Comments on Lowering Miners' Exposure to Respirable Coal Mine Dust: Regulatory Economic Analysis

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Regulatory Economics Experience – Dr. Cantor

- Economist – over 30 years experience in applied and energy economics research and consulting.
- Principal at Exponent, a scientific and engineering consulting company.
- Former Program Director for Decision, Risk, and Management Sciences, a research program of the National Science Foundation.
- Senior researcher at Oak Ridge National Laboratory.
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Disclosure

- Exponent was asked to independently review the Preliminary Regulatory Economic Analysis (PREA) prepared by MSHA.
- Exponent received funding from Murray Energy Corporation to conduct a review of the health, exposure, and economic data and methods used for risk assessment in the proposed MSHA Coal Dust Standard.
- The opinions and comments presented herein reflect the independent assessment of Dr. Cantor.

Why Economics Matters

- Costs of proposed regulations directly impact the bottom line for coal mining companies, which in turn impacts energy markets and workers' jobs, livelihoods, and health opportunities.
- Comparing costs and benefits of the proposed regulations gives insight into the value of the regulations to the mining community as a whole.
- Under existing regulatory rules, MSHA is required to examine the potential compliance costs and economic impacts of the proposed rules on small businesses and the broader economy.

Areas of Concern with PREA

- Compliance Costs
  - Where is the supporting documentation/analysis for assumed facts and conditions?
  - Cost estimates fail simple fact verification and for the selected examples that I examined - considerable discrepancy was observed.
  - No formal treatment of uncertainties.
  - Critical cost items are omitted or left incomplete.
- Benefits
  - Uses a hypothetical cohort of miners (completely new workforce) that maximizes benefits.
  - No formal treatment of uncertainty of benefits.

Brief Summary of the PREA 2010

Costs of Compliance:

- The PREA contains a detailed listing of activities and costs for mines in size categories determined by the number of employees per mine.
- Cost items include the installation of engineering controls, abatement costs, certification costs, use of CPDMs, sampling methods, training, and citations.
- The PREA estimates first year, annual and annualized compliance costs.

Brief Summary of the PREA (cont'd)

Benefits:

- The PREA estimates the value of injuries to miners' health that MSHA assumes will be avoided by the implementation of two to four provisions of the proposed Coal Dust Rules.
- Quantitative Risk Assessment (QRA) modeling is used to determine the quantity of health effects avoided by comparison of two worker cohorts over a 45-year period of time.
- The avoided injuries are "monetized" using estimates from the literature for values of avoiding mortality and morbidity risks.

Costs of Compliance

- MSHA estimates approximately $72 million (M) to $93 M in costs for the industry in the first year.

- MSHA estimates approximately $40 M to $45 M in annualized costs.

Annualized Benefits

- MSHA estimates 3,483 to 4,300 avoided health injuries and approximately 106 to 131 avoided deaths as a result of the proposed rule.

- MSHA estimates approximately $99 M to $197 M in annualized benefits.

PREA Assumptions

What is the foundation for assumed compliance needs or industry conditions?

- The PREA contains many specific statements about the scope of compliance actions with few supporting details.

  "These costs are based on the assessment of MSHA staff of the most likely actions that would be necessary to comply with the proposed rule" (PREA, p.41).

- In order to understand the scope and application of actions in the PREA fully, more information about this "assessment" should be included in the report.

MSHA "Facts" on Industry

- "Facts" or "assumptions" regarding new procedures or equipment requirements will obviously impact costs of compliance for the proposed rule.
- Two examples evaluated here, in which MSHA "facts" were checked against available industry data – indicated critical discrepancies.
- There are many other facts and assumptions throughout MSHA PREA that would benefit from comprehensive review and input based on available data.

Verification of Industry Facts

What is the number of MMUs (Mechanized Mining Units) likely to incur costs from the required responses?

The PREA estimates 50 MMUs are likely to be affected by Proposed §75.332 that requires "each MMU where mechanized mining equipment is being installed or removed to be ventilated by a separate split of intake air…" (PREA, p.49).

Likely Affected MMUs Based on Industry Data

Company	# in Super Sections	MSHA
Alpha Natural Resources	22	
Alliance Coal	39	
Arch Coal	1	
Cline Group	10	
CONSOL	12	
ICG	14	
James River	5	
Massey	96	
Murray Energy	6	
Patriot	46	
Peabody	12	
Walter Energy	2	
Total	**265**	**50**

Source: NMA.

Verification of Industry Facts (cont'd)

How many CPDMs (Continuous Personal Dust Monitor) will be required per MMU and what will they cost?

Sampling Category	MSHA Estimate of Average Number of CPDM Units
Designated Occupation (DO)	1.87
Other Designated Occupation (ODO)	0.87
Total	**2.74**

Industry Data Indicate More CPDMs per MMU Will be Required for Reliability

Sampling Category	Number of CPDM Units/MMU
Designated Occupation (DO) (1 per MMU)	2
Other Designated Occupation (ODO) (2 per MMU)	2
Sub - Total	4
Mark-Up for Maintenance/Reliability	25%
Total	**5**

CPDM Costs

- Actual documentation of costs per unit and alternative assumptions regarding the number of CPDMs per MMU demonstrates that compliance costs could be approximately 2 times the MSHA estimate.
- Insufficient analysis is reported to address uncertainties in:
  - Complete CPDM cost (that considers maintenance, repair, and back-up requirements)
  - Reliability of the samples, need for additional compliance sampling
  - The number of CPDM units required per MMU
  - Supply availability in the compliance timeframes

Industry and MSHA CPDM Costs for "First Year"

Label	Estimate	MSHA
Cost/CPDM Unit	**$12,900**	**$10,000**
Five-Year Protection Plan	$2,875	
Total Cost per Unit	$15,775	$12,875
Total MMUs	881	
CPDM Units per MMU	**5**	**2.7**
Total CPDM Units	4,405	2,415
Discount Factor for ODO Units	0.903	
Cost of CPDM Units for DO Sampling	$34,744,438	$21,218,000
Discounted Cost of CPDM Units for ODO Sampling	$31,374,227	$8,917,238
Total "First-Year" Cost of CPDM Units	**$66,118,665**	**$30,135,238**
Cost/Filter	$6.50	$5.50
Total Number of "First-Year" Filters	750,000	763,082
Number of "First-Year" ODO Samples	210,000	215,432
Number of "First-Year" DO Samples	540,000	547,650
Discount Factor for ODO Filters	0.859	
Discount Factor for DO Filters	0.925	
Cost of Filters for ODO Sampling	$1,172,535	$1,017,808
Cost of Filters for DO Sampling	$3,246,750	$2,786,169
Total "First-Year" Filter Cost	$4,419,285	$3,803,978
Total "First-Year" Cost	**$70,537,950**	**$33,939,216**

Important Omitted Cost Categories

The PREA fails to identify all incremental costs associated with the proposed regulations. The following categories are consistently omitted:

- Additional Personnel
- Health and Safety Costs
- Production Changes
- Work Stoppages

Omitted Cost Categories: Additional Personnel

- Information provided by industry suggests a need for additional Safety Technicians on site at underground operations just to conduct exposure measurements with CPDM.
  - CPDM Units must be started approximately 30 minutes prior to the beginning of each shift for warm-up and diagnostic testing.
  - If the machine fails to start properly, the sequence must be initiated again. Therefore, it is estimated that one hour and fifteen minutes will be needed to get all machines ready for use on the following shift.
  - The CPDM units must then be distributed to each DO in various staging areas of the mine.

Omitted Cost Categories: Additional Personnel

- A Safety Technician would have to observe workers at different sections of the mine to ensure that the CPDM units were being properly used and their readings monitored.
- Data from multiple CPDM units would need to be downloaded and documented at the end of each shift.

- This process occurs with every shift. Assuming 4 to 6 CPDM units per shift distributed across various DOs, and 3 shifts, this process is likely to require multiple technicians per mine.
- The costs of hiring additional personnel to perform these tasks and the subsequent additional personnel in the mines is not addressed in the PREA.

Omitted Cost Categories: Health and Safety

- Ergonomic considerations
  - Size and weight of the CPDM
  - Light cord/sample hose
  - Attachment to miner's belt
  - Additional musculoskeletal disorders (MSDs) that might result from use of CPDMs on a continuous basis
  - Acute injuries that could result because of distraction created by CPDMs
- MSHA reports no estimate for the health and productivity costs that these conditions might imply for miners or a foundation for omitting them.

Omitted Cost Categories: Citation-related Events

- Omitted costs fall into two sub-groups:
  1. Penalties resulting from citations
  2. Work stoppages as a result of triggering corrective actions
  - The PREA states the following concerning calculations of penalties resulting from citations:

    "MSHA did not estimate the cost of the penalties resulting from the citations because the Agency considers penalties to be transfer payments (as are taxes and subsides) and not to be social costs"
  - Penalties can affect mine operations, industry structure, and innovation.

Omitted Cost Categories: Production Delays

- The majority of costs resulting from citations or their avoidance are likely to come in the form of work stoppages or delays due to taking corrective actions.
- Exponent has conservatively assumed that exceeding or nearing exposure limits will require immediate corrective action and work stops on the MMU for 1 hour.
- The costs of work stoppages due to exceeding or nearing the applicable standard can be illustrated with industry data.

Production Assumptions

	Mining Method			
	Longwall Production	Continuous Miner for Longwall Production	Other Continuous Miner Production	Total Underground Production
Tons	133,132,800	33,284,000	160,760,000	327,176,800
% Underground Production	40.69%	10.17%	49.14%	100.00%
Tons Per Hour of Production	783	65	102*	
Revenue per Hour Production	$43,668	$3,625	$5,689	

*Based on MSHA estimate. On-going work may lead to a revised number.

Near-Term Revenue Loss From (1) Increasing Sample Count and (2) Reducing Exposure Limits

		Longwall Production	Continuous Miner for Longwall Production	Other Continuous Miner Production	Count	Total Revenue Lost
Existing Standard	**Samples Exceeding 2.0 mg/m^3 Standard**	67	145	708	***920***	
	Percent	6%	4%	4%		
	Revenues Lost	$2,915,428	$525,429	$4,027,429		***$7,468,287***
Proposed Standard	**Samples Exceeding 1.0 mg/m^3 Standard**	22,355	25,823	126,075	**174,252**	
	Percent	51%	22%	22%		
	Revenues Lost	$976,188,705	$93,607,911	$717,179,893		**$1,786,976,509**
Annual Revenue Lost Under Proposed Regulations due to Work Stoppages						**$1,779,508,222**

Long-Term Revenue Loss
(assumes current exceedance rates, no discounting)

		Longwall Production	Continuous Miner for Longwall Production	Other Continuous Miner Production	Count	Total Revenue Lost
Proposed Standard	**Samples Exceeding 1.0 mg/m^3 Standard**	2,630	4,695	22,923	**30,248**	
	Percent	6%	4%	4%		
	Revenues Lost	$114,845,730	$17,019,620	$130,396,475		**$262,261,825**
Annual Revenue Lost Under Proposed Regulations due to Work Stoppages						**$254,793,538**

Summary: Omitted Costs Categories

- I selected 3 omitted cost categories as examples demonstrating the need for more in-depth analysis

- Continuing review of the required actions is likely to demonstrate:
  - Additional discrepancies between MSHA assumptions regarding corrective actions and existing industry data, and
  - Additional omitted costs due to concerns about the CPDM reliability.

Conflicting Modeling Approaches: Costs v. Benefits

- When estimating the costs of the proposed regulations, MSHA assumes the existing workers and existing infrastructure are in place.
- When calculating the benefits, MSHA adopts a different model, one that compares a cohort of workers under a continuation of existing regulations to a hypothetical new cohort *only* exposed to the proposed standards.
- This model is the maximum benefit obtainable from the proposed rules assuming that the MSHA QRA is correct.

MSHA's Benefit Assumptions

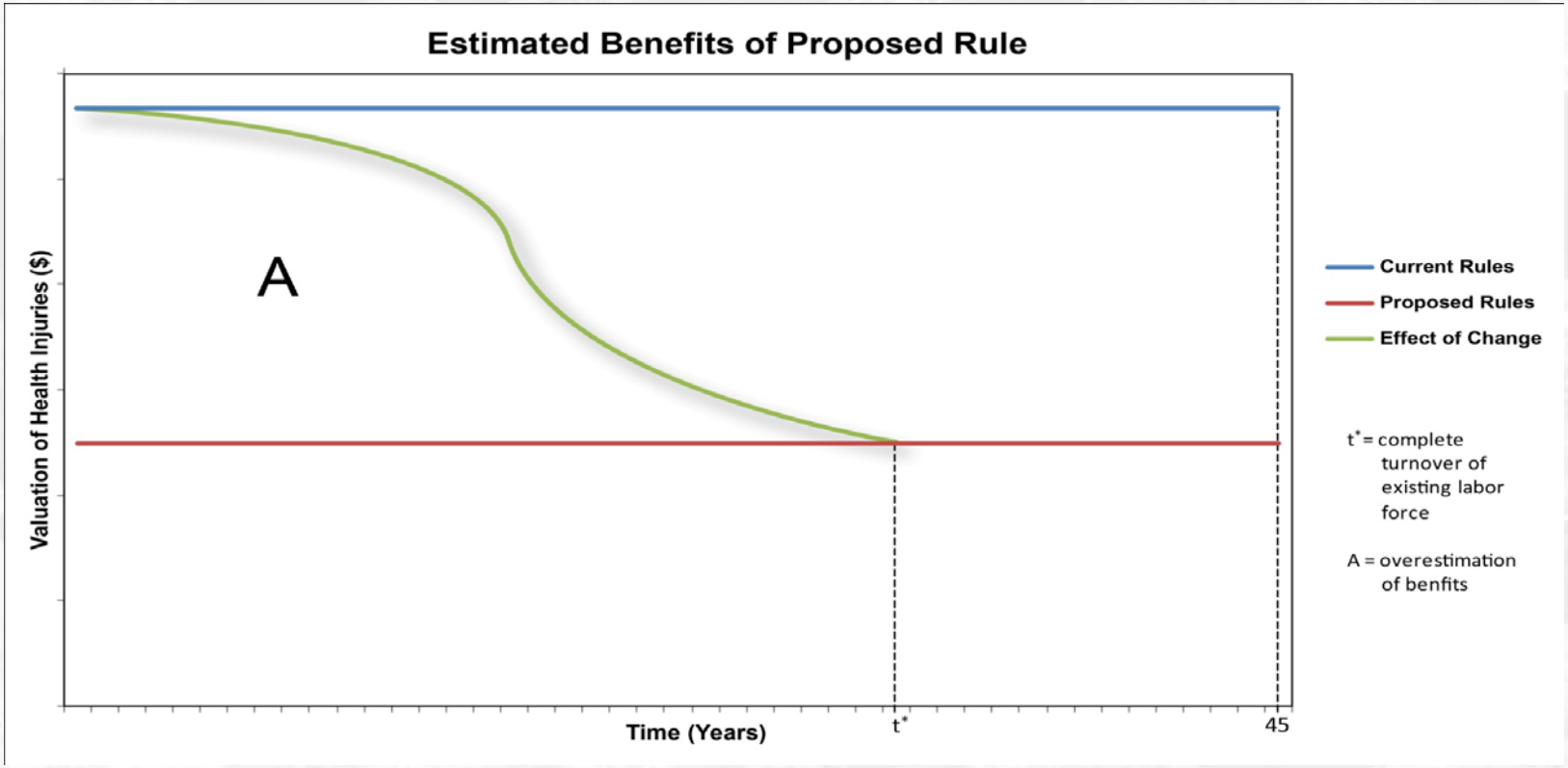
- Only 2 cohorts
- Status quo exposure for 45 years
- Reduced coal dust limits and increased sampling with cohort not previously exposed

These assumptions fail to reflect that the coal industry relies heavily on experienced workers.

Standard Methods to Estimate the Benefits of Avoided Health Injuries or Illnesses

- Define existing worker cohorts, exposures and turnover conditions
- Control for other causes of injuries & adverse conditions
- Simulate injuries due to current exposures (status quo)
- Identify how exposures change from implementation of the new regulations
- Simulate injuries due to reduced exposures (assumed from proposed standards)
- Find differences between the status quo and the proposed standards.

Benefits are Over Estimated



Area A measures the value of injuries that cannot be avoided by the proposed rule.

MSHA has Acknowledged This Issue Before in A Related PREA

Because these diseases typically arise after many years of cumulative exposure, allowing for a period of latency, and the pre-existing occupational exposure histories of members of the current coal mining workforce, the beneficial effects of reducing exposures are expected to become evident only after a sufficient time has passed so that the reduction in cumulative exposure could have its effect. ***The total realized benefits would not be fully evident until after the youngest of today's underground coal miners retire.*** If the size of this workforce substantially changed in the future and the projected pattern of prevented overexposures remained the same, the number of cases of prevented simple CWP and PMF would need to be adjusted to account for the change. (emphasis added)

Are Benefits Correctly Defined?

- MSHA suggests that many mines in the industry might be meeting the new standard.

- In the PREA, MSHA admits that:

  - "MSHA does not have data from which to predict disease latency, thus it is not clear how soon the benefits estimated in this analysis will accrue.

  - MSHA's analysis compares two separate cohorts who experience two different life-time exposure scenarios, thus, it is not clear whether the actual cohort of miners (who already have prior exposures) are likely to experience the magnitude of "avoided" adverse health effects documented" (PREA, p.24).

Summary

- MSHA's cost of compliance analysis is based on assumptions not supported by industry facts.
- Using *only* the omitted costs in this presentation indicates that the estimate likely is many times the MSHA estimate of total industry costs.
- MSHA's estimate of benefits is based on an unrealistic hypothetical.
- MSHA suggests in the PREA that it cannot estimate benefits properly.
- Currently we do not have an accurate or complete analysis of costs and benefits of the proposed rule.

Questions and Comments?

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Professional Profile

Dr. Robin Ann Cantor is a Principal in Exponent's Alexandria, VA office. She specializes in applied economics, environmental and energy economics, statistics, risk management, and insurance claims analysis. Prior to joining Exponent, she led the Liability Estimation practice at Navigant Consulting and assisted companies and financial institutions with analysis to better understand asbestos and other product liability exposures. Other positions she has held include: Principal and Managing Director of the Environmental and Insurance Claims Practice at LECG, LLC, Program Director for Decision, Risk, and Management Sciences, a research program of the National Science Foundation, and senior research appointments at Oak Ridge National Laboratory. Dr. Cantor has a faculty appointment in the Graduate Part-time Program in Engineering of the Johns Hopkins University. She was the President of the Society for Risk Analysis in 2002, and from 2001-2003, she served as an appointed member of the Research Strategies Advisory Committee of the US Environmental Protection Agency's Science Advisory Board. She is a member of the Executive Committee for the Women's Council on Energy and the Environment. Dr. Cantor's testimonial experience includes analysis of economic damages, product liability estimation in bankruptcy matters and insurance disputes, statistical analysis of asbestos settlements, analysis of premises and product claims, cost contribution allocation in Superfund disputes, analysis of derailment risks, reliability of statistical models and estimation methods, and economic analysis of class certification issues. She has prepared expert reports that address economic issues in antitrust, commercial practices and contracts, intellectual property, employment discrimination, false advertising, regulation, and other areas of product and market analysis. Dr. Cantor has submitted analysis, testimony and affidavits in federal arbitration, regulatory and Congressional proceedings, and state and federal courts. Dr. Cantor's publications include refereed journal articles, book chapters, expert reports, reports for federal sponsors, and a book on economic exchange under alternative institutional and resource conditions.

Academic Credentials and Professional Honors

Ph.D., Economics, Duke University, 1985
B.S., Mathematics, Indiana University of Pennsylvania, 1978

Fellow, Society for Risk Analysis, 2002
President, Society for Risk Analysis, 2002
YWCA Tribute to Women Award for Business and Industry, 1990

Society for Risk Analysis Presidential Recognition Award, 2008; Society for Risk Analysis Outstanding Service Award, 1999; NSF Director's Award for Superior Accomplishment, 1996; NSF Special Act Award, 1995; NSF Director's Award for Program Officer Excellence, 1994;

Oak Ridge National Laboratory Significant R&D Accomplishment Award, 1993; Martin Marietta Special Achievement Award, 1990; Martin Marietta Special Achievement Award, 1989; Martin Marietta Energy Systems Significant Event Award, 1988; C.B. Hoover Scholar, 1980–1981; Mellon Fellowship, 1978–1981

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Cantor RA. Evaluating vulnerabilities and identifying emerging risks. Invited presentation, The Conference Board EHS Legal Counsel Meeting, Houston TX, January 15–16, 2009.

Cantor RA. Using exposure science to ascertain asbestos liabilities. Invited CLE presentation, Business Valuation Resources, LLC Teleconference, November 18, 2008.

Cantor RA. Weather and temperature: Emerging health issues for US companies. REBEX 2008, Wheeling IL, October 23–24, 2008.

Cantor RA. Asbestos risk transfers: Unlocking value by walling off asbestos liabilities. Invited CLE session at Willkie Farr & Gallagher, New York, NY, June 4, 2008.

Cantor RA. The future of asbestos—New techniques for unlocking value by selling liabilities to investors. Mealey's™ Teleconference, March 25, 2008.

Cantor RA. Update on other U.S. long-tailed product liabilities. Invited presentation, 4th International Asbestos Claims & Liabilities Conference: The Practical Guide to Litigating, Settling and Managing Asbestos Claims, London, January 30–31, 2008.

Cantor RA. Tax or cap: What are the real differences for carbon policy in the US? Invited session and presentation, McDermott Will & Emery 10th Annual Energy Conference, Washington DC, October 9–10, 2007.

Cantor RA. Managing nanotechnology's life cycle risks responsibly. Invited ALI-ABA teleconference, June 27, 2007.

Cantor RA. Carbon emissions—Planning for the change. Invited teleconference, Environmental Law Network, June 15, 2007.

Cantor RA. Liability estimation and the historical future. Invited presentation, Mealey's™ Asbestos Bankruptcy Conference, Chicago, IL, June 7–8, 2007.

Cantor RA. Renewables and the value proposition for carbon credits. Invited presentation, McDermott Will & Emery 9th Annual Energy Conference, Washington DC, October 19–20, 2006.

Cantor RA. The ABCs of the value proposition for carbon credits. Invited presentation, the Environmental Trading Congress, New York, NY, July 24–25, 2006.

Cantor RA, Lyman M. Liability estimation in U.S. bankruptcy cases. London Underwriting Centre, London, UK, January 10, 2006.

Cantor RA, Lyman M. The status of the FAIR Act. London Underwriting Centre, London, UK, January 10, 2006.

Cantor RA. Economic appraisal of ecological assets. Invited presentation, U.S. Environmental Protection Agency Science Advisory Board "Science and the Human Side of Environmental Protection" Series, Washington, DC, July 6, 2002.

Cantor RA. Scientists and Homeland Security—The relevance of risk analysis. Invited presentation, Council of Scientific Society Presidents, Washington, DC, May 2002.

Cantor RA. NRD rules and economics. Invited presentation, Environmental and Admiralty Law Committees of the Association of the Bar of the City of New York, December 7, 2000.

Cantor RA. Revealed preferences and environmental risks: Lessons learned from two policy debates. Annual Meetings of the Society For Risk Analysis, Phoenix, AZ, December 8, 1998.

Cantor RA. Valuing environmental impacts: Lessons learned from the natural resource damage debate. Invited Paper, Society of Environmental Toxicology and Chemistry, 19th Annual Meeting, November 19, 1998.

Cantor RA. How will climate change affect economics and politics? Invited panel speaker, Policy and Politics of Climate Change, ABA Section of Natural Resources, Energy, and Environmental Law Fall Meeting, October 8, 1998.

Cantor RA. Natural resource damage rules: A search for the path of least resistance in value disputes? George Washington University Seminar Series on Environmental Values and Strategies, September 1997.

Cantor RA. Rethinking the science of risk management: Changing paradigms of the process and function. Operations and Information Management Department Workshop, Wharton School of the University of Pennsylvania, November 1995.

Cantor RA, Arkes H. Interdisciplinary perspectives on experimental methods. 1995 Meetings of the American Economic Association, January 1995.

Cantor RA. Risk management: Four different views. Invited presentation, The Conservation of Great Plains Ecosystems Symposium, April 1993.

Cantor RA. Human dimensions of global change: A white paper on the USGCRP research programs. National Academy of Sciences Board on Global Change, November 1993.

Cantor RA, Rayner S. Changing perceptions of vulnerability. Invited paper, NCAR/UCAR Summer Institute on Industrial Ecology and Global Change, July 17–31, 1992.

Cantor RA. Should economic considerations limit the conservatism of risk assessment? Invited paper, Workshop of the International Society of Regulatory Toxicology and Pharmacology on Risk Assessment and OMB's Report on its Application in Regulatory Agencies, Washington, DC, June 11, 1991.

Cantor RA. Beyond the market: Recent regulatory responses to the externalities of energy production. Annual Meetings of the National Association of Environmental Professionals, Baltimore, MD, April 30, 1991.

Cantor RA. Understanding community preferences at Superfund sites. National Meeting of EPA Community Relations Coordinators, Chicago, IL, April 4–6, 1990.

Cantor RA. Methodological myths and modeling markets: A common framework for analyzing exchange. Second Annual International Conference on Socio-Economics, Washington, DC, March 1990.

Cantor RA, Schoepfle GM, Szarleta EJ. Sources and consequences of hypothetical bias in economic analyses of risk behavior. 1989 Meetings of Society for Risk Analysis, October 1989.

Cantor RA, Jones D, Lieby P, Rayner S. Policies to encourage private sector responses to potential climate change. 1989 Meetings of International Association of Energy Economists, October 1989.

Cantor RA, Szarleta EJ. The experimental approach in public policy analysis: precepts and possibilities. Public Choice Society and Economic Science Association Annual Meetings, Orlando, FL, March 17–19, 1989.

Cantor RA, Rayner S. Global disaster management: Developing principles for research. 1988 Meetings of the Association for Public Policy Analysis and Management, October 1988.

Cantor RA. Implementation and enforcement issues from early adopter experience. Regional Evaluation Network, Northwest Power Planning Council, Portland, OR, June 1988.

Cantor RA. Using information from toxic-tort litigation to value the health and safety consequences of regulatory decisions. Public Policy Workshop, the Department of Economics and Waste Management Research and Education Institute, University of Tennessee, Knoxville, TN, February 1988.

Cantor RA, Bishop R, Jr. Valuing safety and health effects in regulatory decisions: A revealed-preference approach. 1987 Annual Meeting of the Society for Risk Analysis, November 3, 1987.

Cantor RA. Government intervention and technology prices: The CANDU example. Invited paper, WATTEC Conference, Knoxville, TN, February 19, 1987.

Cantor RA. Fairness hypothesis and managing the risks of societal technology choices. 1986 Winter Annual Meeting of the American Society of Mechanical Engineers, Anaheim, CA, December 10–12, 1986.

Cantor RA. A retrospective analysis of technological risk: The case of nuclear power. Invited paper, Center of Resource and Environmental Policy Workshop Series, Vanderbilt University, Nashville, TN, December 4, 1986.

Cantor RA, Petrich C, Mercier J-R. Evaluation of a large-scale charcoal project in Madagascar: Attacking the deforestation problem from the supply side. 1986 IAEE North American Conference, Cambridge, MA, November 19–21, 1986.

Cantor RA, Rayner S. Tools for the job: Choosing appropriate strategies for risk management. 1986 Annual Meeting of the Society for Risk Analysis, Boston, MA, November 9–12, 1986.

Cantor RA, Rayner S. Thinking the unthinkable: Preparing for global disaster. 1986 Annual Meeting of the Society for Risk Analysis, Boston, MA, November 9–12, 1986.

Cantor RA, Rayner S, Braid B. The Role of liability preferences in societal technology choices: Results of a pilot study. 1985 Annual Meetings of Society for Risk Analysis, Washington, DC, October 8, 1985.

Conference Participation

Invited panelist for "An Integrated Risk Framework for Gigawatt-Scale Deployments of Renewable Energy: The Wind Energy Case Study," 2009 Annual Meeting for the Society for Risk Analysis, Baltimore, MD, December 9, 2009.

Invited session organizer and panelist for "Global Warming and Greenhouse Gas Controls: What do they mean for you?" 2008 Annual Meeting of the National Association of Publicly Traded Partnerships, Washington DC, June 26, 2008.

Co-chair, "Second World Congress on Risk," Guadalajara, Mexico, June 2008.

Invited panelist for "Climate Litigation: The Next Asbestos or the Next Y2K?" ABA Section of Litigation Annual Conference, Washington DC, April 17, 2008.

Invited panelist for "Business of Mitigation: Carbon Offsets and Trading," Oxford University Capstone Conference, Oxford, UK, September 10, 2007.

Panelist for "Issues Concerning Implementation," at the Public Forum on OMB's Proposed Risk Assessment Bulletin: Implications for Practice Inside and Outside Government, sponsored by Society for Risk Analysis, Society of Environmental Toxicology and Chemistry in North America, Society of Toxicology, and International Society of Regulatory Toxicology and Pharmacology.

Session Chair, "Challenges Facing Industrial Countries," with key-note speeches by Philippe Busquin, EU Commissioner for Research, and Dr. John Graham, Administrator of the US Office of Information and Regulatory Affairs, Inaugural Conference of the International Risk Governance Council, Geneva, Switzerland, June 29, 2004.

Co-Chair, “First World Congress on Risk,” Brussels, Belgium, June 2003.

Chair of the Organizing Committee, 2001 Annual Meetings for the Society for Risk Analysis.

Member of the Organizing Committee, Risk and Governance Symposium, Society for Risk Analysis, June 2000.

Organizing Committee Member for the 1996, 1997, 1998, and 2002 Annual Meetings of the Society for Risk Analysis.

Panelist for Net Environmental Benefits Assessment for Restoration Projects after Oil Spills, Conference on Restoration for Lost Human Uses of the Environment, Washington, DC, May 1997.

Session Organizer and Chair for Cost Benefit Analysis and Risk Assessment at the 1996 Annual Meeting of the Society for Risk Analysis.

Panelist for Challenges in Risk Assessment and Risk Management sponsored by The Annenberg Public Policy Center of the University of Pennsylvania at the National Press Club, Washington, DC, May 16, 1996.

Panelist for Media and Risk in a Democracy: Who Decides What Hazards Are Acceptable? At the 1995 Annual convention of the Association for Education in Journalism and Mass Communication.

Session Organizer and Co-Chair for Experimental Methods: Insights from Economics and Psychology at the 1995 Meetings of the American Economic Association.

U.S. Organizer for the Third Japan-U.S. Workshop on Global Change Modeling and Assessment: Improving Methodologies and Strategies, Hawaii, October 1994.

Cluster Organizer for three sessions on Competitiveness at the Fall Meeting of the Operations Research Society of America/The Institute of Management Sciences, 1994.

Roundtable Panelist for Risk Communication Research: Defining Practitioner Needs at the 1994 Meetings of the Society for Risk Analysis.

Workshop Organizer for Organizational Transformation and Quality Systems, National Science Foundation, 1993.

Session Chair and Organizer for the NSF/Private Sector Research Initiative Projects at the 1992 Meetings of the Society for Risk Analysis.

Roundtable Panelist for the EPA Session on Risk Communication at the 1990 Meetings of the Society for Risk Analysis.

Session Chair and Organizer for the Computer Assisted Market Institutions Session at the Advanced Computing for the Social Sciences Conference, April 1990.

Discussant for the Issues in LDC Public Finance Session at the 1988 Meetings of the American Economic Association.

Session Chair and Organizer for Social Science Innovations in Risk-Analysis Methods, Special Session at the 1988 Meetings of the Society for Risk Analysis.

Prior Experience

Managing Director, Navigant, 2004–2008
Lecturer, Graduate Program, Johns Hopkins University, Engineering and Applied Science Programs for Professionals, Program in Environmental Engineering, Science and Management, 1996–present
Principal and Managing Director, LECG, 1999–2004
Senior Managing Economist, LECG, 1999
Managing Economist, LECG, 1996–1998
Member, U.S. Environmental Protection Agency, Science Advisory Board, Research Strategies Advisory Committee, 2001–2003
Program Director, Decision, Risk, and Management Science, National Science Foundation, 1992–1996
Coordinator, NSF Human Dimensions of Global Change, 1992–1996
Project Manager, Oak Ridge National Laboratory, 1990–1991
Technical Assistant to the Associate Director, Advanced Energy Systems, Oak Ridge National Laboratory, 1989–1990
Group Leader, Social Choice and Risk Analysis Group, Energy and Economic Analysis Section, Oak Ridge National Laboratory, June 1987–1989
Research Staff, Energy and Economic Analysis Section, Oak Ridge National Laboratory, Oak Ridge National Laboratory, October 1982–1987
Consultant, Indonesian Energy Project, Harvard Institute For International Development, July 1987
Visiting instructor, North Carolina Central University, Spring 1982

Advisory and Other Appointments

- National Research Council Committee to Review the Department of Homeland Security's Approach to Risk Analysis, November, 2008–present
- Executive Committee, Women's Council on Energy and the Environment, 2006–present
- Board Member, Women's Council on Energy and the Environment, 2004–2006
- Member, Advisory Group for the Joint Global Change Research Institute, a collaboration between Pacific Northwest National Laboratory and the University of Maryland, 2004–2008

- Member, Planning Committee for a study to evaluate the U.S. National Assessment of the Potential Consequences of Climate Variability and Change, coordinated through Carnegie Mellon University, 2004
- Neutral technical panelist working with Arbitrator Anthony Sinicropi on negotiation issues related to the pilots' compensation contract. Retained by US Airways and the Air Line Pilots Association (ALPA), 2001 and 2002
- Advisory Board Member, Johns Hopkins University Graduate Part-Time Program in Environmental Engineering and Science, 2000–2004
- Planning Committee Member, Carnegie Council on Ethics and International Affairs Long Term Study of Culture, Social Welfare, and Environmental Values in the U.S., China, India, and Japan, initiated January 1997
- Vice-Chair, U.S. Global Change Research Program working group on Assessment Tools and Policy Sciences, 1994–1996
- US Federal Reviewer for the Intergovernmental Panel on Climate Change working group III 1995 Report on Socioeconomics
- NSF Principal for the Committee on the Environment and Natural Resources' Subcommittee on Risk Assessment, 1993–1996. Also served as the liaison between the Subcommittee on Risk Assessment and the Subcommittee on Social and Economic Sciences
- Advisory panel member for Environmental Ethics and Risk Management, National Academy of Public Administration and George Washington University, 1993–1994
- Science Advisory Board member for Consortium for International Earth Science Information Network, 1993
- Review Panel member for Economics and the Value of Information, NOAA, 1993
- NSF technical representative to the FCCSET Ad Hoc Working Group on Risk Assessment and member of its Subcommittee on Risk Assessment, 1992–1993
- NSF representative to Working Party of the FCCSET Subcommittee for Global Change Research on Assessment, 1992–1993
- Affirmative Action Representative for the Energy Division, Oak Ridge National Laboratory 1984–1989, AA Rep for the Central Management Organization of ORNL, October 1989 to November 1990
- Board of Directors, Vice President (1987–1988), President (1988–1989), Matrix Organization, The Business Center for Women and Minorities, Knoxville, TN

Editorships and Editorial Review Boards

- Editorial Board, *Journal of Risk Analysis*, 1997–present
- Editorial Board, *Journal of Risk Research*, 1997–2005

Peer Reviewer

- The Energy Journal, Climate Change, Contemporary Economic Policy, Growth and Change, Ecological Applications, Risk Analysis, Duke University Press, Princeton University Press, J. of Environmental Economics and Management, Resources and Energy, The Environmental Professional, Journal of Risk Research, National Science Foundation, National Oceanic and Atmospheric Administration, FORUM, U.S. Environmental Protection Agency

Professional Affiliations

- American Economic Association
- Women's Council on Energy and the Environment
- Society for Risk Analysis
  – President, Society for Risk Analysis, 2002
  – President-Elect, Society for Risk Analysis, 2001
  – Councilor, Society for Risk Analysis, 1996–1999
- American Bar Association

Deposition /Trial Testimony

Available on request