill disposal of chromated copper arsenate (CCA) treated wood and potential effects on groundwater: Evidence from Florida." *Chemosphere.* 70:1932-1934.

Goodman, JE; Gaylor, D; Beyer, LA; Rhomberg, LR; Beck, BD. 2008. "Effects of MTBE on the reported incidence of Leydig cell tumors in Sprague-Dawley rats: Range of possible poly-3 results." *Regul. Toxicol. Pharmacol.* 50:273-284.

Beck, BD; Calabrese, EJ; Slayton, TM; Rudel, R. 2008. "The use of toxicology in the regulatory process." In *Principles and Methods of Tox., Fifth Edition.* (Ed.: Hayes, AW), Taylor & Francis, Philadelphia, PA, p45-102.

Petito Boyce, C; Lewis, AS; Butler, EL; Saxe, JK; Beck, BD. 2007. Letter to the editor re: Datta *et al.*, 2006: "Arsenic biogeochemistry and human health risk assessment in organo-arsenical pesticide-applied acidic and alkaline soils: An incubation study." *Sci. Total Environ.* 388(1-3):372-375.

Seeley, MR; Beck, BD. 2007. Commentary on "Hormesis and Toxic Torts." *Belle Newsletter.* 14:2(16).

Bowers, TS; Beck, BD. 2007. Response to second comment by Bergdahl on "What is the meaning of non-linear dose-response relationships between blood lead concentration and IQ" and our earlier response. *NeuroToxicol*. 28:706.

Bowers, TS; Beck, BD. 2007. Response to comments by Bergdahl, Hornung *et al*., Jusko *et al*., and Svendsgaard *et al*. on "What is the meaning of non-linear dose-response relationships between blood lead concentration and IQ." *NeuroToxicol*. 28:196-201.

Saxe, JK; Wannamaker, EJ; Conklin, SW; Shupe, TF; Beck, BD. 2007 "Evaluating landfill disposal of chromated copper arsenate (CCA) treated wood and potential effects on groundwater: Evidence from Florida." *Chemosphere.* 66:496-504.

Bowers, TS; Beck, BD. 2006. "What is the meaning of non-linear dose-response relationships between blood lead concentrations and IQ?" *Neurotoxicol.* 27:520-524.

Beck, BD. 2006. "An evaluation of the US Environmental Protection Agency definition of a risk assessment." *Hum. Exp. Toxicol*. 25:3-5.

Beck, BD; Seeley, MR; Ghosh, RS; Drivas, PJ; Shifrin, NS. 2006. "Human health risk assessment of cyanide compounds in water and soil." In *Cyanide in Water and Soil: Chemistry, Risk, and Management*. (Eds: Dzombac, D; Ghosh, R; Wong-Chong, GM), Taylor & Francis, Boca Raton, FL, p309-330.

Braverman, LE; Pearce, EN; He, X; Pino, S; Seeley, M; Beck, B; Magnani, B; Blount, BC; Firek, A. 2006. "Effects of six months of daily low-dose perchlorate exposure on thyroid function in healthy volunteers." *J. Clin. Endocrinol. Metab.* 91(7):2721-2724.

Lewandowski, TA; Hayes, AW; Beck, BD. 2005. "Risk evaluation of occupational exposure to methylene dianiline and toluene diamine in polyurethane foam." *Hum. Exp. Toxicol*. 24:655-662.

Cohen, SM; Arnold, LL; Eldan, M; Schoen, AS; Beck, BD. 2005. "Methylated arsenicals: The implications of metabolism and carcinogenicity studies in rodents to human risk assessment." *Crit. Rev. Toxicol.* 36:99-133.

Beck, BD. 2005. "An evaluation of the EPA definition of a risk assessment." *Belle Newsletter*. 13(1):4-6.

Long, CM; Seeley, M; Beck, BD. 2005. "Tiny particles, large data gaps: A risk assessment perspective on nanotechnology." *Risk Policy Rep.* 12(13):12-14.

Petito Boyce, C; Beck, BD; Dubé, EM; Lewandowski, TA. 2005. Letter to the Editor re: Hemond and Solo-Gabriele, 2004: "Children's exposure to arsenic from CCA-treated wooden decks and playground structures." *Risk Analysis.* 25(1):1-5.

Lewandowski, TA; Seeley, MR; Beck, BD. 2004. Response to Letter to the Editor re: Zoeller, RT, 2004: "Interspecies differences in susceptibility to perturbation of thyroid homeostasis requires a definition of 'sensitivity' that is informative for risk analysis." *Reg. Toxicol. and Pharm.* 40:381-382.

Dubé, EM; Petito Boyce, C; Beck, BD; Lewandowski, TA; Schettler, S. 2004. "Assessment of potential human health risks from arsenic in CCA-treated wood." *Hum. & Ecol. Risk Assess.* 10:1019-1067.

Lewandowski, TA; Beck, BD. 2004. Letter to the Editor re: Tsuji *et al*., 2004. "Additional support for derivation of an acute/subchronic reference level for arsenic." *Reg. Toxicol. and Pharm.* 40:370-371.

Lewandowski, TA; Seeley, MR; Beck, BD. 2004. "Interspecies differences in susceptibility to perturbation of thyroid homeostasis: A case study with perchlorate." *Reg. Toxicol. and Pharm.* 39(3):348-362.

Schoen, A; Beck, BD; Sharma, R; Dubé, EM. 2004. "Arsenic toxicity at low doses: Epidemiological and mode of action considerations." *Toxicol. Appl. Pharm.* 198(3):253-267. ****Named as one of the top 10 published papers demonstrating application of risk assessment by the Risk Assessment Specialty Section of the Society of Toxicology, 2004.**

Lewandowski, TA; Seeley, MR; Beck, BD. 2003. "The importance of interspecies differences in susceptibility to perchlorate for human health risk assessment." In *Proceedings of the Groundwater Resources Association of California Symposium: Perchlorate in Groundwater: Occurrence, Analysis & Treatment*, July.

Beyer, LA; Seeley, MR; Beck BD. 2003. "Evaluation of potential exposure to metals in laundered shop towels." *Int. Nonwovens Journal* 12(4):22-37.

Beck, BD; Mattuck, RL; Bowers, TS. 2002. "Adult:child differences in the intraspecies uncertainty factor: A case study using lead." *Hum. & Ecol. Risk Assess.* 8(4):877-884.

Beck, BD; Slayton, TM; Farr, CH; Sved, DW; Crecelius, EA; Holson, JF. 2002. "Systemic uptake of inhaled arsenic in rabbits." *Human & Experimental Tox.* 21:205-215.

Mattuck, RL; Beck, BD; Bowers, TS; Cohen, JT. 2001. "Recent trends in childhood blood lead levels." *Arch. Environ. Health.* 56(6):536-541.

Seeley, MR; Tonner-Navarro, LE; Beck, BD; Deskin, R; Feron, VJ; Johanson, G; Bolt, HM. 2001. "Procedures for health risk assessment in Europe." *Reg. Toxicol. and Pharm.* 34:153-169.

Beck, BD; Mattuck, RL; Bowers, TS; Cohen, JT; O'Flaherty, E. 2001. "The development of a stochastic physiologically-based pharmacokinetic model for lead." *The Science of the Total Environment.* 274:15-19.

Beck, BD; Clewell, III, HJ. 2001. "Uncertainty/safety factors in health risk assessment: Opportunities for improvement." *Hum. & Ecol. Risk Assess.* 7(1):203-207.

Beck, BD; Slayton, TM; Calabrese, EJ; Baldwin, L; Rudel, R. 2001. "The use of toxicology in the regulatory process." In *Principles and Methods of Tox., Fourth Edition.* (Ed.: Hayes, AW), Taylor & Francis, Philadelphia, PA, p23-75.

Slikker, W; Beck, BD; Anger, WK; Bellinger, D; Cory-Slechta, DA; Paule, MG. 2000. "Cognitive tests: Interpretation for neurotoxicity?" *Tox. Sciences.* 58:222-234.

Abernathy, CO; Liu, Y-P; Longfellow, D; Aposhian, HV; Beck, BD; Fowler, B; Goyer, R; Menzer, R; Rossman, T; Thompson, C; Waalkes, M. 1999. "Arsenic: Health effects, mechanisms of actions, and research issues." *Environ. Health Perspect.* 107(7):593-597.

Connolly, RB; Beck, BD; Goodman, JI. 1999. "Stimulating research to improve the scientific basis of risk assessment. *Tox. Sciences.* 49:1-4.

Goering, PL; Aposhian, HV; Mass, MJ; Cebrian, M; Beck, BD; Waalkes, M. 1999. "The enigma of arsenic carcinogenesis: role of metabolism." *Tox. Sciences.* 49:5-14.

Shifrin, NS; Beck, BD. 1999. "Debating RBCA." *Civil Engineering.* Feb:10-11.

Beyer, LA; Beck, BD. 1998. "Confronting challenges in integrated risk assessment." *Env. Compliance & Lit. Strategy.* 14(5):3-4.

Cohen, JT; Beck, BD; Bowers, TS; Bornschein, RL; Calabrese, EJ. 1998. "An arsenic exposure model: Probabilistic validation using empirical data." *Hum. & Ecol. Risk Assess.* 4(2):341-377.

Valberg, PA; Beck, BD; Boardman, PD; Cohen, JT. 1998. "Likelihood ratio analysis of skin cancer prevalence associated with arsenic in drinking water in the USA." *Environ. Geochemistry and Health.* 20(2):61-66.

Beck, BD; Cohen, JT. 1997. "Risk assessment for criteria pollutants *vs.* other non-carcinogens: The difference between implicit and explicit conservatism." *Hum. & Ecol. Risk Assess.* 3(4):617-626.

Cohen, JT; Beck, BD; Rudel, R. 1997. "Life years lost at hazardous waste sites: Remediation worker fatalities *vs.* cancer deaths to nearby residents." *Risk Analysis.* 17(4):419-425.

Valberg, PA; Beck, BD; Bowers, TS; Keating, JL; Bergstrom, PD; Boardman, PD. 1997. "Issues in setting health-based cleanup levels for arsenic in soil." *Reg. Toxicol. and Pharm*. 26:219-229.

Beck, BD. 1997. "The use of information on susceptibility in risk assessment: State of the science and potential for improvement." *Environ. Toxicol. and Pharm*. 4(4):229-234.

Chappell, WR; Beck, BD; Brown, KG; Chaney, R; Cothern, CR; North, KJ; Thornton, I; Tsongas, TA. 1997. "Inorganic arsenic: A need and an opportunity to improve risk assessment." *Environ. Health Perspect*. 105(10):1060-1067.

Foster, SJ; Beck, BD. 1996. "Basement gas: Issues related to the migration of potentially toxic chemicals into house basements from distant sources." *Toxicology and Industrial Health* 12(2):165-177.

Brown, KG; Beck, BD. 1996. "Arsenic and bladder cancer mortality." *Epidemiol*. 7:557-558.

Slayton, TM; Beck, BD; Reynolds, KA; Chapnick, SD; Valberg, PA; Yost, LJ; Schoof, RA; Gauthier, T; Jones, L. 1996. "Issues in arsenic cancer risk assessment." *Environ. Health Perspect*. 104:2-4.

Brain, JD; Blanchard, JD; Heyder, J; Wolfthal, SF; Beck, BD. 1996. "Relative toxicity of di(2-ethylhexyl) sebacate and related compounds in an *in vivo* hamster bioassay." *Inhal. Toxicology.* 8:579-593.

Shifrin, NS; Beck, BD; Gauthier, TD; Chapnick, SD; Goodman, G. 1996. "Chemistry, toxicology, and human health risk of cyanide compounds in soils at former manufactured gas plant sites." *Regul. Toxicol. Pharmacol.* 23:106-116.

Rudel, R; Slayton, TM; Beck, BD. 1996. "Implications of arsenic genotoxicity for dose-response of carcinogenic effects." *Regul. Toxicol. Pharmacol.* 23:87-105.

Sexton, K; Beck, BD; Bingham, E; Brain, JD; DeMarini, DM; Hertzberg, RC; O'Flaherty, EJ; Pounds, JG. 1995. "Chemical mixtures from a public health perspective: The importance of research for informed decision making." *Toxicology.* 105:429-441.

Beck, BD; Boardman, PD; Hook, GC; Rudel, RA; Slayton, TM; Carlson-Lynch, RA. 1995. Response to Smith *et al*. *Environ. Health Perspect.* 103(1):15-17.

Beck, B; Rudel, RA; Hook, GC; Bowers, TS. 1995. "Risk Assessment." In *Organ-Specific Metal Toxicology*. (Eds.: Klaasen, C; Waalkes, M; Goyer, R), Academic Press, p141-185.

Beck, BD; Rudel, R; Calabrese, EJ. 1994. "The use of toxicology in the regulatory process." In *Principles and Methods of Toxicology*. (Ed.: Hayes, AW), Raven Press, New York, p19-58.

Carlson-Lynch, H; Beck, BD; Boardman, PD. 1994. "Arsenic risk assessment." *Environ. Health Perspect.* 102(4):354-356.

Bowers, TS; Beck, BD; Karam, HS. 1994. "Assessing the relationship between environmental lead concentrations and adult blood lead levels." *Risk Analysis.* 14(2):183-189.

Beck, BD. 1993. Coauthor of section on antimony in "Metals bioavailability and disposition kinetics - research needs." Workshop (Chairman, J. McKinney). *Toxicol. Environ. Chem.* 38 :1-71.

Beck, BD; Conolly, RB; Dourson, ML; Guth, D; Hattis, D; Kimmel, C; Lewis, SC. 1993. "Improvements in quantitative noncancer risk assessment." *Fund. Appl. Toxicol*. 20:1-14.

Rudel, RA; Beck, BD. 1993. "Risk assessment for indoor air: Evaluating risks to susceptible populations." In *Methods of Risk Assessment for the Indoor Environment*. (Ed.: Seifert, B). NATO/CCMS Pilot Study of Indoor Air Quality and European Collaborative Action. Indoor Air Quality and its Impact on Man (Formerly Cost Project 613). Report on a Joint Workshop, held in Kloster Banz, Federal Republic of Germany, p67-80, October 15-17, 1991.

Calabrese, EJ; Beck, BD; Chappell, WR. 1992. "Does the animal-to-human uncertainty factor incorporate interspecies differences in surface area?" *Reg. Toxicol. Pharmacol.* 15:172-179.

Brainard, J; Beck, BD. 1992. "A review of the bioavailability of petroleum constituents." *J. Soil Contam*. 1:273-307.

Beck, BD. 1992. "Symposium overview: An update on exposure and effects of lead." *Fund. Appl. Toxicol.* 18:1-16.

Hemphill, CP; Ruby, MV; Beck, BD; Davis, A; Bergstrom, PD. 1991. "The bioavailability of lead in mining wastes: Physical/chemical considerations." *Chem. Speciation and Bioavailability.* 3:135-148.

Karam, HS; Beck, BD. 1991. "Evaluation of two methods for determining cleanup levels for mining derived lead in soil." In *Proceedings of the 24th Annual Conference on Trace Substances in Environmental Health and Annual Meeting of the Society for Environmental Geochemistry and Health*, p98-104, July 9-12.

Beck, BD; Toole, AP; Callahan, BG; Siddhanti, SK. 1991. "Utilization of quantitative structure activity relationships (QSARs) in risk assessment: Alkylphenols." *Reg. Toxicol. Pharmacol*. 14:273-285.

Petito, CT; Beck, BD. 1991. "Evaluation of evidence of non-linearities in the dose-response curve for arsenic carcinogenesis." In *Proceedings of the 24th Annual Conference on Trace Substances in Environmental Health and Annual Meeting of the Society for Environmental Geochemistry and Health*, p143-176, July 9-12.

Beck, BD. 1990. "Current issues in evaluation of hazardous waste sites: An overview." *Comments on Toxicology*. 3(6):445-446.

Beck, BD. 1990. "Overview on adverse effects of ozone." Preface. In *Ozone Risk Communication and Management* (Eds.: Calabrese, EJ; Gilbert, CE; Beck, BD), Lewis Publishing, Chelsea, MI.

Karam, HS; Beck, BD. 1990. "Current issues in determining acceptable levels for lead in soil." *Comments on Toxicology.* 3:509-529.

Steele, MJ; Beck, BD; Murphy, BL; Strauss, HS. 1990. "Assessing the contribution from lead in mining wastes to blood lead." *Reg. Toxicol. Pharmacol*. 11:158-190.

Beck, BD; Calabrese, EJ; Anderson, PD. 1989. "The use of toxicology in the regulatory process." In *Principles and Methods of Toxicology*. (Ed.: Hayes, AW), Raven Press, New York, p1-28.

Beck, BD. 1989. "Risk assessment for soils contaminated with petroleum products: An overview." In *Petroleum Contaminated Soils, Vol.* (Eds.: Kostecki, PT; Calabrese, EJ), Lewis Publishing, Chelsea, MI, p221-224.

Rose, RM; Fuglestad, JM; Skornik, WA; Hammer, SM; Wolfthal, SF; Beck, BD; Brain, JD. 1988. "The patho-physiology of enhanced susceptibility to murine cytomegalovirus respiratory infection during short-term exposure to 5 ppm nitrogen dioxide." *Am. Rev. Respir. Dis*. 137:912-917.

Weinstock, S; Beck, BD. 1988. "Age and nutrition." In *Variations in Susceptibility to Inhaled Pollutants: Identification, Mechanisms, and Policy Implications* (Eds.: Brain, JD; Beck, BD; Warren, AJ; Shaikh, RA), Johns Hopkins University Press, Baltimore, MD, p104-126.

Beck, BD; Weinstock, S. 1988. "Gender." In *Variations in Susceptibility to Inhaled Pollutants: Identification, Mechanisms, and Policy Implications* (Eds.: Brain, JD; Beck, BD; Warren, AJ; Shaikh, RA), Johns Hopkins University Press, Baltimore, MD, p127-141.

Beck, BD; Greaves, IA. 1988. "Screening and monitoring for nonneoplastic pulmonary disease." In *Variations in Susceptibility to Inhaled Pollutants: Identification, Mechanisms, and Policy Implications* (Eds.: Brain, JD; Beck, BD; Warren, AJ; Shaikh, RA), Johns Hopkins University Press, Baltimore, MD, p335-375.

Warren, AJ; Beck, BD. 1988. "Screening and monitoring for exposure and susceptibility to carcinogens." In *Variations in Susceptibility to Inhaled Pollutants: Identification, Mechanisms, and Policy Implications* (Eds.: Brain, JD; Beck, BD; Warren, AJ; Shaikh, RA), Johns Hopkins University Press, Baltimore, MD, p376-418.

Musk, AW; Beck, BD; Greville, HW; Brain, JD; Bohannon, DE. 1988. "Pulmonary disease from exposure to an artificial aluminum silicate." *Br. J. Ind. Med.* 45:246-250.

Beck, BD; Brain, JD; Wolfthal, SF. 1988. "Assessment of lung injury produced by particulate emissions of space heaters burning automotive waste oil." *Ann. Occup. Hyg.* 32(Suppl. 1):257-265.

Beck, BD. 1987. "Overview: Assessing health risks from contaminated soil." *Comments Toxicol.* 1(3-4):171-175.

Beck, BD; Feldman, HA; Brain, JD; Smith, TJ; Hallock, M; Gerson, B. 1987. "The pulmonary toxicity of talc and granite dust as estimated from an *in vivo* hamster bioassay." *Toxicol. Appl. Pharmacol.* 87:222-234.

Hallock, MF; Smith, TJ; Hammond, SK; Beck, BD; Brain, JD. 1987. "A new technique for collecting ambient diesel particles for bioassays." *Am. Ind. Hyg. Assoc. J.* 48:487-492.

Brain, JS; Beck, BD. 1985. "Bioassays for minerals dusts and other particulates." In *In vitro Effects of Minerals Dusts.* (Eds.: Beck, EG; Bignon, J), NATO ASI Series Vol. G3, Springer-Verlag, New York, p323-335.

Brain, JD; Beck, BD. 1985. "Bronchoalveolar lavage." In *Handbook of Experimental Pharmacology, Vol. 75.* (Eds.: Witschi, HP; Brain, JD), Springer-Verlag, Germany, p203-226.

Brain, JD; Valberg, PA; Bloom, SB; Gehr, P; Beck, BD. 1984. "Morphological, physiological, and magnetometric studies of inhaled iron oxide particles." *J. Aerosol Sci*. 15:227-229.

Beck, BD; Gerson, B; Feldman, HA; Brain, JD. 1983. "Lactate dehydrogenase isoenzymes in hamster lung lavage fluid after lung injury." *Toxicol. Appl. Pharmacol.* 71:59-71.

Beck, BD; Brain, JD. 1983. "Predicting the pulmonary toxicity of particulates using damage indicators in lung lavage fluid." In *Health Issues Related to Metal and Nonmetallic Mining* (Eds.: Wagner, WL; Rom, WN; Merchant, JA), Butterworth Publishers, Woburn, MA, p83-104.

Brain, JD; Beck, BD. 1983. "Assessment of particulate toxicity." In *Health Issues Related to Metal and Nonmetallic Mining.* (Eds.: Wagner, WL; Rom, WN; Merchant, JA), Butterworth Publishers, Woburn, MA, p51-61.

Beck, BD; Brain, JD. 1982. "Prediction of the pulmonary toxicity of respirable combustion products from residential wood and coal stoves." In *Residential Wood and Coal Combustion*, Air Pollution Control Association, Pittsburgh, PA, p264-280.

Beck, BD; Brain, JD; Bohannon, DE. 1982. "An *in vivo* hamster bioassay to assess the toxicity of particulates for the lungs." *Toxicol. Appl. Pharmacol.* 66:9-29.

Smith, TJ; Beck, BD; Brain, JD; Hinds, WC; Baron, SG; Weil, L. 1982. "Prediction of pneumoconiosis risk by bioassays of particulate from occupational exposures." *Ann. Occup. Hyg.* 26(1-4):435-448.

Beck, BD; Brain, JD; Bohannon, DE. 1981. "The pulmonary toxicity of an ash sample from the Mt. St. Helens volcano." *Exp. Lung Res.* 2:289-301.

Beck, BD. 1979. "Polymerization of the bacterial elongation factor for protein synthesis, EF-Tu." *Eur. J. Biochem.* 97:495-502.

Beck, BD; Arscott, PG; Jacobson, A. 1978. "Novel properties of bacterial elongation factor Tu." *Proc. Natl. Acad. Sci. USA.* 75(3):1250-1254.

Beck, BD; Park, JT. 1977. "Basis for the observed fluctuation of carboxypeptidase II activity during the cell cycle in BUG 6, a temperature-sensitive division mutant of *Escherichia coli*." *J. Bacteriol.* 130(3):1292-1302.

Beck, BD; Park, JT. 1976. "Activity of three murein hydrolases during the cell division cycle of *Escherichia coli* K-12 as measured in toluene-treated cells." *J. Bacteriol.* 126(3):1250-1260.

Mirelman, D; Beck, BD; Shaw, DRD. 1970. "The location of the D-alanyl ester in the ribitol teichoic acid of *Staphylococcus aureus.*" *Biochem. Biophys. Res. Comm.* 39(4):712-717.

Publications – *Abstracts*

Seeley, M; Beyer, LA; Beck, BD. 2011. "Is MTBE genotoxic or mutagenic?" *The Toxicologist.* 120(2):1950.

Beyer, LA; Mattuck, RL; Thakali, S; Beck, BD. "A comparative risk evaluation of MTBE and other compounds (including naturally occurring compounds) in drinking water in New Hampshire." *The Toxicologist.* 120(2):1952.

Beyer, LA; Rhomberg, LR; Beck, BD. 2010. "Evaluation of recent information on carcinogenicity of perchloroethylene (PCE) in humans." *The Toxicologist.* 114(1):1946.

Nascarella, M; Lewis, AS; Beck, BD. 2010. "Mode-of-action proposal for oral hexavalent chromium carcinogenesis." *The Toxicologist.* 114(1):1942

Seeley, M; Beck, BD; Drivas, PJ. 2010. "Blue soil at former MGP sites – Is it a health hazard?" *The Toxicologist.* 114(1):1039.

Dodge, DG; Goodman, JE; Beck, BD. 2010. "Weight-of-evidence analysis of Hydroquinone and leukemia." *The Toxicologist.* 114(1):514.

Nascarella, MA; Calabrese, EJ; Beck, BD. 2009. "Quantifying hormetic (biphasic) dose-responses in the assessment of nanoparticle toxicology." In *Proceedings for the International Conference on the Environmental Implications and Applications of Nanotechnology*, University of Massachusetts Amherst, June 9-11, 2009.

Conolly, R; Beck, BD [Chairs]. 2009. "What is an adverse effect in the age of 'omics?" *The Toxicologist.* 108(1):1990.

Lewis, AS; Sax, SN; Thakali, S; Beck, BD. 2009. "Evaluation of risk for fetal limb defects from occupational exposure to Mancozeb and Ethylene Thiourea during pregnancy." *The Toxicologist.* 108(1):832.

Beyer, LA; Beck, BD; Goodman, JE. 2009. "Background rates of lymphomas/leukemias and Leydig cell tumors in Sprague-Dawley rats. *The Toxicologist.* 108(1):2028.

Goodman, JE; Bailey, LA; Beck, BD. 2008. "Recent occupational studies of manganese and their bearing on the reference concentration (RfC)." Presented at the Annual Meeting of the American College of Epidemiology, Tucson, AZ, September 14-16.

Goodman, JE; Bailey, LA; Beck, BD. 2008. "Recent studies of the health effects of manganese and the implications for the Reference Concentration (RfC)." *The Toxicologist.* 102(1):1787.

Beyer, LA; Slayton, TM; Goodman, JE; Greenberg, GI; Hudson, TC; Beck, BD. 2008. "Evaluation of key information forming the basis of EPA's new recommended ozone standard." *The Toxicologist.* 102(1):1462.

Lewis, AS; Beyer, LA; Beck, BD. 2008. "Evaluating the toxicological significance of end points from human and animal studies: Using Perfluorinated Compounds (PFCS) as an example." *The Toxicologist.* 102(1):1188.

Goodman, JE; Gaylor, D; Beyer, LA; Rhomberg, LR; Beck, BD. 2007. "MTBE is not associated with a statistically significant increase in Leydig cell tumors in Sprague-Dawley rats." *The Toxicologist.* 96(1):1637.

Seeley, M; Beyer, LA; Beck, BD. 2007. "Margin of exposure analysis for MTBE in drinking water." *The Toxicologist.* 96(1):1636.

Lewis, AS; Eldan, M; Beck, BD. 2007. "Determining risks to background arsenic using a margin of exposure approach." *The Toxicologist.* 96(1):1632.

Beyer, LA; Goodman, JE; Seeley, M; Slayton, T; Beck, BD. 2007. "Carcinogenicity evaluation of Methyl Tert-Butyl Ether (MTBE)." *The Toxicologist.* 96(1):1569.

Beck, BD; Lewis AS. 2007. "Using modeling to inform the risk assessment process for arsenic." *The Toxicologist.* 96(1):702.

Lewandowski, TA; Beck, BD. 2006. "Evaluation of potential lithium toxicity associated with a monitoring device used in elephants." *The Toxicologist.* 90(1):2341.

Beyer, LA; Long, CM; Beck, BD; Slayton, TM. 2006. "Ambient concentrations of benzene are below those associated with significant cancer risk." *The Toxicologist.* 90(1):2305.

Beck, BD; Lewandowski, TA; Yager, JW. 2006. "Evaluation of the possible toxicological interaction of lead and mercury for use in risk assessment." *The Toxicologist.* 90(1):2195.

Schoen, A; Eldan, M; Goodman, JE; Beck, BD. 2006. "DMAV-induced bladder tumors: Unique rat susceptibility." *The Toxicologist.* 90(1):2186.

Bowers, TS; Beck, BD. 2006. "Distributional controls on non-linear dose-response relationships." *The Toxicologist.* 90(1):875.

Beck, BD; Schoen, A. 2006. "Metabolism and toxicities of inorganic and organic as species." *The Toxicologist.* 90(1):759.

Beck, BD; Lewis, AS. 2006. "Interpretation of biomonitoring studies to assess exposure and risk of inorganic arsenic: Confounding by other sources of arsenic." Presented at Toxicology and Risk Assessment Conference, Cincinnati, OH.

Beck, BD. 2005. "Regulation of nanotechnology in the environment and workplace: Comparative approaches." Presented at MRS 2005 Fall Conference, Boston, MA.

Lewandowski, TA; Beck; BD; Beyer, LA; Rhomberg, LR. 2005. "A historical perspective on long-term animal bioassays." *The Toxicologist.* 84(1):384.

Schettler, S; Seeley, MR; Lewandowski, TA; Beck, BD. 2005. "Perinatal perchlorate exposure in the rat: Does thyroid status affect brain morphometry?" *The Toxicologist.* 84(1):1071.

Beyer, LA; Beck, BD. 2005. "Glass bead inhalation and induction of dilicosis." *The Toxicologist.* 84(1):1472.

Seeley, MR; Wells, CS; Ren, SJ; Beck, BD. 2005. "Determining soil remedial action criteria for acute effects: The challenge of copper." *The Toxicologist.* 84(1):2083.

Schoen, A; Beck, BD. 2005. "The role of methylated metabolites in inorganic arsenic-induced cancer: A synthesis of information from *in vitro* and human biomonitoring studies." *The Toxicologist.* 84(1):2085.

Beyer, LA; Seeley, MR; Beck, BD. 2004. "Evaluation of exposure to metals on reusable shop towels." *The Toxicologist.* 78(S-1):107.

Lewandowski, TA; Hayes, A; Beck, BD. 2004. "Potential health effects of exposure to Methylenedianiline and Toluenediamine during Polyurethane foam manufacturing." *The Toxicologist.* 78(S-1):107.

Beck, BD; Schoen, A. 2004. "Arsenic methylation: considerations for risk assessment." *Toxicologist.* 78(S-1):129.

Shipp, BK; Dubé, EM; Beck, BD; Seeley, MR; Radloff, KA; Schettler, S; Petito Boyce, C. 2004. "Development of a risk assessment to evaluate human health risks from exposure to Tebuconazole used as a wood preservative." *The Toxicologist.* 78(S-1):154.

Schoen, A; Beck, BS; Sharma, R; Dubé, EM. 2004. "Evidence from epidemiological and mode of action studies support a nonlinear dose-response relationship for arsenic-induced carcinogenesis." *The Toxicologist.* 78(S-1):369.

Beyer, LA; Beck, BD. 2003. "Derivation of air action levels for use in monitoring during site remediation." *The Toxicologist.* 72(1):395.

Seeley, MR.; Lewandowski, TA; Beck, BD. 2003. "Evaluating health implications of lubricating oil on orthopedic medical implant devices." *The Toxicologist.* 72(1):384.

Lewandowski, TA; Seeley, MR; Beck, BD. 2003. "Inter-species differences in susceptibility to Perchlorate: A critical consideration for human health risk assessment." *The Toxicologist.* 72(1):390.

Wells, CS; Slayton, TM; Beck, BD; Lewandowski, TA. 2002. "Risk modeling implications of mechanistic differences between low and high dose effects of arsenic." Presented at Non-Linear Dose-Response Relationships in Biology, Toxicology and Medicine, School of Public Health and Health Sciences, University of Massachusetts, Amherst, MA.

Beck, BD; Slayton, TM; Farr, CH; Sved, DW; Crecelius, EA; Holson, JF. 2002. "Systemic uptake of inhaled arsenic in rabbits." *The Toxicologist.* 66(1):83.

Slayton, TM; Lewandowski, TA; Petito Boyce, C; Beck, BD. 2002. "Is there a special sensitivity of children to inorganic asenic?" *The Toxicologist.* 66(1):86.

Petito Boyce, C; Dubé, EM; Wells, CS; Beck, BD. 2002. "Assessing bioavailability and other parameters influencing exposures to arsenic associated with CCA-treated wood." *The Toxicologist.* 66(1):103.

Dubé, EM; Boyce, C; Beck, BD; Schettler, S. 2002. "Evaluation of human health risks from exposures to arsenic associated with CCA-treated wood." *The Toxicologist.* 66(1):103.
****Received award for "Best Posters in Risk Assessment" at 2002 Society of Toxicology Meeting.**

Beyer, LA; Beck, BD; Chan, K. 2002. "Assessment of 'all cancers' in dioxin epidemiology studies." *The Toxicologist.* 66(1):158.

Chan, K.; Beyer, LA; Beck, BD. 2002. "Assessment of benzene carcinogenic potential in humans." *The Toxicologist.* 66(1):159.
****Received award for "Best Posters in Risk Assessment" at 2002 Society of Toxicology Meeting.**

Slayton, TM; Beck, BD. 2001. "Mechanistic differences between low dose and high dose effects of arsenic." *The Toxicologist.* 60(1):76.

Bowers, TS; Mattuck, RL; Beck, BD; Cohen, JT. 2000. "Recent trends in childhood blood lead levels." *The Toxicologist.* 54(1):72.

Beck, BD; Seeley, MR; Tonner-Navarro, LE; Deskin, R. 2000. "Variations in cancer classification between European countries and organizations." *The Toxicologist.* 54(1):273.

Seeley, MR; Beck, BD; Tonner-Navarro, LE; Deskin, R. 2000. "European differences in derivation of occupational exposure levels." *The Toxicologist.* 54(1):274.

Slayton, TM; Beck, BD; Yager, JW. 2000. "EPRI-sponsored arsenic research program – Application to arsenic cancer risk assessment." SEGH Fourth International Conference on Arsenic Exposure and Health Effects, Book of Abstracts, San Diego, p 171, CA, June 18-22.

Kitchin, KT; Beck, BD. 2000. "Arsenic: Carcinogenic mechanisms, risk assessment and the Maximum Contaminant Level (MCL)." *The Toxicologist.* 54(1):356.

Beck, BD; Daly, HE; Slayton, TM. 1999. "Development of copper toxicity values for human health risk assessment." *The Toxicologist.* 48(1-S):82.

Beck, BD; Cohen, JT; Lampson, MA; Sinha, R. 1999. "The development of a stochastic physiologically-based pharmacokinetic model for lead." Presented at the International Conference on Lead Exposure, Reproductive Toxicity and Carcinogenicity, Gargnano, Italy.

Bowers, TS; Cohen, JT; Beck, BD. 1999. "Implications of blood lead models on permissible exposure levels for protection of adults and children." Presented at the International Conference on Lead Exposure, Reproductive Toxicity and Carcinogenicity, Gargnano, Italy.

Beyer, LA; Beck, BD; Maier, WE. 1999. "Is Perchloroethylene (perc) a probable carcinogen in humans?" *The Toxicologist.* 48(1-S):343.

Daly, HE; Schmidt, C; Beck, BD. 1999. "Aggregate exposure model for pesticide drift." *The Toxicologist.* 48(1-S):190.

Slikker, W; Beck, BD. 1999. "Cognitive tests: Interpretation for neurotoxicity?" *The Toxicologist.* 48(1-S):2-3.

Beck, BD; Slayton, TM. 1998. "Impact of arsenic (As_i) metabolism on human populations: Dose-response relationships in arsenic-induced cancers." *The Toxicologist.* 42(1-S):354.

Beyer, LA; Beck, BD; Maier, WE. 1998. "Classification of Perchloroethylene (PCE) as a probable human carcinogen: Is it supported by the data?" Presented at the International Congress of Toxicology - ICT VIII, Paris, France.

Beck, BD; Beyer, LA; Price, C; Robertson, J; Hiller, D. 1998. "An exposure assessment for inorganic arsenic in vegetables using site-specific data from a tailings site in Ontario." Presented at the Third International Conference on Arsenic Exposure and Health Effects, San Diego, CA.

Beyer, LA; Beck, BD. 1997. "Key issues raised by EPA's proposed ozone standards and supporting analysis." Presented at the 1997 Society For Risk Analysis Annual Meeting and Exposition, Washington, DC.

Cohen, JT; Lampson, MA; Beck, BD. 1997. "Use of a Monte Carlo exposure model to estimate blood lead distributions in U.S. children." *The Toxicologist.* 36:337-338.

Cohen, JT; Beck, BD; Bowers, TS. 1996. "Validation of an arsenic model through urine and fecal measurements." *The Toxicologist.* 30:49.

Cohen, JT; Beck, BD; Boardman, PD; Beyer, LA; Hiller, D. 1995. "Use of an arsenic exposure model at a gold mining and milling site." Presented at 1995 International Conference on Arsenic, San Diego, CA.

Beck, BD; Boardman, PD; Beyer, LA; Cohen, JT; Hiller, D. 1995. "Validation of an arsenic exposure model at a mining and milling site through urinalysis." Presented at 1995 International Conference on Arsenic, San Diego, CA.

Slayton, TM; Beck, BD; Valberg, PA. 1995. "Evaluation of health effects resulting from accidental exposures." Presented at 1995 Air and Waste Management Meeting.

Beck, BD; Boardman, PD; Watson, A. 1995. "Urinalysis study for evaluating arsenic exposure in a population residing on mill tailings." *The Toxicologist.* 15:87.

Beck, BD; Goodman, G; Gauthier, TD. 1994. "Risk assessment for cyanides in soil at manufactured gas plant (MGP) sites." *The Toxicologist.* 14:154.

Schoof, RA; Yost, LJ; Valberg, PA; Beck, BD. 1994. "Recalculation of the oral arsenic reference dose and cancer slope factor using revised assumptions in inorganic arsenic intake from food." *The Toxicologist.* 14:37.

Bowers, TS; Michelson, AR; Beck, BD. 1994. "Short-term lead exposure modeling." *The Toxicologist.* 14:36.

Beck, BD; Bowers, TS. 1993. "Uptake of Pb into the body: Geochemical characteristics affecting uptake, host modifying factors, and approaches to quantify." *Proceedings of the 1993 Annual Meeting of the Geological Society of America*.

Karam, HS; Beck, BD; Goodman, G; Steele, MJ. 1993. "The value of blood lead measurements in children in estimating past, present, and future exposures to lead: Application to risk management decisions at superfund sites." *The Toxicologist*. 13(1):302.

Beck, BD; Bowers, TS; Karam, HS. 1993. "An adult lead risk assessment model." *The Toxicologist.* 13:141.

Beck, BD; Dourson, ML. 1992. "Improvements in quantitative noncancer risk assessment: Introduction." *The Toxicologist.* 12(1):23.

Beck, BD; Karam, HS. 1990. "Evaluation of two methods to determine cleanup levels for lead in soil." *Proceedings of the 24th Annual Conference on Trace Substances in Environmental Health.*

Petito, CT; Beck, BD. 1990. "Evaluation of nonlinearities in the dose-response curve for arsenic carcinogenesis." *Proceedings of the 24th Annual Conference on Trace Substances in Environmental Health.*

Beck, BD; Brain, JD. 1988. "Application of short-term lung bioassays to risk assessment for metals." *The Toxicologist.* 8:154.

Beck, BD; Tsai, PY. 1987. "Risk assessment for lead contaminated soil." *The Toxicologist.* 7:729.

Beck, BD; Brain, JD; Wolfthal, SF; Zibrak, J; Sommers-Smith, S. 1985. "Possible sources of biochemical indicators of lung injury in bronchoalveolar lavage fluid from hamsters." *Am. Rev. Respir. Dis.* 131:A184.

Zibrak, JD; Beck, BD; Sadoski, J; Wolfthal, S; Gerson, B; Sommers-Smith, S. 1985. "Cytoplasmic enzyme patterns in isolated hamster Alveolar type II Cells (ATII)." *J. Cell. Biol.* 99: (abs).

Beck, BD; Brain, JD; Wolfthal, SF. 1984. "Are combustion products of automobile waste oil (AWO) toxic to the lungs?" *Am. Rev. Respir. Dis.* 129:152.

Beck, BD; Brain, JD; Shera, NS. 1983. "Acute indicator of lung damage in hamsters exposed to Bleomycin plus 70% O_2 or Elastase." *Am. Rev. Respir. Dis.* 127:171.

Beck, BD; Gerson, B; Feldman, H; Brain, JD. 1982. "LDH Isoenzymes in hamster lung lavage fluid as a means of assessing pulmonary damage." *Am. Rev. Respir. Dis.* 125:230.

Beck, BD; Brain, JD; Bohannon, DE. 1982. "Are respirable combustion products from home heating stoves toxic to the lungs?" *Am. Rev. Respir. Dis.* 125:156.

Beck, BD; Brain, JD; Bohannon, DE. 1981. "Will Mt. St. Helens volcanic ash injure the lungs?" *Am. Rev. Respir. Dis.* 123:149.

Beck, BD; Park, JT. 1970. "Study on the relationship between three Murein Hydrolases and cell division in *E. coli*." *Annu. Meeting Amer. Soc. Microbiol.* G38:26.

Publications – *Other Publications/Reports*

Beck, BD. 2009. "Congress should take risk-based approach to lead-content law." *Wall Street J.* 253(88):A14. April 16.

Valberg, PA; Beck, BD. 1993. "Recalculation of the Arsenic Cancer Slope Factor." Report to IRIS Information Submission Desk (US EPA), August 9.

Beck, BD; Goodman, G, Hemphill, CP. 1993. "Summary of Naphthalene Toxicity Information and Derivation of a Naphthalene Oral RfD." Draft report to US EPA Naphthalene RfD Work Group August 30.

Beck, BD. 1987. "Acute and Chronic Toxicity of Trichloroethylene," "Non-carcinogenic Risk Assessment," "The Role of Peroxisomal Proliferation in Trichloroethylene Hepatotoxicity and Carcinogenicity." Draft NESCAUM (Northeast States for Coordinated Air Use Management) Health Assessment Document.

Beck, BD 1982. "The use of bioassays to assess the toxicity of particulates; evaluation of bioassays." In *Appendix 2: Toxic Effects of Airborne Particulates*, p119 - 167, Appendix to Report "Analysis of Health Effects Resulting from Population Exposures to Ambient Particulate Matter." Prepared by Harvard University, Energy and Environmental Policy Center, for US Dept. of Energy, Agreement No. DE-AC02-81EV10731.

Beck, BD. 1975. "*Activity of three murein hydrolases during the cell cycle of Escherichia coli. K-12*." Ph.D. Dissertation, Tufts University.

Invited Lectures/Other Presentations – *1985 – Present*

4/10 – "Medical Monitoring and Environmental Exposures." Presented in a session entitled "Presenting Effective Arguments to Courts Against Awarding Medical Monitoring Damages" at the American Chemical Institute's Chemical Products Liability and Environmental Litigation Conference, Chicago, IL, April 28.

3/10 – "These Kids are Driving Me Crazy: The Science of Sensitive Subpopulations." Presented at the DRI Toxic Torts and Environmental Law Seminar, New Orleans, LA, March 18.

3/10 – "Weighing Complex Data in Risk Decisions: Concepts of Evidence-Based Toxicology." Roundtable discussion presented at the Society of Toxicology Annual Meeting, Salt Lake City, UT, March 9.

2/10 – "Buckyballs and Nanotubes: Insurance Issues Related to Nanotechnology." Panelist for talk presented at the American Bar Association's 18th Annual Insurance Coverage Litigation Committee Midyear Program. Phoenix, AZ, February 26.

1/10 – "Overview of Arsenic Epidemiology." Presented as part of the EPRI Arsenic Project Scientific Review Panel Meeting, Research Triangle Park, NC, January 28.

12/09 – "Current Risk from Exposure to Nanoparticles." Presented as part of webinar held by Day Pitney, LLP, December 9.

4/09 – "Testimony of Barbara D. Beck, Ph.D, DABT Regarding the Consumer Product Safety Improvement Act: The Need for a Risk-Based Approach." CPSIA Congressional Briefing, Washington, DC, April 1.

3/09 – "What is an Adverse Effect in the Age of 'Omics?" Roundtable discussion presented at the Society of Toxicology Annual Meeting, Baltimore, MD, March 18.

12/08 – "Inorganic Arsenic: Health Risks and Regulations." Presented at the University of Connecticut, School of Pharmacy, Storrs, CT.

5/08 – "Risk Assessment for Essential Metals: Considerations for 'The Path Forward.'" Presented at the Workshop on Health Risk Assessment of Essential Metals, Ottawa, Canada.

5/08 – "Nanotechnology: An Overview of Environmental Health & Safety Issues." Presented as part of webinar held by Day Pitney, LLP.

3/08 – "Challenge in Using Hazard-based Binning in Risk Assessment & Risk Management." Presented at the Society of Toxicology 47th Annual Meeting, Seattle, WA.

1/08 – "Determining Risks to Background Arsenic Using a Margin-of-Exposure Approach." Presented at the Society of Risk Analysis, New England Chapter Meeting, Boston, MA.

10/07 – "An Update on Risk Management Approaches for Nanotechnology: Recent Regulatory Activities and Trends Affecting Product Development." Presented at the Lux Executive Summit, Cambridge, MA.

9/07 – "Is Smaller Always Worse: What Do We Know Now About the Toxicity and Potential Risks of Nanoparticles? What More Do We Need to Know?" Presented at the PANWAT SOT Meeting, Seattle, WA.

7/07 – "The Role of Regulatory Science in Tort Litigation." Presented as part of the Environmental Law Institute's *Critical Developments in Toxic Torts Seminar Series*, Washington, DC.

3/07 – "Using Modeling to Inform the Risk Assessment Process for Arsenic." Presentation at the Society of Toxicology 46th Annual Meeting, Charlotte, NC.

2/07 – "Health Risks of Inorganic Arsenic: A Serious Threat or are there Better Ways to Spend our Resources?" Presented at the Risk Assessment Forum, Yale University, New Haven, CT.

12/06 – "Risk Assessment: An Overview." Presented at the University of Connecticut, School of Pharmacy, Storrs, CT.

12/06 – "Industry Challenges – Getting the Lead Out: Health Risk Considerations." Presented at Plumbing Manufacturers Association and Copper Development Association Roundtable, Chicago, IL.

10/06 – "Use of Nanoscale Zero-Valent Iron (NZVI) Particles for Groundwater Remediation: A Qualitative Risk Assessment." Presented at the University of Massachusetts Soils, Sediments, and Water Conference, Amherst, MA.

9/06 – "Overview of Science Issues Associated with Assessing Lead Health Effects." Presented at the Battery Council International Convention, Tucson, AZ.

4/06 – "Interpretation of Biomonitoring Studies to Assess Exposure and Risk of Inorganic Arsenic: Confounding by Other Sources of Arsenic." Presented at Toxicology and Risk Assessment Conference, Cincinnati, OH.

1/06 – "A Qualitative Risk Assessment to Evaluate the Remediation of Trichloroethylene by Nanoscale Zero-Valent Iron Particles." Presented at the 1st International Conference on Nanotoxicology: Biomedical Aspects, Miami, FL.

12/05 – "Regulation of Nanotechnology in the Environment and Workplace: Comparative Approaches." Presented at the 2005 Materials Research Society Meeting Session S9: Regulation of Nanotechnology and Nanomaterials, Boston, MA.

9/05 – "Recommendations for DMA Assessment." Presented on behalf of MAA Research Task Force, US EPA, Washington, DC.

9/05 – "Characterization of DMA Risk Using a Nonlinear Dose-Response Approach." Presented on behalf of MAA Research Task Force, US EPA, Washington, DC.

3/05 – "The Life of a Consultant." Society of Toxicology 44th Annual Meeting, New Orleans, LA.

3/04 – "Arsenic Methylation: Considerations for Risk Assessment." Society of Toxicology 43rd Annual Meeting, Baltimore, MD.

1/04 – "Lack of Relevance of DMA-Induced Rat Bladder Tumors for Human Risk Assessment: Metabolism and Disposition Studies of DMA and MMA." Presented to Office of Pesticide Programs, US EPA, Washington, DC.

12/03 – "Selected Comments on Draft EPA Exposure & Risk Assessments for CCA-Treated Wood Using SHEDS-Wood Model." Presented at FIFRA SAP Meeting, Washington, DC.

11/03 – "Risk Assessment: An Overview." University of Connecticut, School of Pharmacy, Storrs, CT.

10/03 – "Comparison of a Probabilistic/Mechanistic Approach to a Deterministic/Empirical Approach for Evaluating CCA-Treated Wood Exposures." Presented at 19th Annual International Conference on Soils, Sediments and Water, Amherst, MA.

4/03 – "Evaluation of Potential Human Health Risks from Copper Azole-Treated Wood." Presented at 99th Annual Meeting of the American Wood-Preservers' Association, Boston, MA.

11/02 – "A Case Study of Arsenic Risk Assessment and Risk Management." Presented at NIEHS DERT Science Retreat, Wilmington, NC.

10/02 – "CCA-Treated Wood: Science and Politics." Presented at University of Massachusetts, Amherst.

10/02 – "Research Activities to Refine Human Health Risk Assessment for CCA-Treated Wood." Presented to CPSC, Washington, DC.

8/02 – "Comments on EPA Background Documents Regarding SHEDS-Wood Model." Presented at Science Advisory Panel meeting, Washington, DC.

1/02 – "Principles of Toxicology." Harvard School of Public Health, Boston, MA.

12/01 – "Risk Assessment: An Overview." University of Connecticut, School of Pharmacy, Storrs, CT.

10/01 – "Comments on EPA Background Documents Regarding CCA-Treated Wood." Presented to Scientific Advisory Panel, Washington, DC.

10/01 – "Statement by Barbara D. Beck re: Arsenic in Drinking Water: An Update on the Science, Benefits and Cost." Presented at Congressional Hearing, Washington, DC.

8/01 – "Focused Evaluation of Health Risks from Exposure to Arsenic Associated with CCA-Treated Wood." Presented to Consumer Product Safety Commission, Washington, DC.

6/01 – "Adult:Child Differences in the Intra-Species Uncertainty Factor: A Case Study Using Lead." Presented at the Fifth Annual Workshop on Evaluation of Default Safety Factors in Health Risk Assessment, UMDNJ-New Jersey Medical School, Newark, NJ.

3/01 – "Risk Assessment for Metals: Physiologically-Based Pharmacokinetic Models for Metals." Society of Toxicology 40th Annual Meeting, San Francisco, CA.

6/00 – "EPRI-Sponsored Arsenic Research Program – Application to Arsenic Cancer Risk Assessment." SEGH Fourth International Conference on Arsenic Exposure and Health Effects, San Diego, CA.

5/00 – Invited Participant/Speaker to the Fourth Annual Workshop on Evaluation of Uncertainty/Safety Factors in Health Risk Assessment, Nutley, NJ.

4/00 – "Development of a Stochastic Physiologically-Based Pharmacokinetic Model for Lead." Toxicology and Risk Assessment Approaches for the 21st Century Conference, Kings Island, OH.

6/99 – "The Development of a Stochastic Physiologically-Based Pharmacokinetic Model for Lead." US EPA Workshop on Lead Model Development: Probabilistic Risk Assessment and Biokinetic Modeling, Raleigh-Durham, NC.

6/99 – "The Development of a Stochastic Physiologically-Based Pharmacokinetic Model for Lead." WHO/IARC Conference on Lead Exposure, Reproductive Toxicity and Carcinogenicity, Gargnano, Italy.

3/99 – "Strategies for Prosecuting and Defending Toxic Tort Litigation – A Toxicologist's Perspective." ABA Annual Conference on Environmental Law, Keystone, CO.

3/99 – "Principles of Toxicology." Harvard Center for Risk Analysis Course "Analyzing Risk: Assessment and Management," Boston, MA.

2/99 – "Comments on EPA Perchlorate RfD Draft Document." Perchlorate Peer Review Workshop, San Bernardino City Council Chambers, San Bernardino, CA.

1/99 – "Risk Assessment: An Overview." Harvard School of Public Health Principles of Toxicology Course, Boston, MA.

12/98 – "Risk Assessment: An Overview." University of Connecticut Advanced Toxicology Course, Storrs, CT.

11/98 – "EPA's Proposed Residential Lead Standards." US EPA's Children's Health Protection Advisory Committee Meeting, New Carrolton, MD.

10/98 – "What are the Characteristics of a Well-designed Environmental Lead/Blood Lead Study?" National Environmental Policy Institute's Conference "Protecting Children's Health: Assessing the Relationship of Soil Lead to Blood Lead," Washington, DC.

10/98 – "Principles of Toxicology." Harvard Center for Risk Analysis Course "Analyzing Risk: Assessment and Management," Boston, MA.

10/98 – "Cumulative Risk – Case Study." American Law Institute-American Bar Association Course of Study, "Risk Assessment and Risk Management in Environmental Law," Washington, DC.

10/98 – "Introduction to Recent Developments in Risk Assessment: Aggregate Exposure and Cumulative Risk." American Law Institute-American Bar Association Course of Study, "Risk Assessment and Risk Management in Environmental Law," Washington, DC.

4/98 – "Principles of Toxicology." Harvard Center for Risk Analysis Course "Analyzing Risk: Assessment and Management," Boston, MA.

3/98 – "Impact of Arsenic (As_i) Metabolism on Human Populations: Dose-Response Relationships in Arsenic-Induced Cancers." Society of Toxicology 37th Annual Meeting, Seattle, WA.

3/98 – "Effective Risk Communication: Avoiding the Pitfalls." Continuing Education Course, Society of Toxicology 37th Annual Meeting, Seattle, WA.

12/97 – "Key Issues Raised by EPA's Proposed Ozone Standards and Supporting Analysis." Society for Risk Analysis, Annual Meeting and Exposition, Washington, DC.

5/97 – "Testimony on Analysis of Risk Assessment Used by the EPA in Support of Its Proposed Ozone Standards." Before the Joint Hearing of the Health and Environment Subcommittee and the Oversight and Investigations Subcommittee, Commerce Committee, US House of Representatives, Washington, DC.

3/97 – "Principles of Toxicology." Harvard Center for Risk Analysis Course "Analyzing Risk: Assessment and Management," Boston, MA.

12/96 – "Risk Assessment for Criteria Pollutants *versus* Other Noncarcinogens: The Difference Between Implicit and Explicit Conservativism." Rutgers University 2nd Annual Workshop "The Evaluation of EPA 10X Safety Factors in Health Risk Assessment," Nutley, NJ.

9/96 – "The Quantitative Use of Information on Susceptibility in Risk Assessment: Where is it Working or Not Working? How Can We Make It Better?" Third Annual NHEERL Symposium on Susceptibility and Risk Assessment, Raleigh, NC.

9/96 – "Principles of Toxicology." Harvard Center for Risk Analysis Course "Analyzing Risk: Assessment and Management," Boston, MA.

8/96 – "The Role of Risk Assessments in Superfund." American Bar Association, Orlando, FL.

12/95 – "Use of Monte Carlo Arsenic (As) Model to Predict Distributions of Urine Arsenic at a Mining and Milling Site." Society for Risk Analysis, Honolulu, HI.

10/95 – "Use of Information on Variations in Susceptibility – Ozone." ILSI Risk Science Institute Workshop on Human Variability, Washington, DC.

10/95 – "Evaluation of Health Effects Resulting from Accidental Exposures." Michigan Society for Risk Analysis, Dearborn, MI.

9/95 – "Principles of Toxicology." Harvard Center for Risk Analysis Course on "Analyzing Risk: Assessment and Management," Boston, MA.

6/95 – "Validation of an Arsenic Exposure Model at a Mining and Milling Site through Urinalysis." "Use of an Arsenic Exposure Model at a Gold Mining and Milling Site." Second International Conference on Arsenic Exposure and Health Effects, San Diego, CA.

7/94 – "A Review of Scientific Issues Pertaining to Arsenic." Society for Environmental Geochemistry and Health Conference on Lead and Arsenic Exposure in the Rocky Mountains, Salt Lake City, UT.

5/94 – "Use of Lead Exposure Assessment in the Regulatory Process." International Lead Zinc Research Organization Lead Exposure Assessment Workshop, Research Triangle Park, NC.

3/94 – "Non-linearities in Arsenic Risk Assessment." Boston Risk Assessment Group, Cambridge, MA.

3/93 – "Basic Risk Assessment: Current Developments." Continuing Education Course, Society of Toxicology, New Orleans, LA.

3/92 – "A Review of the Bioavailability of Petroleum Constituents." West Coast Soils and Groundwater Conference, Long Beach, CA.

3/92 – "Bioavailability of Metals and Organics." Workshop on Human Health and Ecological Risk Assessments for Contaminated Sites, Toronto, Canada.

2/92 – "Improvements in Quantitative Noncancer Risk Assessment." Chair of Symposium of Society of Toxicology Meeting, Seattle, WA.

2/92 – "Perspectives on the Development of Soil Cleanup Levels at Mining Sites." Colorado Bar Association, Denver, CO.

11/91 – "Environmental Law Update: Toxic Torts and How Clean is Clean?" Squire, Sanders & Dempsey, Cincinnati, OH.

10/91 – "Risk Assessment for Indoor Air: Evaluating Risks to Susceptible Populations." NATO/CCMS-COST 613 Joint Workshop, Kloster Banz, Bavaria, Germany.

2/91 – "An Update on Exposure and Risks of Lead." Chair of Symposium at Society of Toxicology Meeting.

2/90 – "Inhalation Risk Assessment." Chair of Symposium at Society of Toxicology Meeting.

1/90 – "The Use of Structure Activity Relationships for Alkyl Phenol Risk Assessment." New England Society for Risk Analysis, Boston, MA; RJR/Nabisco, Winston-Salem, NC.

1/90 – "The Use of Structure Activity Relationships in Risk Assessment." Harvard School of Public Health, Boston, MA; Northeastern University, Boston, MA.

11/89 – "How Protection Levels are Developed and What They Mean." Course on Risk Assessment and Epidemiology for Lawyers, Harvard School of Public Health, Boston, MA.

9/89 – "An Environmental Health Case Study." Tufts Medical School, Boston, MA.

3/89 – "Impact of Lead Derived from Mining Sources on Blood Lead." Boston Risk Assessment Group, Boston, MA.

2/89 – "Ecological and Health Risk Assessment for Arsenic in Soil." Society of Toxicology, Atlanta, GA.

12/88, 1/89, 9/89, 10/89, and 4/90 – "Risk Assessment for Hazardous Waste Sites, Including a Perspective on Toxic Torts." Executive Enterprises, Inc., Washington, DC, Chicago, IL, Philadelphia, PA, and Orlando, FL.

10/88 – "Ozone Toxicology and Risk Assessment." Harvard School of Public Health, Boston, MA.

10/88 – "Risk Assessment for Arsenic in Soil." University of Massachusetts, Amherst, MA.

9/88 – "The Use of Animal Bioassays to Assess Lun26 Toxicity." NESCAUM, Princeton, NJ.

6/88 – "Review of Epidemiological and Toxicological Studies on Mining Derived Lead." US EPA, Philadelphia, PA.

3/88 – "Assessment of Impact on Blood Lead of Lead from Mining Sources. " US EPA, Washington, DC.

2/88 – "Regulatory Toxicology." Tufts University School of Medicine, Boston, MA.

12/87 – "Risk Assessment for Soil." Harvard School of Public Health, Boston, MA.

12/87 – "Health Effects of Ozone and the Clean Air Act." New England Chapter for Society for Risk Analysis, Cambridge, MA.

11/87 – "Health Effects of Ozone." Harvard School of Public Health, Boston, MA.

9/87 – "Health Risk Assessment for Soil." University of Massachusetts, Amherst, MA.

4/87 – "Key Issues in Addressing Adverse Effects of Ozone." University of Massachusetts, Amherst, MA.

1/87 – "Risk Assessment for Dioxin in Soil." MIT, Cambridge, MA.

10/86 – "Pulmonary Toxicology." Harvard School of Public Health, Boston, MA.

10/86 – "Risk Assessment." University of Massachusetts, Amherst, MA.

10/86 – "Regulatory Toxicology." Tufts University School of Medicine, Boston, MA.

7/86 – "Health Effects of Indoor Air Pollutants." Region I US EPA, Lexington, MA.

6/86 – "Health Effects of Radon." Society of Women Engineers, Hartford, CT.

6/86 – "Contacting the Health and the Medical Community About the Adverse Effects of Ozone." US EPA, Washington, DC.

6/86 – "Animal Toxicology." US EPA Region I, Boston, MA.

4/86 – "Health Effects of Ozone." NESCAUM meeting, Newport, RI.

2/86 – "Pulmonary Toxicology." US EPA Region I, Boston, MA.

12/85 – "Toxicology of Dioxin." US EPA Dioxin Workshop, Lexington, MA.

11/85 – "Animal Bioassays." Harvard School of Public Health, Boston, MA.

11/85 – "Pulmonary Toxicology." Harvard School of Public Health, Boston, MA.

10/85 – "Indoor Air Pollution." Air Pollution Control Association meeting, Enfield, CT.

1/85 – "Indoor Air Pollution." NESCAUM workshop, Northampton, MA.

Editor

2010 to Present. Associate Editor. *Toxicology and Applied Pharmacology*.

2006 to 2010. Specialty Editor. *Toxicology and Applied Pharmacology*.

1995 to Present. *Human and Experimental Toxicology* (Editorial Board).

1991. *Trace Substances in Environmental Health: Supplement to Volume 14 (1992) of Environmental Geochemistry and Health. Proceedings of the 25th Annual Conference on Trace Substances in Environmental Health*, May 20-23, Columbia, MO.

Reviewer

Fundamental and Applied Toxicology; Toxicological Sciences; Cancer Research; Environmental Research; Annals of Internal Medicine; Human and Ecological Risk Assessment; Journal of Society of Environmental Geochemistry and Health; Human and Experimental Toxicology; Environmental Health Perspectives; Regulatory Toxicology and Pharmacology.

Continuing Education Courses

- Epigenetics in Toxicology: Introduction, Mechanistic Understanding, and Applications in Safety Assessment, Society of Toxicology, 2011.

- Technologies and Tools for Toxicity Testing in the 21st Century, Society of Toxicology, 2010.
- Immunology for Toxicologists, Society of Toxicology, 2009.
- Nanotoxicology: The Science of Developing a Safe Technology, Society of Toxicology, 2008.
- Dose-Response Modeling for Occupational and Environmental Risk Assessment, Society of Toxicology, 2008.
- Toxicology and Molecular Biology of Tissue Repair, Society of Toxicology, 2007.
- Use of Genome Databases for Toxicology, Society of Toxicology, 2006.
- Neuropathology for the Toxicologist, Society of Toxicology, 2006.
- Fundamentals of Nanotechnology: Chemistry, Exposure, Environmental/Health Assessments and Societal Impacts, Society of Toxicology, 2005.
- Integrating Toxicologic Pathology into Compound Evaluation and Risk Assessment, Society of Toxicology, 2002.
- Rodent Toxicity and Nongenotoxic Carcinogenesis: Knowledge-Based Human Risk Assessment from Molecular Mechanisms, Society of Toxicology, 2000.
- An Overview of the Tier 1 Screening Battery Proposed by EDSTAC, Society of Toxicology, 1999.
- Benchmark Dose, Society of Toxicology, 1997.
- Principles of Metal Toxicology, Society of Toxicology, 1997.
- Epidemiology for Toxicologists, Society of Toxicology, 1996.
- International Harmonization: Update on Scientific and Regulatory Issues. Part II: Toxic Substances and Environmental Issues, Society of Toxicology, 1994.
- Case Studies in Risk Assessment: Emphasis on Exposure, Society of Toxicology, 1992.
- Environmental Toxicology, Society of Toxicology, 1991.
- Target Organ Toxicity: Advanced Hepatotoxicity, Society of Toxicology, 1990.
- Toxicity of Agents: Pesticides, Society of Toxicology, 1990.
- Neurotoxicology, Society of Toxicology, 1989.
- Respiratory Tract Toxicology by Classes of Agents, Society of Toxicology, 1988.
- Mid-America Course in Toxicology, 1988.
- Pulmonary Pathophysiology, University of Vermont Medical School, 1979.