



Attachment C

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Explanation Supporting Reasonableness of Requested Rates

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1. Attorneys

Sabrina Venskus (Lead Attorney)

Surfrider requests an hourly rate of \$350 for work conducted by Sabrina Venskus in 2009-2011. Ms. Venskus has been in practice for 10 years and received her Bachelor of Arts at UCLA in 1996 with honors, her Juris Doctor at Northwestern School of Law of Lewis & Clark College, in Portland, Oregon, in 1999 with honors, and a Certificate in Environmental and Natural Resources Law in 1999.

The Commission, in D10-06-045, previously awarded Ms. Venskus a rate of \$330 per hour for work conducted in 2009 and 2010 on the CEQA portion of these proceedings. In D10-06-045, ALJ Minkin found Surfrider's requested rate of \$350 unreasonable because the Request did not specifically identify Ms. Venskus' other litigation experience that would be comparable to CPUC proceedings. (D10-06-045 at p. 12.) Ms. Venskus has been practicing environmental law in the State of California for approximately nine years and has extensive litigation experience. This experience is commensurate with issues litigated before the Commission. The bulk of Ms. Venskus' experience is in CEQA litigation, representing public interest clients enforcing CEQA's public review requirements and ensuring public agencies fully address and consider the environmental impact of their decisions.

Ms. Venskus' work in other forums supports the \$350.00 rate requested. For example, over the last few years, Ms. Venskus has obtained successful results in highly politicized and complex environmental litigation, such as a favorable ruling in the California Court of Appeal overturning project approvals for the largest development in the City of Los Angeles' history due to a woefully inadequate EIR on issues of water treatment and historic resources (*City of Santa Monica, et al., v. City of Los Angeles*, 2007 WL 2677035); and a multi-party settlement of CEQA litigation involving water supply issues, among others, over a politically-charged project in Hollywood resulting in a much scaled-down and environmentally-conscious project (*La Brea-Willoughby Coalition, et al., v. City of Los Angeles*, L.A.S.C. No. BS121492). Ms. Venskus is often brought in as settlement counsel by public interest entities seeking to resolve matters before they enter full-blown litigation. Ms. Venskus was able to achieve successful results in two such disputes just last year, wherein opponents agreed to revise their projects to reduce negative environmental impacts. In addition, Ms. Venskus is currently representing Environmental Law Foundation against Southern California Gas Company in complex environmental litigation involving groundwater contamination from leaking wells and underground natural gas storage facility. The case was filed in 2007 and is set to go to trial later this year. (*Environmental Law Foundation v. Southern California Gas Co.*, L.A.S.C., No., BC364555)

Surfrider requests a rate of \$350 per hour for work conducted in 2009-2011 by Ms. Venskus.

Theresa Labriola (Associate Attorney)

Surfrider requests an hourly rate of \$285 for work conducted by Theresa Labriola in 2009 and 2010. The Commission previously awarded this rate for Ms. Labriola in D10-06-045. Ms. Labriola received an undergraduate degree from Cornell University in Ithaca, NY in 1994 and a J.D. from Vermont Law School in South Royalton, VT in 2002. She has been practicing law for more than six years, the majority of which involved environmental litigation.

The requested rate of \$285 per hour for work conducted in 2009 and 2010 for Ms. Labriola is reasonable. This rate is commensurate with the 2008 rates adopted in D.08.04-011, which remain the same for 2009 and rates previously applied to attorneys with comparable experience.

Emilee Moeller (Associate Attorney)

Surfrider requests an hourly rate of \$295 for work conducted by Emilee Moeller in 2009. The Commission previously awarded this rate for Ms. Moeller in D10-06-045. Ms. Moeller earned her Bachelor of Arts at Washington State University in 1995 and her J.D. and Certificate in Environmental and Natural Resource Law from Northwestern School of Law at Lewis & Clark College in 1999. In addition, in 2006, Ms. Moeller graduated with distinction from Loyola Law School's Tax L.L.M. program. Ms. Moeller has over six years of litigation experience in California.

Ms. Moeller assisted lead attorney Sabrina Venskus in some substantive issues and in the drafting of the present request for compensation. The requested rate of \$295 per hour for work conducted in 2009 and 2011 is reasonable.

2. Experts

Steven Kasower, Principal, Strategic Economics Applications Company (SEACO)

Surfrider requests an hourly rate of \$325 for work conducted by Mr. Kasower in 2009 and 2010. Mr. Kasower is an economist with three decades of work in water supply, environmental enhancement, and multi-objective water, energy, and environmental projects. Mr. Kasower has extensive experience in identifying and implementing new water supplies that meet the complex demands of the 21st Century. His consultancy gives consideration to environmental justice, climate change risk and uncertainty, and environmental degradation, which are key perspectives in today's water supply project planning and implementation.

Prior to running SEACO, Mr. Kasower was the Senior Research Economist at the University of California, Santa Cruz, Center for Integrated Water Research, where he was responsible for conducting research in the areas of water resources from the political, regulatory, economic, and institutional perspectives. Mr. Kasower's extensive experience is documented in his CV attached to this request. As his resume indicates, Mr. Kasower has worked on water issues for the U.S. Bureau of Reclamation as well as the California Water Resources Department. Mr. Kasowner has completed his Ph.D. coursework in economics at U.C. Davis after obtaining his BA and MA in Economics at San Francisco State University and U.C. Davis, respectively.

Mr. Kasower, an economist, participated in all stages of the proceedings under the direction of the customer, Surfrider Foundation, and its lead attorney, Ms. Venskus.

Surfrider asserts that the requested rate of \$325 per hour for work conducted in 2009 and 2010 by Mr. Kasower is reasonable.

Bill Powers, Principal, Powers Engineering Co.

Surfrider is requesting an hourly rate of \$200 for work conducted by Bill Powers. Mr. Powers has previously been awarded this hourly rate by the Commission in D.08-12-015. Mr. Powers has a Masters in Public Health and Environmental Sciences from the University of North Carolina and a BS in Mechanical Engineering from Duke University. He has twenty-five years of experience in power plant air emission control system and cooling system assessments; regional renewable energy planning; combustion equipment permitting, testing and monitoring; and air pollution control equipment retrofit design/performance testing. Mr. Powers' CV is attached to this request.

Mr. Powers assisted Surfrider in this proceeding to:

- 1) Quantify and verify the carbon footprint of each of the three primary alternatives, Coastal Water Project (Moss Landing), Cal Am CWP Alternative, and Regional Alternative.
- 2) Evaluate the cost and carbon footprint of substituting a portion of the desalination component of the Regional Alternative using recycled water for groundwater recharge as suggested by Monterey Regional Water Pollution Control Agency.
- 3) Corroborate that the estimates of urban storm water and river storm water availability assumed for "aquifer storage and recovery" (ASR) in the Regional Alternative are accurate, and determine if additional storm water could be feasibly stored and treated as substitute for desalination component of Regional Alternative.
- 4) Corroborate the amount of gray water currently discharged by the MRWPCA Marina treatment plant, Watsonville Treatment Plant, and City of Santa Cruz Treatment Plant that is potentially available as substitute water for desalination component of Regional Alternative.
- 5) Recalculate the carbon footprint of the Regional Project based on the degree of substitution of desalination water with either additional supplies of storm water or gray water.

Surfrider asserts that the requested rate of \$200 per hour for work conducted in 2009 and 2010 by Mr. Powers is reasonable.

Pacific Institute.

The Pacific Institute prepared two analyses for Surfrider. The first analysis, conducted by Heather Cooley, Peter Gleick, and Lucy Allen, evaluated the water conservation and efficiency efforts in the Cal-Am Water service area and whether there is the potential to reduce water demand further. The second analysis, conducted by Matthew Heberger, evaluated potential sea level rise impacts and whether these risks implicated increased costs of the three projects.

The Pacific Institute (through its affiliated group, the Green Power Institute) has previously been eligible by the Commission to apply for awards of compensation, and has been granted such awards of compensation (see, for example, D.05-10-030, D.04-01-046). Resumes for Heather Cooley, Peter Gleick, Lucy Allen and Matthew Heberger are attached to this request.

Lucy Allen

Surfrider asserts that the requested rate of \$ 75 per hour for work conducted by Ms. Allen is reasonable. Lucy Allen is a Research Associate with the Pacific Institute's Water Program. Her research interests include water quality, drinking water regulation, and the links between water, energy, and climate change. In May 2008, Ms. Allen received a B.S. with Honors in Conservation and Resource Studies from the University of California, Berkeley. While at Berkeley, she worked at Lawrence Berkeley National Laboratory where she assisted with research on soil organic carbon cycling and completed an honors research project on the effect of earthworm invasion on the turnover and stability of soil organic carbon.

Heather Cooley

Surfrider asserts that the requested rate of \$ 175 per hour for work conducted by Ms. Cooley is reasonable. Heather Cooley is the Co-Director of the Pacific Institute's Water Program and has over 5 years of experience in her field of expertise. Ms. Cooley's research addresses the connections between water and energy, sustainable water use and management, and the hydrologic impacts of climate change. Ms. Cooley holds a B.S. in Molecular Environmental Biology from University of California, Berkeley and an M.S. in Energy and Resources from UC Berkeley. Prior to coming to the Pacific Institute, Ms. Cooley worked at Lawrence Berkeley Laboratory studying climate and land use change, and carbon cycling.

Peter Gleick

Surfrider asserts that the requested rate of \$ 250 per hour for work conducted by Dr. Gleick is reasonable. Dr. Peter H. Gleick is co-founder and president of the Pacific Institute and has over 22 years experience in his field of expertise. His research and writing address the critical connections between water and human health, the hydrologic impacts of climate change, sustainable water use, privatization and globalization, and international conflicts over water resources. Dr. Gleick is an internationally recognized water expert and was named a MacArthur Fellow in October 2003 for his work. In 2001, Gleick was dubbed a "visionary on the environment" by the British Broadcasting Corporation. In 1999, Gleick was elected an Academician of the International Water Academy, in Oslo, Norway and in 2006, he was elected to the National Academy of Sciences, Washington, D.C. Gleick received a B.S. from Yale University and an M.S. and Ph.D. from the University of California, Berkeley. He serves on the boards of numerous journals and organizations, and is the author of many scientific papers and seven books, including the biennial water report, *The World's Water*, and the new *Bottled and Sold: The Story Behind Our Obsession with Bottled Water*.

Matthew Heberger

Surfrider asserts that the requested rate of \$ 175 per hour for work conducted by Mr. Heberger is reasonable. Matthew Heberger is a Research Associate with the Pacific Institute's Water Program. Mr. Heberger is a licensed Professional Engineer, registered as an Environmental Engineer in the Commonwealth of Massachusetts. He holds a BS in Agricultural and Biological Engineering from Cornell University and an MS in Water Resources Engineering from Tufts University in Boston. Prior to joining the Institute, Mr. Heberger worked for the consulting firm of Camp, Dresser, and McKee (CDM) in Cambridge, Massachusetts as a water resources engineer, performing hydraulic, hydrologic, and water quality analyses and modeling. He has also worked for the non-profit International Network

on Participatory Irrigation Management in Washington, DC. In addition, Matt spent two years with the Peace Corps as a water and sanitation extension agent in Mali, West Africa.

Steven Kasower
Principal, Strategic Economic Applications Company

Principal, Water Energy Partners Company

1720 Q Street, Sacramento, CA 95811

Phone (916) 442-1477; Fax (916) 442-3109;

steve@seacompany.org, www.seacompany.org

steve@wepco.org, www.wepco.org

EMPLOYMENT HISTORY

- 2009 Water Energy Partners Company, Principal
WEPCO is a company focused on the water/energy nexus. Basically a development partnership, WEPCO plans, finances, and builds alternative “green” power plants for industry and agriculture. Concentrating on stand-alone “green” power for water treatment, data centers, and other industrial and commercial activities whose objectives are to attain LEED ratings and minimize their “carbon footprint.”
- One area of contemporary expertise, WEPCO can provide power supplies for new data centers designed to bring State IT centers into compliance with Governor’s Executive Order S-03-10, dated 2/09/10 (<http://gov.ca.gov/index.php?/press-release/14406/>) . As State Chief Information Officers begin migrating to Tier III centers by September, 2010, WEPCO can provide carbon neutral wind and solar and carbon negative bio-digesting methane-based power supplies for new private and public data centers. WEPCO Principals view this new potential market as a wide open opportunity for private enterprise to provide the State IT environment with the green-based data centers it is required to use. WEPCO’s expertise makes the difference between competitive and profitable new data centers and those left behind in the dust of a fast moving technological 21st Century.
- 2009 Strategic Economic Applications Company, Principal
SEACO is a consultancy focused on resource solutions with vision and value. Capitalized on Mr. Kasower’s three decades of work in water supply, environmental enhancement, and multi-objective water, energy, and environmental projects, SEACO can identify and implement new water supplies that meet the complex demands of the 21st Century. Consideration of environmental justice, climate change risk and uncertainty, and environmental degradation are key perspectives in today’s water supply project planning and implementation.
- 2006-9 University of California, Santa Cruz, Researcher in Environmental Studies, Senior Research Economist, Center for Integrated Water Research
- Responsible for conducting research in the areas of water resources from the political, regulatory, economic, and institutional perspectives. This applied research track is designed to provide a means for society to most acceptably and economically provide water for human and environmental uses.

Development of a robust water research program with a diverse funding base to best effect a viable water research agenda for the Center for Integrated Water Research (CIWR). Work with Researchers, Academic Coordinators, and Graduate Students on CIWR's projects

- 2003-6 United States Bureau of Reclamation, Desalination Planning Manager, Water Treatment and Engineering Group, Technical Service Center, Denver, Colorado, Responsible for planning and identifying the appropriate role for advanced treatment technologies in creating new water supplies in the West. Particular emphasis given to the impacts of new water supplies from the hydraulic, operational, environmental, economic, legal, and institutional perspectives.
- Responsible for bringing alternative and interdisciplinary perspectives to Reclamation's applied water treatment technology research.
- At the request of the Congress, responsible for identifying new water supplies in the 17 western States based on advanced treatment technologies.
- Mentored young technical staff members to a meaningful role for their expertise within interdisciplinary processes.
- 2003 Big Bear Area Regional Wastewater Agency, Big Bear City, California, Water Recycling Project Coordinator
- Responsible for implementing a water recycling program that converts BBARWA from a traditional wastewater treatment and disposal entity to a recycled water producer treating 100% of the waste flow into water suitable for recharging the drinking water aquifer.
- Working with the Board of Directors and the General Manager, responsible for identification and evaluation of project alternatives. Analytical work includes project planning design, permitting, environmental documentation, and public information programs. Responsible for establishing proposals and managing professional contracts for various components of the recycling project.
- 1998-03 United States Bureau of Reclamation, Lower Colorado Region, Southern California Area Office, Temecula, California, Area Planning Officer
- Responsible for all aspects of federal water resource planning in southern California, including water conservation, water recycling, conjunctive ground and surface water management, brackish and ocean water desalination, regional water planning activities with local southern California water, stormwater, and wastewater agencies, urban, industrial, and agricultural interests, and with Mexico.
- Study Manager, Southern California Comprehensive Water Reclamation and Reuse Study, a six-year, \$6 million study of regional water recycling potential under the direction of an eight member Executive Management Team comprised of regional water and wastewater agency cost-sharing partners and collaborative participation with 70 local water and wastewater agencies from Ventura County in the north to San Diego County in the south.

Study Manager, Southern California Water Recycling Projects Initiative, a 4-year \$3.5 million study aimed at implementing by 2010, 15 regional water recycling projects with yield over 380,000 acre-feet annually with nearly 800,000 acre-feet of recyclable water potential. This is a focused continuation of the Southern California Comprehensive Water Reclamation and Reuse Study.

Study Manager for Santa Margarita River Watershed and Los Angeles-San Gabriel Watershed Studies, Congressionally authorized activities aimed at augmenting local water supplies through more coordinated and efficient storm water management.

Oversight of a Bureau of Reclamation southern California Native American Affairs program, aimed at assisting the thirty-one federally recognized tribes in southern California in establishing and managing their water supplies.

Establishment and management of a multiple year water resource planning program serving southern California water, stormwater, and wastewater agencies.

1990-97 State of California, Department of Water Resources, Sacramento, California, Water Recycling Specialist

DWR's water recycling spokesperson and manager of water recycling activities.

The water recycling position, conceived by me, focused entirely on local resource issues and was designed to facilitate the adoption by local agencies of integrated local resources management programs including water conservation and recycling as part of their Urban Water Management Planning activities

Worked with Legislature to include program funding (Proposition 204) to fund and institutionalize a water recycling activity in DWR's budget.

1985-90 United States Bureau of Reclamation, Mid Pacific Region, Fish and Wildlife Service, and Geologic Survey, California Department of Water Resources, and Department of Fish and Game, San Joaquin Valley Drainage Program, Sacramento, California, San Joaquin Valley Drainage Program Liaison to the National Academy of Sciences.

Liaison to the National Academy of Sciences/National Research Council's Committee on Irrigation Induced Water Quality Problems.

Technical and policy advisory to the Federal-State SJVDP during its five-year study of the environmental consequences of irrigated agriculture overlying shallow saline aquifers on the west side of the San Joaquin Valley.

1977-85 California Department of Water Resources, Sacramento, California, Statistical Method Analyst, Senior Staff Economist and Chief of Planning Evaluation

Over seven years of progressively responsible management and administrative experience at the California Department of Water Resources, including activities in Water Conservation, Groundwater, Water Quality, Financial Programs, and local district activities. Began career as a statistician and rapidly advanced to manage the technical economics program, serving the policy makers and producing technical reports and memoranda. Ultimately, I had responsibility for technical oversight of all planning analyses and methodologies.

EDUCATION

- 1988 University of California, Davis, completed all class work and examinations leading to Ph.D. in Economics with specialization in Energy and Natural Resource Economics, Comparative Economic Systems, Industrial Organization, Econometrics, Mathematical Economics, Chinese Economic History; dissertation title, "A Public-Private Approach to Managing Saline Soils in the San Joaquin Valley, California."
- 1988 University of California, Davis, Master of Arts, Economics
- 1975 San Francisco State University, Bachelor of Arts in Economics and Chinese Language

PROFESSIONAL COMPETENCE AND ACTIVITY

Honors, Awards, Grants

- 2007 Monterey Regional Water Pollution Control Agency, Multi-phase investigation of federal and state benefits of regional water treatment projects, \$42,000.
- 2007 California Public Utilities Commission, Division of Ratepayer Advocates, research and administrative coordination of a process to identify a regional solution to Monterey County water supply needs, \$326,000.
- 2006 California Public Utilities Commission, Division of Ratepayer Advocates, research support for analysis of the Central California Water Project, \$100,000.
- 2001 WateReuse Association, Professional of the Year, 2001. Awarded for sustained analytical and policy work on recycled water issues.
- 1980 Governors Commendation, for economic evaluations and staff work on the California Wild and Scenic Rivers Task Force

RECENT CLIENT LISTING

Some recent clients who have relied upon Strategic Economic Applications Company for solutions to pressing resource issues:

- Conaway Preservation Group, Conanway Ranch, Yolo County California
- Independent Recycled Water Users Group, Pebble Beach Golf Course, Cypress Point Golf Course, and Poppy Hills Golf Course
- Surfrider Foundation
- West Basin Municipal Water District
- The Water Replenishment District of Southern California
- Marina Coast Water District
- Monterey Regional Water Pollution Control Agency
- Monterey Peninsula Water Management District
- California-American Water Company
- Planning Conservation League
- RMC Water-Environment, Inc.
- HDR Engineering, Inc.

PUBLISHED WRITINGS AND CREATIVE ACTIVITIES

Books and Monographs

- 2004 S. Kasower, A. Lynch, S. Lynch, U.S. Bureau of Reclamation, Southern California Water Recycling Projects Initiative, March 2004.
- 1998 Study Manager and lead author, U.S. Bureau of Reclamation, Southern California Comprehensive Water Reclamation and Reuse Study, (December).

Articles in Professional Journals

- 2000 S. Kasower, Recharging Groundwater in Southern California A Six-County Recycling Program, Proceedings of the American Groundwater Association Conference, 2000.
- 2000 S. Kasower, Regional Water Recycling Projects Gain Momentum In California, Proceedings of the Water Environment Federation, WEFTEC, Anaheim, CA.
- 1998 B. Sheikh, E. Rosenblum, S. Kasower, and E. Hartling Accounting for the Benefits of Water Reuse AWWA: Denver in Proceedings AWWA/WEF Water Reuse Conference, Orlando, FL.
- 1998 S Kasower and D. Braver, Regional Water Recycling Innovations: Strategies to Implement California's New Water Supply, Proceedings of the WaterReuse Association of California, Symposium XIII, San Jose, CA.
- 1998 B. Sheikh, E. Rosenblum, S. Kasower, and E. Hartling Accounting for the Benefits of Water Reuse AWWA: Denver in Proceedings AWWA/WEF Water Reuse Conference, Orlando, FL.
- 1996 S. Kasower and D. Spath, California Department of Health Services and California Department of Water Resources. A Proposed Framework for Regulating the Indirect Potable Reuse of Advanced Treated Reclaimed Water by Surface Water Augmentation in California (January).
- 1996 Bulletin 160-86, California Department of Water Resources, The California Water Plan Update.
- 1991 Bay-Delta Reclamation Sub-Work Group and the State Water Conservation Coalition, Reclamation/Re-Use Task Force. Water Recycling 2000 California's Plan for the Future, (September).
- 1979 Bulletin 205, California Department of Water Resources, The Impact of Severe Drought in Marin County California.

Chapters in Books

- 2008 Desalination Handbook, University of California Press (pending publication)

Book Reviews

Newspaper Articles

Other

- 2006 S. Kasower, B. Raucher, G. Wolff, and M. Beuhler, Portfolio Theory: Implications for Valuing New Sources in Water Supply Planning, Draft Technical Paper intended for journal publication, January 25, 2006.

OUTSIDE PROFESSIONAL ACTIVITIES

Public Lecture or Forum Participation

- 2006 At the request of the Governor of Wyoming, and in collaboration with Bureau of Reclamation, Family Farm Alliance, National Institutes for Water Resources, Ruckelshaus Institute of Environment and Natural Resources, and U.S. Geological Survey, created and executed the first conference of its kind on produced water from oil and gas production: "Produced Waters Workshop Energy and Water – How Can We Get Both for the Price of One?" April 4-6, 2006, Fort Collins, Colorado
- 2005 S. Kasower and A. Lynch, California Water Law and Policy Conference, Irvine, CA 2002, "Aggressive Water Management Through the Looking Glass: Is There a Problem?"
- 2005 S. Kasower, Kevin Price, Rick Martin, "Proposed Desalination Strategy for the Bureau of Reclamation," presented to Commissioner's Policy Forum, Department of the Interior, December 23, 2005
- 2005 S. Kasower, Water Supply Planning Data Needs for the Chickasaw Tribe in Oklahoma, Oklahoma-East Texas Water Supply Seminar, July 13, 2005
- 2004 S. Kasower, Making Good Interdisciplinary Decisions, A Concept Paper on Resolving Water Resource Supply and Management Issues in a Complex and Challenging World, Presented to Reclamation Science and Technology Directorate, March 1, 2004,
- 2004 S. Kasower, "South Platte River Integrated Regional Water Supply Study Concept," presented to USGS National Water-Quality Assessment (NAWQA) Program for the South Platte River System Forum, November 23, 2004
- 2001 S. Kasower, "Careful Planning, Technical Competence, Exacting Science ... You Lose! (But Why?)" California Hazardous Materials Investigators Association Annual Training Conference. Shell Beach, CA (May 4).
- 2001 S. Kasower, "The Future of Business in the Big Bear Valley: Will We Survive the Sentimental Drought? And What YOU Can Do About It" Kiwanis Club of Big Bear. Big Bear, CA.
- 1999 S. Kasower, Regional Planning Partnerships Lead to Successful Projects, Presented to the Focus on Orange County, Workshop for Managers, Irvine, CA.
- 1999 S. Kasower, California Agriculture at the brink of the 21st Century: You are the Pivotal Generation. Presented to the California Farm Bureau Federation, Young Farmers/Future Leaders Conference, Walnut Creek, CA.
- 1998 S Kasower and D. Braver, Lessons Learned From Regional Resources Planning, Presented to Department of the Interior planners, San Antonio, TX.

Membership or Activities in Professional Associations

- 2007 Member (Since 2003), American Membrane Technology Association
- 2007 Member (Since 1999), Colorado River Water Users Association
- 2007 Member (Since 2006), Association of California Water Agencies, Water Management Committee
- 2007 Member (Since 2006), Association of California Water Agencies, Desalination Sub-Committee
- 2001- Member, Proposal Advisory Committee, WateReuse Foundation Research Program. Attended workshop to making funding decisions for the 2001 Call for Proposals, San Diego, September 7.
- 1999 to 2002 Chair, WateReuse Foundation, Agricultural Reuse Committee
- 1996 to 2000 Member, WateReuse Association Legislative Committee

Papers Presented at Professional Meetings

- 2009 S. Kasower, "A 21st Century Project Must Be Diverse in its Solutions, Socially and Politically Astute, and Environmentally Sound," presented at the WateReuse Association Annual Conference, Seattle, WA, September, 2009
- 2009 S. Kasower with Jim Heitzman, "Carbon Neutral Desalination in Monterey, California," presented at the WateReuse Association Annual Conference, Seattle, WA, September, 2009
- 2008 S. Kasower with Jim Heitzman, "Water for Monterey County, An Affordable, Sustainable Water Supply Solution Solves Difficult Water Issues for a Community That Relies on Its Own Water Supplies, presented at the Watersmart Conference, Las Vegas, NV, October 2008
- 2008 S. Kasower, "Recycled Water is the Key to Resolving Regional Water Issues in Monterey California," Presented at the 23rd Annual WateReuse Symposium, September 7-10, 2008, Dallas, Texas
- 2007 S. Kasower, "Beneficiary Pays...Cool Idea! *But*....Who is Benefiting & What is the Benefit?" Presented at the Northern California Chapter WateReuse Association Meeting December 7, 2007
- 2007 S. Kasower with William Bourcier, Elizabeth Burton, and Robin Newmark, "New Materials and Separations Science for Sustainable Water," First Western Forum on Energy and Water Sustainability, Santa Barbara, March 2007
- 2006 S. Kasower, Moderator, "Innovated Uses for Recycled Water, 21th Annual WateReuse Symposium, Hollywood, California, September 2006
- 2006 S. Kasower, "Impaired Water in California's Future," Sacramento Environmental Attorneys Brown Bag Lunch Bunch, November 3, 2006

- 2000 S. Kasower, "Southern California Comprehensive Water Reclamation and Reuse Study & The Southern California Water Recycling Projects Initiative, US Bureau of Reclamation's Regional Water Recycling Partnerships", Urban Water Institute's Spring Conference, Ventura, CA.
- 1998 S. Kasower, Can Reclaimed Water be a Serious New California Water Supply? Presented to the American Society of Civil Engineers, Ontario, CA.
- 1997 S. Kasower, Agricultural Irrigation Using Recycled Municipal Water...or, what does this have to do with reality? Presented to the Association of California Water Agencies Conference.

Service to Local, State, or Federal Government

- 1996 to 2000 Elected Board Member, Fremont Park Neighborhood Association, City of Sacramento
- 1996 Co-Chair, State of California Planned Indirect Potable Reuse Regulatory Committee
- 1997 City of Sacramento, SMART Traffic Calming Neighborhood Advisory Committee, City of Sacramento

EDUCATION

Tufts University, Medford, MA

September 2003

M.S., Water Resources Engineering

- Thesis Title: Modeling Nonpoint Source Bacteria Loading in Urban Watersheds
- Coursework: Hydrology, Water Quality Modeling, River Hydraulics, Systems Analysis, Advanced Statistics, Geographic Information Systems, Watershed Management

Cornell University, Ithaca, NY

May 1996

B.S., Agricultural and Biological Engineering,

- Significant coursework in Economics and Public Policy, Biology, and Ecology.

PROFESSIONAL EXPERIENCE

Pacific Institute, Oakland, CA

Research Associate

March 2007 – present

- Performed geographic and demographic analyses for major, state-funded study, “Adapting to Sea Level Rise on the California Coast”.
- Established Institute’s Geographic Information System; create maps and conduct geographic analyses for a number of projects on health, water use, and conservation.
- Perform basic research on water-related public policy issues including water and sanitation in Africa, interstate water disputes, conservation and efficiency
- Designed and programmed three decision-support systems:
 - Cost Effectiveness of Water Conservation and Efficiency
 - StopWaste Economic Toolkit
 - Personal Water-Greenhouse Gas Emissions Calculator

Camp Dresser & McKee, Cambridge, MA

February 2007

Water Resources Engineer

December 2001 –

- Performed a range of hydrologic, hydraulic, and water quality engineering analyses.
- Major projects have included watershed and water quality modeling, FEMA flood mapping, stormwater management plans, water supply planning, and dam removal studies.
- Wrote proposals and staffing plans; manage budgets.
- Trained and supervised junior engineers, interns, and coops.
- Gave presentations at national conferences and to clients and technical reviewers.
- Wrote reports and prepared presentation maps and graphics.
- Met with clients and state and federal regulators; participate in public meetings.

Tufts University, Medford, MA

September 2003

Research Assistant, Department of Civil and Environmental Engineering

September 2001 –

- Installed and maintained five continuous water quality monitoring stations, including related hardware, software, and radio telemetry equipment, for the project *Real-Time Water Quality Monitoring and Modeling on the Mystic River*.
- Applied for permits under Massachusetts Wetlands Protection Act.

- Performed weekly field checks and monthly calibrations of equipment.
- Reviewed incoming data and performed Quality Assurance/Quality Control necessary for final data publication.
- Created protocols and computer programs for water quality data management, visualization, and post-processing.

International Network on Participatory Irrigation Management, Washington, DC *September 1999-
August 2001*

Coordinator

- Responsible for all aspects of running a non-profit organization.
- Wrote grant proposals funded for \$0.9 million.
- Organized international seminars for 200+ participants from over 20 countries.
- Maintained budgets and accounts, administered databases.
- Edited and published newsletters; created and maintained website.
- Regularly communicated with Board of Directors and members, academics, consultants, and staff from organizations such as the World Bank, Ford Foundation, and UN Food and Agriculture Organization.

United States Peace Corps, Mali, West Africa *August 1996 –
October 1998*
Water and Sanitation Extension Agent

- Trained local gardeners to install and maintain low-cost pumps.
- Applied for and received Small Project Assistance Grant from the US Agency for International Development to train local artisans in well rehabilitation.
- Planned, wrote, and presented health and hygiene talks for women.
- Conducted cooking demonstrations to combat infant malnutrition.
- Introduced iodized salt and soybeans in three villages.

REGISTRATIONS

- Registered Professional Engineer, Massachusetts, 2007–present
- Certified Floodplain Manager, Association of State Floodplain Managers, 2004

RESEARCH PAPERS AND PUBLICATIONS

- Cooley, H., Christian-Smith, J., Cohen, M., Gleick, P.H., and Heberger, M. *California's Next Million Acre-Feet: Saving Water, Energy, and Money*. Pacific Institute: Oakland, CA. August 2010.
- Heberger, M.G., et al. *Combining real-time bacteria models and uncertainty analysis for establishing health advisories for recreational waters*. Journal of Water Resources Planning and Management. 2007.

SOFTWARE SKILLS

- Advanced user of MS Office: Excel, Access, Word
- Advanced user of calculation software: MathCAD and Matlab
- Statistical analysis: Minitab, Systat, R
- Cartography and geographic analysis: ArcGIS, Google Maps “mashups”
- Watershed and water quality modeling: HSPF, GWLF, WASP, Qual2
- Collection system modeling: SWMM
- Systems analysis: STELLA and GoldSim
- Linear programming: Lindo and Lingo
- Hydrology and hydraulics: HEC-RAS, HEC-HMS, PeakFQ
- Computer programming/web design: Python, VBA, Perl, javascript, SQL, html, CSS

TRAININGS

- Principles of Editing for Publication, USDA Graduate School, 2001
- USEPA Watershed Academy, 2001
- Stormwater Management Model (SWMM) course, 2004
- Hydrologic Simulation Program-Fortran (HSPF) course, 2004
- Project Management Fundamentals, 2005–2006

PROFESSIONAL MEMBERSHIPS

- American Society of Civil Engineers (ASCE)
- International Water Resources Association (IWRA)
- International Association of Hydrological Sciences (IAHS)
- American Geophysical Union (AGU)
- Association of State Floodplain Manager (ASFPM)
- New England Water Environment Association (NEWEA)

EDUCATION

University of California – Berkeley

1986

Ph.D., Energy and Resources

University of California – Berkeley

1980

M.S. Energy and Resources

Yale University, Hartford, CT

1978

B.S. Engineering and Applied Sciences (cum laude, with distinction)

PROFESSIONAL EXPERIENCE

Pacific Institute, Oakland, CA

President and Co-Founder

1987 – present

Energy and Resource Group at University of California – Berkeley, Berkeley, CA

Research Associate

1983-1986

Office of the Governor of California

Deputy Assistant to the Governor of California on Energy and Environment

1980-1982

Lawrence Berkeley National Laboratory, Berkeley, CA

Research and Teaching Associate

1978-1981

HONORS, AWARDS AND FELLOWSHIPS

- Recipient of 2009 Region 9 Award for Environmental Excellence from the U.S. Environmental Protection Agency.
- The 2009 American Water Resources Association's "Csallany Award" for exemplary contributions to water resources.
- Named "one of 15 People the Next President Should Listen To" by Wired Magazine, September 2008.
- Awarded 2007 Top Environmental Achievement Awards for Freshwater Protection and Restoration, Environment Now Foundation.
- Elected to United States National Academy of Sciences: April 2006.
- Elected AAAS Fellow (Atmospheric and Hydrospheric Sciences): October 2005 (American Association for the Advancement of Science)
- Elected member of AAAS Atmospheric and Hydrospheric Sciences Section: February 2007-2011.
- Awarded 2005 Excellence Award for Statewide/Institutional Innovations, California Urban Water Conservation Council.
- Elected IWRA Fellow: October 2005 (International Water Resources Association)
- Named MacArthur Foundation Fellow. October 2003
- Elected to Phi Beta Delta: Honor Society for scholarly achievement in international education. April 2003
- Named by the BBC as a "Visionary on the Environment" in its Essential Guide to the 21st Century. 2001.
- Elected Academician of the International Water Academy, Oslo, Norway. October 1999

- Awarded MacArthur Foundation Research and Writing Fellowship. International Peace and Security Studies, 1988-1990
- Awarded Social Science Research Council-MacArthur Foundation Post-Doctoral Fellow in International Security. 1986-1988.
- Named San Francisco Chronicle, one of "90 People to Watch in the '90s." 1990.

PUBLIC AND PROFESSIONAL SERVICE

- World Economic Forum's Global Agenda Council on Water Security, 2008-
- National Academy of Sciences Committee on Ecological Impacts of Climate Change, 2008-2009
- U.S. EPA, Human Impacts of Climate Change Advisory Committee, 2007-2009.
- Expert Group on Policy Relevance of the World Water Assessment Program, United Nations, 2008-
- Climate Advisory Group of the California Academy of Sciences, 2007-
- State of California Climate Change Technical Advisory Group, 2007-
- National Academy of Sciences Committee on Advancing Desalination Technology, 2006-2008
- Vice Chair, American Geophysical Union Global Environmental Change Focus Group, 2006-2008
- United Nations-Sigma Xi Scientific Expert Group on Climate Change and Sustainable Development, 2004-2007.
- Water Science and Technology Board, National Academy of Sciences, 2001-2007.
- Public Advisory Committee: California Water Plan. Department of Water Resources, 2001-2006.
- Board of Directors: Pacific Institute, 1988-present.
- Editorial Board: Senior Advisory Council. Environmental Research Letters, 2006-2008.
- Editorial Board, Annual Reviews of Energy and the Environment, 2001-2004
- Editorial Board, Climatic Change, 1990-present.
- Advisory Council, International Water Academy, Oslo, Norway, 2003-2005.
- Scientific Advisor: IMAX Film "The Water Planet," 2003-2006.
- Advisory Board: Documentary film "Thirst," 2002-2004.
- Co-Chair: Water Sector: National Assessment of the Potential Impacts of Climatic Variability and Change on the United States, 1998-2000.
- Board of Directors: International Water Resources Association, 1997-2000.
- Global Environmental Change Committee, American Geophysical Union, 1993-1998.
- Public Advisory Forum: American Water Works Association, 1993-1998.
- 1990 Water Task Group, Second World Climate Conference, Geneva, Switzerland.
- Advisor, Comprehensive Freshwater Assessment, Stockholm Environment Institute, 1996-1997.
- Advisory Board: Documentary film "Cadillac Desert," 1995-1997
- Advisory Committee: Climate Institute's Environmental Refugee Program, 1993-1995.
- Climate and Water Panel, American Association for the Advancement of Science, 1986-1990.
- Co-Chair, Working Group 2, Advisory Group on Greenhouse Gases (AGGG), WMO/UNEP, 1989-91.
- Committee on Science & International Security, American Association for the Advancement of Science, 1993-95.
- Editorial Board, Environment and Security, 1993-2001.
- Editorial Board, Encyclopedia of Life Support Systems, 1997-2002.
- Editorial Board, Encyclopedia of Global Change (Oxford University Press), 1996-2000.
- Editorial Board: Global Change and Human Health, 1999-2003
- Interim Board of Directors: Middle East Water Information Network, 1994-1996
- Project Steering Committee: IUCN (World Conservation Union): Water Demand Management in Southern Africa, 2000-2003.
- Scientific Review Group, President's Council on Sustainable Development, 1994-1996.
- Surface Water Committee, American Geophysical Union, 1992-1993
- Working Group VIII Special Report, United States-Soviet Agreement on Protection of the Environment, 1989-1990.

(A full publications list is available upon request)

EDUCATION

University of California – Berkeley

May 2004

M.S., Energy and Resources

University of California – Berkeley

May 1998

B.S., Molecular and Environmental Biology, emphasis in ecology

PROFESSIONAL EXPERIENCE

Pacific Institute, Oakland, CA

Water Program Co-Director

November 2004 – present

Lawrence Berkeley National Laboratory, Berkeley, CA

Research Associate & Lab Manager

October 2000 – September 2004

University of California – Berkeley, Berkeley, CA

Teaching Assistant

January 2001 – June 2001

Pesticide Action Network North America, San Francisco, CA

Cartographer and Database Assistant

January 2001 – June 2001

Mountain Trail Outdoor School, Hendersonville, NC

Outdoor/Environmental Educator

February 2000 – June 2000

Silver Lab, University of California - Berkeley, Berkeley, CA and Puerto Rico

Field/Laboratory Technician

June 1998 – December 1999

Weston Lab, University of California - Berkeley, Berkeley, CA

Field/Laboratory Assistant

October 1996 – September 1997

SELECT RESEARCH PAPERS AND PUBLICATIONS

- Cooley, H., Christian-Smith, J., Cohen, M., Gleick, P.H., and Heberger, M. *California's Next Million Acre-Feet: Saving Water, Energy, and Money*. Pacific Institute: Oakland, CA. August 2010.
- Cooley, H., J. Christian-Smith, P.H. Gleick, L. Allen, and M. Cohen. 2009. Understanding and Reducing the Risks of Climate Change for Transboundary Waters. United Nations Environment Programme.
- Cooley, H. 2008. Adapting Water Resource Management to a Changing Climate. In Gleick, P.H. et al. *The World's Water 2008-2009: The Biennial Report on Freshwater Resources*.
- Cooley, H. 2006. Floods and Droughts. In Gleick, P.H., H. Cooley, D. Katz, E. Lee, J. Morrison, M. Palaniappan, A. Samulon, and G.H. Wolff. *The World's Water 2006-2007: The Biennial Report on Freshwater Resources*.
- Cooley, H., P.H. Gleick, G. Wolff. 2006. Desalination, With a Grain of Salt: A California Perspective. Pacific Institute for Studies in Development, Environment, and Security. Oakland, California.
- Palaniappan, M., H. Cooley, P. Gleick, and G. Wolff. 2006. Assessing the long-term outlook for current business models in the construction and provision of water infrastructure and services. Organization for Economic Co-operation and Development.
- Cooley, H. and P.H. Gleick. 2006. "Water efficiency is key in California." [World Water and Environmental Engineering](#). Vol. 29(1): 27-28.

- Gleick, P.H., H. Cooley, and D. Groves. 2005. *California Water 2030: An Efficient Future*. Pacific Institute for Studies in Development, Environment, and Security. Oakland, California.
- Cooley et al. 2005. "Impact of agricultural practice on regional climate in a coupled land surface mesoscale model." *Journal of Geophysical Research-Atmospheres*. Vol. 110.
- Cooley, H.S., W.J. Riley, and M.S. Torn. 2003. "Interactions between land cover change and regional climate in a coupled regional climate model." Poster. Annual meeting of the Ecological Society of America, Savannah, Georgia.
- Cooley, H.S., W.J. Riley, and M.S. Torn. 2003. "Agricultural practice and regional climate interactions in a coupled land surface mesoscale model." Poster. American Geophysical Union Fall Meeting, San Francisco, CA.
- Cooley, H.S., W.J. Riley, and M.S. Torn. 2003. "Effect of harvest on regional climate and soil moisture and temperature." Poster. American Geophysical Union conference on ecosystem interactions with land use change. Santa Fe, New Mexico.

SELECT PRESENTATIONS

- Asia Society. "Water Issues in California and China." January 14, 2010. San Francisco, California.
- United State Committee on Irrigation and Drainage. "The Future of Water and Agriculture in California." March 25, 2010. Sacramento, California
- City of Oakland. Sea-Level Rise and the San Francisco Bay. March 30, 2010. Oakland, California.
- State of the Estuary Annual Conference. The Impacts of Sea Level Rise on the San Francisco Bay. September 29, 2009. Oakland, California.
- House Subcommittee on Water and Power. "Extinction is not a Sustainable Water Policy: The Bay-Delta Crisis and the Implications for California Water Management." July 2, 2007. Vallejo, California.
- Multi-State Salinity Coalition. The Environmental Impacts of Seawater Desalination. January 12, 2007.
- Water Education Foundation Board of Directors. California and Floods. December 5, 2006.

PUBLIC AND PROFESSIONAL SERVICE

- California Urban Water Conservation Council, Vice-President of the Board of Directors
- Urban Stakeholder Committee, convened by the California Department of Water Resources
- Water Education Foundation, Water Leaders.
- California Water Plan (B160-05) Public Advisory Committee

EDUCATION

University of California – Berkeley
2008

May

B.S., Conservation and Resource Studies (College Honors, High Distinction)

PROFESSIONAL EXPERIENCE

Pacific Institute, Oakland, CA
Research Associate

May 2008 – present

Torn Laboratory, Lawrence Berkeley National Laboratory, Berkeley, CA
Laboratory Assistant

April 2007 – May 2008

Bancroft Technical Services, Berkeley, CA
2007
Archivist Assistant

Feb. 2005 – July

PUBLICATIONS

- L. Allen, “Water Quality.” Chapter in: Gleick, P. and J. Christian-Smith (editors). In press. *A 21st Century Water Policy*. New York: Oxford University Press.
- Allen, L., J. Christian-Smith, and M. Palaniappan. 2010. Overview of Greywater Reuse: The Potential of Greywater Systems to Aid Sustainable Water Management. Oakland: Pacific Institute.
- Christian-Smith, J., L. Allen, E. Moore, and P. H. Gleick. 2010. The 2010 California Water Bond: An Independent Analysis of the “Safe, Clean, and Reliable Drinking Water Supply Act of 2010.” Oakland: Pacific Institute.
- Schulte, P., J. Morrison, M. Morikawa, E. Moore, M. Heberger, and L. Allen. 2010. The Water Footprints of Steel, Petrochemicals, and Forest Products: An Analysis of Water-Related Business Risks and Impacts in the United States. Written for the U.S. Environmental Protection Agency. Oakland: Pacific Institute.
- Christian-Smith, J., L. Allen, M. Cohen, P. Schulte, C. Smith, and P. Gleick. 2010. California Farm Water Success Stories. Oakland: Pacific Institute.
- Palaniappan, M., P. Gleick, L. Allen, M. Cohen, J. Christian-Smith, and C. Smith. 2010. Clearing the Waters: A Focus on Water Quality Solutions. United Nations Environmental Program Publication. Available online: www.unep.org/PDF/Clearing_the_Waters.pdf.
- Cooley, H., J. Christian-Smith, M. Cohen, P. Gleick, and L. Allen. 2009. “Understanding and Reducing the Risks of Climate Change for Transboundary Waters.” Prepared for the United Nations Environmental Program. Oakland: Pacific Institute.

SELECTED PRESENTATIONS

- Panel Participant, Climate Corps Bay Area training. “Water-Energy-Climate: Critical Links.” (2010).
- Panel Participant, Bay Area Water Forum. “Overview of the 2010 Water Bond” (2010).
- Invited Speaker, Water Summit. “Pacific Institute Analysis of the 2010 Water Bond” (2010).

SELECTED HONORS AND AWARDS

- Phi Beta Kappa member
- Golden Key International Honour Society Scholar

BILL POWERS, P.E.

PROFESSIONAL HISTORY

Powers Engineering, San Diego, CA 1994-
ENSR Consulting and Engineering, Camarillo, CA 1989-93
Naval Energy and Environmental Support Activity, Port Hueneme, CA 1982-87
U.S. Environmental Protection Agency, Research Triangle Park, NC 1980-81

EDUCATION

Master of Public Health – Environmental Sciences, University of North Carolina
Bachelor of Science – Mechanical Engineering, Duke University

PROFESSIONAL AFFILIATIONS

Registered Professional Mechanical Engineer, California (Certificate M24518)
American Society of Mechanical Engineers
Air & Waste Management Association

TECHNICAL SPECIALTIES

Twenty-five years of experience in:

- Power plant air emission control system and cooling system assessments
- Regional renewable energy planning
- Combustion equipment permitting, testing and monitoring
- Air pollution control equipment retrofit design/performance testing
- Petroleum refinery air engineering and testing
- Latin America environmental project experience

POWER PLANT EMISSION CONTROL AND COOLING SYSTEM CONVERSION ASSESSMENTS

Biomass Plant NO_x and CO Air Emissions Control Evaluation. Lead engineer for evaluation of available nitrogen oxide (NO_x) and carbon monoxide (CO) controls for a 45 MW Aspen Power biomass plant in Texas where proponent had identified selective non-catalytic reduction (SNCR) for NO_x and good combustion practices for CO as BACT. Identified the use of tail-end SCR for NO_x control at several operational U.S. biomass plants, and oxidation catalyst in use at two of these plants for CO and VOC control, as BACT for the proposed biomass plant. Administrative law judge concurred in decision that SCR and oxidation catalyst is BACT. Developer added SCR and oxidation catalyst to project in subsequent settlement agreement.

Biomass Plant Air Emissions Control Consulting. Lead expert on biomass air emissions control systems for landowners that will be impacted by a proposed 50 MW biomass to be built by the local East Texas power cooperative. Public utility agreed to meet current BACT for biomass plants in Texas, SCR for NO_x and oxidation catalyst for CO, in settlement agreement with local landowners.

Combined-Cycle Power Plant Startup and Shutdown Emissions. Lead engineer for analysis of air permit startup and shutdown emissions minimization for combined-cycle power plant proposed for the San Francisco Bay Area. Original equipment was specified for baseload operation prior to suspension of project in early 2000s. Operational profile described in revised air permit was load following with potential for daily start/stop. Recommended that either fast start turbine technology be employed to minimize start/stop emissions or that “demonstrated in practice” operational and control software modifications be employed to minimize startup/shutdown emissions.

IGCC as BACT for Air Emissions from Proposed 960 MW Coal Plant. Presented testimony on IGCC as BACT for air emissions reduction from 960 MW coal plant. Applicant received air permit for a pulverized coal plant to be equipped with a baghouse, wet scrubber, and wet ESP for air emissions control. Use of IGCC technology at the emission rates permitted for two recently proposed U.S. IGCC projects, and demonstrated in practice at a Japanese IGCC plant firing Chinese bituminous coal, would substantially reduce potential emissions of NO_x, SO₂, and PM. The estimated control cost-effectiveness of substituting IGCC for pulverized coal technology in this case was approximately \$3,000/ton.

Analysis of Proposed Air Emission Limits for 600 MW Pulverized Coal Plant. Project engineer tasked with evaluating sufficiency of air emissions limits and control technologies for proposed 600 MW coal plant Arkansas. Determined that the applicant had: 1) not properly identified SO₂, sulfuric acid mist, and PM BACT control levels for the plant, and 2) improperly utilized an incremental cost effectiveness analysis to justify air emission control levels that did not represent BACT.

Eight Pulverized Coal Fired 900 MW Boilers – IGCC Alternative with Air Cooling. Provided testimony on integrated gasification combined cycle (IGCC) as a fully commercial coal-burning alternative to the pulverized coal (PC) technology proposed by TXU for eight 900 MW boilers in East Texas, and East Texas as an ideal location for CO₂ sequestration due to presence of mature oilfield CO₂ enhanced oil recovery opportunities and a deep saline aquifer underlying the entire region. Also presented testimony on the major increase in regional consumptive water use that would be caused by the evaporative cooling towers proposed for use in the PC plants, and that consumptive water use could be lowered by using IGCC with evaporative cooling towers or by using air-cooled condensers with PC or IGCC technology. TXU ultimately dropped plans to build the eight PC plants as a condition of a corporate buy-out.

Utility Boilers – Conversion of Existing Once-Through Cooled Boilers to Wet Towers, Parallel Wet-Dry Cooling, or Dry Cooling. Provided expert testimony and preliminary design for the conversion of four natural gas and/or coal-fired utility boilers (Unit 4, 235 MW; Unit 3, 135 MW; Unit 2, 65 MW; and Unit 1, 65 MW) from once-through river water cooling to wet cooling towers, parallel wet-dry cooling, and dry cooling. Major design constraints were available land for location of retrofit cooling systems and need to maintain maximum steam turbine backpressure at or below 5.5 inches mercury to match performance capabilities of existing equipment. Approach temperatures of 12 oF and 13 oF were used for the wet towers. SPX Cooling Technologies F-488 plume-abated wet cells with six feet of packing were used to achieve approach temperatures of 12 oF and 13 oF. Annual energy penalty of wet tower retrofit designs is approximately 1 percent. Parallel wet-dry or dry cooling was determined to be technically feasible for Unit 3 based on straightforward access to the Unit 3 surface condenser and available land adjacent to the boiler.

Utility Boiler – Assessment of Air Cooling and Integrated Gasification/Combined Cycle for Proposed 500 MW Coal-Fired Plant. Provided expert testimony on the performance of air-cooling and IGCC relative to the conventional closed-cycle wet cooled, supercritical pulverized coal boiler proposed by the applicant. Steam Pro™ coal-fired power plant design software was used to model the proposed plant and evaluate the impacts on performance of air cooling and plume-abated wet cooling. Results indicated that a conservatively designed air cooled condenser could maintain rated power output at the design ambient temperature of 90 oF. The IGCC comparative analysis indicated that unit reliability comparable to a conventional pulverized coal unit could be achieved by including a spare gasifier in the IGCC design, and that the slightly higher capital cost of IGCC was offset by greater thermal efficiency and reduced water demand and air emissions.

Utility Boiler – Assessment of Closed-Cycle Cooling Retrofit Cost for 1,200 MW Oil-Fired Plant. Prepared an assessment of the cost and feasibility of a closed-cycle wet tower retrofit for the 1,200 MW Roseton Generating Station. Determined that the cost to retrofit the Roseton plant with plume-abated closed cycle wet cooling was well established based on cooling tower retrofit studies performed by the original owner (Central Hudson Gas & Electric Corp.) and subsequent regulatory agency critique of the cost estimate.

Also determined that elimination of redundant and/or excessive budgetary line items in owners cost estimate brings the closed-cycle retrofit in line with expected costs for comparable new or retrofit plume-abated cooling tower applications.

Nuclear Power Plant – Assessment of Closed-Cycle Cooling Retrofit Cost for 2,000 MW Plant. Prepared an assessment of the cost and feasibility of a closed-cycle wet tower retrofit for the 2,000 MW Indian Point Generating Station. Determined that the most appropriate arrangement for the hilly site would be an inline plume-abated wet tower instead of the round tower configuration analyzed by the owner. Use of the inline configuration would allow placement of the towers at numerous sites on the property with little or need for blasting of bedrock, greatly reducing the cost of the retrofit. Also proposed an alternative circulating cooling water piping configuration to avoid the extensive downtime projected by the owner for modifications to the existing discharge channel.

Kentucky Coal-Fired Power Plant – Pulverized Coal vs IGCC. Expert witness in Sierra Club lawsuit against Peabody Coal Company's plan to construct a 1,500 MW pulverized-coal fired power plant in Kentucky. Presented case that Integrated Gasification Combined Cycle (IGCC) is a superior method for producing power from coal, from environmental and energy efficiency perspective, than the proposed pulverized-coal plant. Presented evidence that IGCC is technically feasible and cost competitive with pulverized coal.

Power Plant Dry Cooling Symposium – Chair and Organizer. Chair and organizer of the first symposium held in the U.S. (May 2002) that focused exclusively on dry cooling technology for power plants. Sessions included basic principles of wet and dry cooling systems, performance capabilities of dry cooling systems, case studies of specific installations, and reasons why dry cooling is the predominant form of cooling specified in certain regions of North America (Massachusetts, Nevada, northern Mexico).

Utility Boiler Best Available NO_x Control System for 525 MW Coal-Fired Circulating Fluidized Bed Boiler Plant. Expert witness in dispute over whether 50 percent NO_x control using selective non-catalytic reduction (SNCR) constituted BACT for a proposed 525 MW circulating fluidized bed (CFB) boiler plant. Presented testimony that SNCR was capable of continuous NO_x reduction of greater than 70 percent on a CFB unit and that tail-end selective catalytic reduction (SCR) was technically feasible and could achieve greater than 90 percent NO_x reduction.

Utility Boilers – Evaluation of Correlation Between Opacity and PM₁₀ Emissions at Coal-Fired Plant. Provided expert testimony on whether correlation existed between mass PM₁₀ emissions and opacity during opacity excursions at large coal-fired boiler in Georgia. EPA and EPRI technical studies were reviewed to assess the correlation of opacity and mass emissions during opacity levels below and above 20 percent. A strong correlation between opacity and mass emissions was apparent at a sister plant at opacities less than 20 percent. The correlation suggests that the opacity monitor correlation underestimates mass emissions at opacities greater than 20 percent, but may continue to exhibit a good correlation for the component of mass emissions in the PM₁₀ size range.

Utility Boilers Retrofit of SCR and FGD to Existing Coal-Fired Units.

Expert witness in successful effort to compel an existing coal-fired power plant located in Massachusetts to meet an accelerated NO_x and SO₂ emission control system retrofit schedule. Plant owner argued the installation of advanced NO_x and SO₂ control systems would generate > 1 ton/year of ancillary emissions, such as sulfuric acid mist, and that under Massachusetts Dept. of Environmental Protection regulation ancillary emissions > 1 ton/year would require a BACT evaluation and a two-year extension to retrofit schedule. Successfully demonstrated that no ancillary emissions would be generated if the retrofit NO_x and SO₂ control systems were properly sized and optimized. Plant owner committed to accelerated compliance schedule in settlement agreement.

Utility Boilers – Retrofit of SCR to Existing Natural Gas-Fired Units.

Lead engineer in successful representation of interests of California coastal city to prevent weakening of an existing countywide utility boiler NOx rule. Weakening of NOx rule would have allowed a merchant utility boiler plant located in the city to operate without installing selective catalytic reduction (SCR) NOx control systems. This project required numerous appearances before the county air pollution control hearing board to successfully defend the existing utility boiler NOx rule.

REGIONAL RENEWABLE ENERGY PLANNING

San Diego Smart Energy 2020 Plan. Author of October 2007 “San Diego Smart Energy 2020,” an energy plan that focuses on meeting the San Diego region’s electric energy needs through accelerated integration of renewable and non-renewable distributed generation, in the form of combined heat and power (CHP) systems and solar photovoltaic (PV) systems. PV would meet approximately 28 percent of the San Diego region’s electric energy demand in 2020. CHP systems would provide approximately 47 percent. Annual energy demand would drop 20 percent in 2020 relative to 2003 through use all cost-effective energy efficiency measures. This target is based on City of San Diego experience. San Diego has consistently achieved energy efficiency reductions of 20 percent on dozens of projects. Existing utility-scale gas-fired generation would continue to be utilized to provide power at night, during cloudy weather, and for grid reliability support.

Photovoltaic technology selection and siting for SDG&E Solar San Diego project. Served as PV technology expert in California Public Utilities Commission proceeding to define PV technology and sites to be used in San Diego Gas & Electric (SDG&E) \$250 million “Solar San Diego” project. Recommendations included: 1) prioritize use of roof-mounted thin-film PV arrays similar to the SCE urban PV program to maximize the installed PV capacity, 2) avoid tracking ground-mounted PV arrays due to high cost and relative lack of available land in the urban/suburban core, 3) and incorporate limited storage in fixed rooftop PV arrays to maximizing output during peak demand periods. Suitable land next to SDG&E substations capable of supporting 5 to 40 MW of PV (each) was also identified by Powers Engineering as a component of this project.

Photovoltaic arrays as alternative to natural gas-fired peaking gas turbines, Chula Vista. Served as PV technology expert in California Energy Commission (CEC) proceeding regarding the application of MMC Energy to build a 100 MW peaking gas turbine power plant in Chula Vista. Presented testimony that 100 MW of PV arrays in the Chula Vista area could provide the same level of electrical reliability on hot summer days as an equivalent amount of peaking gas turbine capacity at approximately the same cost of energy. The preliminary decision issued by the presiding CEC commissioner in the case recommended denial of the application in part due to failure of the applicant or CEC staff to thoroughly evaluate the PV alternative to the proposed turbines. No final decision has yet been issued in the proceeding (as of May 2009).

San Diego Area Governments (SANDAG) Energy Working Group. Public interest representative on the SANDAG Energy Working Group (EWG). The EWG advises the Regional Planning Committee on issues related to the coordination and implementation of the Regional Energy Strategy 2030 adopted by the SANDAG Board of Directors in July 2003. The EWG consists of elected officials from the City of San Diego, County of San Diego and the four subareas of the region. In addition to elected officials, the EWG includes stakeholders representing business, energy, environment, economy, education, and consumer interests.

Development of San Diego Regional Energy Strategy 2030. Participant in the 18-month process in the 2002-2003 timeframe that led to the development of the San Diego Regional Energy Strategy 2030. This document was adopted by the SANDAG Board of Directors in July 2003 and defines strategic energy objectives for the San Diego region, including: 1) in-region power generation increase from 65% of peak demand in 2010 to 75% of peak demand in 2020, 2) 40% renewable power by 2030 with at least half of this power generated in-county, 3) reinforcement of transmission capacity as needed to achieve these objectives. The SANDAG Board of Directors voted unanimously on Nov. 17, 2006 to take no position on the Sunrise Powerlink proposal primarily because it conflicts the Regional Energy Strategy 2030 objective of increased in-region power generation. The

COMBUSTION EQUIPMENT PERMITTING, TESTING AND MONITORING

EPRI Gas Turbine Power Plant Permitting Documents – Co-Author.

Co-authored two Electric Power Research Institute (EPRI) gas turbine power plant siting documents. Responsibilities included chapter on state-of-the-art air emission control systems for simple-cycle and combined-cycle gas turbines, and authorship of sections on dry cooling and zero liquid discharge systems.

Air Permits for 50 MW Peaker Gas Turbines – Six Sites Throughout California.

Responsible for preparing all aspects of air permit applications for five 50 MW FT-8 simple-cycle turbine installations at sites around California in response to emergency request by California state government for additional peaking power. Units were designed to meet 2.0 ppm NO_x using standard temperature SCR and innovative dilution air system to maintain exhaust gas temperature within acceptable SCR range. Oxidation catalyst is also used to maintain CO below 6.0 ppm.

Kauai 27 MW Cogeneration Plant – Air Emission Control System Analysis. Project manager to evaluate technical feasibility of SCR for 27 MW naphtha-fired turbine with once-through heat recovery steam generator. Permit action was stalled due to questions of SCR feasibility. Extensive analysis of the performance of existing oil-fired turbines equipped with SCR, and bench-scale tests of SCR applied to naphtha-fired turbines, indicated that SCR would perform adequately. Urea was selected as the SCR reagent given the wide availability of urea on the island. Unit is first known application of urea-injected SCR on a naphtha-fired turbine.

Microturbines – Ronald Reagan Library, Ventura County, California.

Project manager and lead engineer for preparation of air permit applications for microturbines and standby boilers. The microturbines drive the heating and cooling system for the library. The microturbines are certified by the manufacturer to meet the 9 ppm NO_x emission limit for this equipment. Low-NO_x burners are BACT for the standby boilers.

Hospital Cogeneration Microturbines – South Coast Air Quality Management District.

Project manager and lead engineer for preparation of air permit application for three microturbines at hospital cogeneration plant installation. The draft Authority To Construct (ATC) for this project was obtained two weeks after submittal of the ATC application. 30-day public notification was required due to the proximity of the facility to nearby schools. The final ATC was issued two months after the application was submitted, including the 30-day public notification period.

Gas Turbine Cogeneration – South Coast Air Quality Management District. Project manager and lead engineer for preparation of air permit application for two 5.5 MW gas turbines in cogeneration configuration for county government center. The turbines will be equipped with selective catalytic reduction (SCR) and oxidation catalyst to comply with SCAQMD BACT requirements. Aqueous urea will be used as the SCR reagent to avoid trigger hazardous material storage requirements. A separate permit will be obtained for the NO_x and CO continuous emissions monitoring systems. The ATCs is pending.

Industrial Boilers – NO_x BACT Evaluation for San Diego County Boilers.

Project manager and lead engineer for preparation of Best Available Control Technology (BACT) evaluation for three industrial boilers to be located in San Diego County. The BACT included the review of low NO_x burners, FGR, SCR, and low temperature oxidation (LTO). State-of-the-art ultra low NO_x burners with a 9 ppm emissions guarantee were selected as NO_x BACT for these units.

Peaker Gas Turbines – Evaluation of NO_x Control Options for Installations in San Diego County.

Lead engineer for evaluation of NO_x control options available for 1970s vintage simple-cycle gas turbines

proposed for peaker sites in San Diego County. Dry low-NO_x (DLN) combustors, catalytic combustors, high temperature SCR, and NO_x absorption/conversion (SCONO_x) were evaluated for each candidate turbine make/model. High-temperature SCR was selected as the NO_x control option to meet a 5 ppm NO_x emission requirement.

Hospital Cogeneration Plant Gas Turbines – San Joaquin Valley Unified Air Pollution Control District. Project manager and lead engineer for preparation of air permit application and Best Available Control Technology (BACT) evaluation for hospital cogeneration plant installation. The BACT included the review of DLN combustors, catalytic combustors, high-temperature SCR and SCONO_x. DLN combustion followed by high temperature SCR was selected as the NO_x control system for this installation. The high temperature SCR is located upstream of the heat recovery steam generator (HRSG) to allow the diversion of exhaust gas around the HRSG without compromising the effectiveness of the NO_x control system.

1,000 MW Coastal Combined-Cycle Power Plant – Feasibility of Dry Cooling.

Expert witness in on-going effort to require use of dry cooling on proposed 1,000 MW combined-cycle “repower” project at site of an existing 1,000 MW utility boiler plant. Project proponent argued that site was too small for properly sized air-cooled condenser (ACC) and that use of ACC would cause 12-month construction delay. Demonstrated that ACC could easily be located on the site by splitting total of up to 80 cells between two available locations at the site. Also demonstrated that an ACC optimized for low height and low noise would minimize or eliminate proponent claims of negative visual and noise impacts.

Industrial Cogeneration Plant Gas Turbines – Upgrade of Turbine Power Output.

Project manager and lead engineer for preparation of Best Available Control Technology (BACT) evaluation for proposed gas turbine upgrade. The BACT included the review of DLN combustors, catalytic combustors, high-, standard-, and low-temperature SCR, and SCONO_x. Successfully negotiated air permit that allowed facility to initially install DLN combustors and operate under a NO_x plantwide “cap.” Within two major turbine overhauls, or approximately eight years, the NO_x emissions per turbine must be at or below the equivalent of 5 ppm. The 5 ppm NO_x target will be achieved through technological in-combustor NO_x control such as catalytic combustion, or SCR or SCR equivalent end-of-pipe NO_x control technologies if catalytic combustion is not available.

Gas Turbines – Modification of RATA Procedures for Time-Share CEM.

Project manager and lead engineer for the development of alternate CO continuous emission monitor (CEM) Relative Accuracy Test Audit (RATA) procedures for time-share CEM system serving three 7.9 MW turbines located in San Diego. Close interaction with San Diego APCD and EPA Region 9 engineers was required to receive approval for the alternate CO RATA standard. The time-share CEM passed the subsequent annual RATA without problems as a result of changes to some of the CEM hardware and the more flexible CO RATA standard.

Gas Turbines – Evaluation of NO_x Control Technology Performance. Lead engineer for performance review of dry low-NO_x combustors, catalytic combustors, high-, standard-, and low-temperature selective catalytic reduction (SCR), and NO_x absorption/conversion (SCONO_x). Major turbine manufacturers and major manufacturers of end-of-pipe NO_x control systems for gas turbines were contacted to determine current cost and performance of NO_x control systems. A comparison of 1993 to 1999 “\$/kwh” and “\$/ton” cost of these control systems was developed in the evaluation.

Gas Turbines – Evaluation of Proposed NO_x Control System to Achieve 3 ppm Limit.

Lead engineer for evaluation for proposed combined cycle gas turbine NO_x and CO control systems. Project was in litigation over contract terms, and there was concern that the GE Frame 7FA turbine could not meet the 3 ppm NO_x permit limit using a conventional combustor with water injection followed by SCR. Operations personnel at GE Frame 7FA installations around the country were interviewed, along with principal SCR

vendors, to corroborate that the installation could continuously meet the 3 ppm NOx limit.

Gas Turbines ~ Title V "Presumptively Approvable" Compliance Assurance Monitoring Protocol.

Project manager and lead engineer for the development of a "presumptively approval" NOx parametric emissions monitoring system (PEMS) protocol for industrial gas turbines. "Presumptively approvable" means that any gas turbine operator selecting this monitoring protocol can presume it is acceptable to the U.S. EPA. Close interaction with the gas turbine manufacturer's design engineering staff and the U.S. EPA Emissions Measurement Branch (Research Triangle Park, NC) was required to determine modifications necessary to the current PEMS to upgrade it to "presumptively approvable" status.

Environmental Due Diligence Review of Gas Turbine Sites ~ Mexico. Task leader to prepare regulatory compliance due diligence review of Mexican requirements for gas turbine power plants. Project involves eleven potential sites across Mexico, three of which are under construction. Scope involves identification of all environmental, energy sales, land use, and transportation corridor requirements for power projects in Mexico. Coordinator of Mexican environmental subcontractors gathering on-site information for each site, and translator of Spanish supporting documentation to English.

Development of Air Emission Standards for Gas Turbines - Peru. Served as principal technical consultant to the Peruvian Ministry of Energy in Mines (MEM) for the development of air emission standards for Peruvian gas turbine power plants. All major gas turbine power plants in Peru are currently using water injection to increase turbine power output. Recommended that 42 ppm on natural gas and 65 ppm on diesel (corrected to 15% O₂) be established as the NOx limit for existing gas turbine power plants. These limits reflect NOx levels readily achievable using water injection at high load. Also recommended that new gas turbine sources be subject to a BACT review requirement.

Gas Turbines ~ Title V Permit Templates. Lead engineer for the development of standardized permit templates for approximately 100 gas turbines operated by the oil and gas industry in the San Joaquin Valley. Emissions limits and monitoring requirements were defined for units ranging from GE Frame 7 to Solar Saturn turbines. Stand-alone templates were developed based on turbine size and NOx control equipment. NOx utilized in the target turbine population ranged from water injection alone to water injection combined with SCR.

Gas Turbines ~ Evaluation of NOx, SO₂ and PM Emission Profiles. Performed a comparative evaluation of the NOx, SO₂ and particulate (PM) emission profiles of principal utility-scale gas turbines for an independent power producer evaluating project opportunities in Latin America. All gas turbine models in the 40 MW to 240 MW range manufactured by General Electric, Westinghouse, Siemens and ABB were included in the evaluation.

Stationary Internal Combustion Engine (ICE) RACT/BARCT Evaluation. Lead engineer for evaluation of retrofit NOx control options available for the oil and gas production industry gas-fired ICE population in the San Joaquin Valley affected by proposed RACT and BARCT emission limits. Evaluation centered on leanburn compressor engines under 500 bhp, and rich-burn constant and cyclically loaded (rod pump) engines under 200 bhp. The results of the evaluation indicated that rich burn cyclically-loaded rod pump engines comprised 50 percent of the affected ICE population, though these ICEs accounted for only 5 percent of the uncontrolled gas-fired stationary ICE NOx emissions. Recommended retrofit NOx control strategies included: air/fuel ratio adjustment for rod pump ICEs, Non-selective catalytic reduction (NSCR) for rich-burn, constant load ICEs, and "low emission" combustion modifications for lean burn ICEs.

Development of Air Emission Standards for Stationary ICEs - Peru. Served as principal technical consultant to the Peruvian Ministry of Energy in Mines (MEM) for the development of air emission standards for Peruvian stationary ICE power plants. Draft 1997 World Bank NOx and particulate emission limits for

stationary ICE power plants served as the basis for proposed MEM emission limits. A detailed review of ICE emissions data provided in PAMAs submitted to the MEM was performed to determine the level of effort that would be required by Peruvian industry to meet the proposed NOx and particulate emission limits. The draft 1997 WB emission limits were revised to reflect reasonably achievable NOx and particulate emission limits for ICEs currently in operation in Peru.

Air Toxics Testing of Natural Gas-Fired ICEs. Project manager for test plan/test program to measure volatile and semi-volatile organic air toxics compounds from fourteen gas-fired ICEs used in a variety of oil and gas production applications. Test data was utilized by oil and gas production facility owners throughout California to develop accurate ICE air toxics emission inventories.

AIR ENGINEERING/AIR TESTING PROJECT EXPERIENCE GENERAL

Reverse Air Fabric Filter Retrofit Evaluation Coal-Fired Boiler. Lead engineer for upgrade of reverse air fabric filters serving coal-fired industrial boilers. Fluorescent dye injected to pinpoint broken bags and damper leaks. Corrosion of pneumatic actuators serving reverse air valves and inadequate insulation identified as principal causes of degraded performance.

Pulse-Jet Fabric Filter Performance Evaluation Gold Mine. Lead engineer on upgrade of pulse-jet fabric filter and associated exhaust ventilation system serving an ore-crushing facility at a gold mine. Fluorescent dye used to identify bag collar leaks, and modifications were made to pulse air cycle time and duration. This marginal source was in compliance at 20 percent of emission limit following completion of repair work.

Pulse-Jet Fabric Filter Retrofit - Gypsum Calciner. Lead engineer on upgrade of pulse-jet fabric filter controlling particulate emissions from a gypsum calciner. Recommendations included a modified bag clamping mechanism, modified hopper evacuation valve assembly, and changes to pulse air cycle time and pulse duration.

Wet Scrubber Retrofit Plating Shop. Project engineer on retrofit evaluation of plating shop packed-bed wet scrubbers failing to meet performance guarantees during acceptance trials, due to excessive mist carryover. Recommendations included relocation of the mist eliminator (ME), substitution of the original chevron blade ME with a mesh pad ME, and use of higher density packing material to improve exhaust gas distribution. Wet scrubbers passed acceptance trials following completion of recommended modifications.

Electrostatic Precipitator (ESP) Retrofit Evaluation MSW Boiler. Lead engineer for retrofit evaluation of single field ESP on a municipal solid waste (MSW) boiler. Recommendations included addition of automated power controller, inlet duct turning vanes, and improved collecting plate rapping system.

ESP Electric Coil Rapper Vibration Analysis Testing - Coal-Fired Boiler. Lead engineer for evaluation of ESP rapper effectiveness test program on three field ESP equipped with "magnetically induced gravity return" (MIGR) rappers. Accelerometers were placed in a grid pattern on ESP collecting plates to determine maximum instantaneous plate acceleration at a variety of rapper power setpoints. Testing showed that the rappers met performance specification requirements.

Aluminum Remelt Furnace Particulate Emissions Testing. Project manager and lead engineer for high temperature (1,600 oF) particulate sampling of a natural gas-fired remelt furnace at a major aluminum rolling mill. Objectives of test program were to: 1) determine if condensable particulate was present in stack gases, and 2) to validate the accuracy of the in-stack continuous opacity monitor (COM). Designed and constructed a customized high temperature (inconel) PM10/Mtd 17 sampling assembly for test program. An onsite natural gas-fired boiler was also tested to provide comparative data for the condensable particulate portion of the test program. Test results showed that no significant levels of condensable particulate in the remelt furnace exhaust gas, and indicated that the remelt furnace and boiler had similar particulate emission rates. Test results also

showed that the COM was accurate.

Aluminum Remelt Furnace CO and NOx Testing. Project manager and lead engineer for continuous weeklong testing of CO and NOx emissions from aluminum remelt furnace. Objective of test program was to characterize CO and NOx emissions from representative remelt furnace for use in the facility's criteria pollution emissions inventory. A TECO Model 48 CO analyzer and a TECO Model 10 NOx analyzer were utilized during the test program to provide +1 ppm measurement accuracy, and all test data was recorded by an automated data acquisition system.

PETROLEUM REFINERY AIR ENGINEERING/TESTING EXPERIENCE

Big West Refinery Expansion EIS. Lead engineer on comparative cost analysis of proposed wet cooling tower and fin-fan air cooler for process cooling water for the proposed clean fuels expansion project at the Big West Refinery in Bakersfield, California. Selection of the fin-fan air-cooler would eliminate all consumptive water use and wastewater disposal associated with the cooling tower. Air emissions of VOC and PM10 would be reduced with the fin-fan air-cooler even though power demand of the air-cooler is incrementally higher than that of the cooling tower. Fin-fan air-coolers with approach temperatures of 10 oF and 20 oF were evaluated. The annualized cost of the fin-fan air-cooler with a 20 oF approach temperature is essentially the same as that of the cooling tower when the cost of all ancillary cooling tower systems are considered.

Criteria and Air Toxic Pollutant Emissions Inventory for Proposed Refinery Modifications. Project manager and technical lead for development of baseline and future refinery air emissions inventories for process modifications required to produce oxygenated gasoline and desulfurized diesel fuel at a California refinery. State of the art criteria and air toxic pollutant emissions inventories for refinery point, fugitive and mobile sources were developed. Point source emissions estimates were generated using onsite criteria pollutant test data, onsite air toxics test data, and the latest air toxics emission factors from the statewide refinery air toxics inventory database. The fugitive volatile organic compound (VOC) emissions inventories were developed using the refinery's most recent inspection and maintenance (I&M) monitoring program test data to develop site-specific component VOC emission rates. These VOC emission rates were combined with speciated air toxics test results for the principal refinery process streams to produce fugitive VOC air toxics emission rates. The environmental impact report (EIR) that utilized this emission inventory data was the first refinery "Clean Fuels" EIR approved in California.

Development of Air Emission Standards for Petroleum Refinery Equipment - Peru. Served as principal technical consultant to the Peruvian Ministry of Energy in Mines (MEM) for the development of air emission standards for Peruvian petroleum refineries. The sources included in the scope of this project included: 1) SO2 and NOx refinery heaters and boilers, 2) desulfurization of crude oil, particulate and SO2 controls for fluid catalytic cracking units (FCCU), 3) VOC and CO emissions from flares, 4) vapor recovery systems for marine unloading, truck loading, and crude oil/refined products storage tanks, and 5) VOC emissions from process fugitive sources such as pressure relief valves, pumps, compressors and flanges. Proposed emission limits were developed for new and existing refineries based on a thorough evaluation of the available air emission control technologies for the affected refinery sources. Leading vendors of refinery control technology, such as John Zink and Exxon Research, provided estimates of retrofit costs for the largest Peruvian refinery, La Pampilla, located in Lima. Meetings were held in Lima with refinery operators and MEM staff to discuss the proposed emission limits and incorporate mutually agreed upon revisions to the proposed limits for existing Peruvian refineries.

Air Toxic Pollutant Emissions Inventory for Existing Refinery. Project manager and technical lead for air toxic pollutant emissions inventory at major California refinery. Emission factors were developed for refinery heaters, boilers, flares, sulfur recovery units, coker deheading, IC engines, storage tanks, process fugitives, and catalyst regeneration units. Onsite source test results were utilized to characterize emissions from refinery combustion devices. Where representative source test results were not available, AP-42 VOC emission factors

were combined with available VOC air toxics speciation profiles to estimate VOC air toxic emission rates. A risk assessment based on this emissions inventory indicated a relatively low health risk associated with refinery operations. Benzene, 1,3-butadiene and PAHs were the principal health risk related pollutants emitted.

Air Toxics Testing of Refinery Combustion Sources. Project manager for comprehensive air toxics testing program at a major California refinery. Metals, Cr+6, PAHs, H₂S and speciated VOC emissions were measured from refinery combustion sources. High temperature Cr+6 stack testing using the EPA Cr+6 test method was performed for the first time in California during this test program. Representatives from the California Air Resources Board source test team performed simultaneous testing using ARB Method 425 (Cr+6) to compare the results of EPA and ARB Cr+6 test methodologies. The ARB approved the test results generated using the high temperature EPA Cr+6 test method.

Air Toxics Testing of Refinery Fugitive Sources. Project manager for test program to characterize air toxic fugitive VOC emissions from fifteen distinct process units at major California refinery. Gas, light liquid, and heavy liquid process streams were sampled. BTXE, 1,3-butadiene and propylene concentrations were quantified in gas samples, while BTXE, cresol and phenol concentrations were measured in liquid samples. Test results were combined with AP-42 fugitive VOC emission factors for valves, fittings, compressors, pumps and PRVs to calculate fugitive air toxics VOC emission rates.

OIL AND GAS PRODUCTION AIR ENGINEERING/TESTING EXPERIENCE

Air Toxics Testing of Oil and Gas Production Sources. Project manager and lead engineer for test plan/test program to determine VOC removal efficiency of packed tower scrubber controlling sulfur dioxide emissions from a crude oil-fired steam generator. Ratfish 55 VOC analyzers were used to measure the packed tower scrubber VOC removal efficiency. Tedlar bag samples were collected simultaneously to correlate BTX removal efficiency to VOC removal efficiency. This test was one of hundreds of air toxics tests performed during this test program for oil and gas production facilities from 1990 to 1992. The majority of the volatile air toxics analyses were performed at in-house laboratory. Project staff developed thorough familiarity with the applications and limitations of GC/MS, GC/PID, GC/FID, GC/ECD and GC/FPD. Tedlar bags, canisters, sorbent tubes and impingers were used during sampling, along with isokinetic tests methods for multiple metals and PAHs.

Air Toxics Testing of Glycol Reboiler Gas Processing Plant. Project manager for test program to determine emissions of BTXE from glycol reboiler vent at gas processing facility handling 12 MM/cfd of produced gas. Developed innovative test methods to accurately quantify BTXE emissions in reboiler vent gas.

Air Toxics Emissions Inventory Plan. Lead engineer for the development of generic air toxics emission estimating techniques (EETs) for oil and gas production equipment. This project was performed for the Western States Petroleum Association in response to the requirements of the California Air Toxics "Hot Spots" Act. EETs were developed for all point and fugitive oil and gas production sources of air toxics, and the specific air toxics associated with each source were identified. A pooled source emission test methodology was also developed to moderate the cost of source testing required by the Act.

Fugitive NMHC Emissions from TEOR Production Field. Project manager for the quantification of fugitive Nonmethane hydrocarbon (NMHC) emissions from a thermally enhanced oil recovery (TEOR) oil production field in Kern County, CA. This program included direct measurement of NMHC concentrations in storage tank vapor headspace and the modification of available NMHC emission factors for NMHC-emitting devices in TEOR produced gas service, such as wellheads, vapor trunklines, heat exchangers, and compressors. Modification of the existing NMHC emission factors was necessary due to the high concentration of CO₂ and water vapor in TEOR produced gases.

Fugitive Air Emissions Testing of Oil and Gas Production Fields. Project manager for test plan/test program

to determine VOC and air toxics emissions from oil storage tanks, wastewater storage tanks and produced gas lines. Test results were utilized to develop comprehensive air toxics emissions inventories for oil and gas production companies participating in the test program.

Oil and Gas Production Field Air Emissions Inventory and Air Modeling. Project manager for oil and gas production field risk assessment. Project included review and revision of the existing air toxics emission inventory, air dispersion modeling, and calculation of the acute health risk, chronic non-carcinogenic risk and carcinogenic risk of facility operations. Results indicated that fugitive H₂S emissions from facility operations posed a potential health risk at the facility fence line.

TITLE V PERMIT APPLICATION/MONITORING PLAN EXPERIENCE

Title V Permit Application San Diego County Industrial Facility. Project engineer tasked with preparing streamlined Title V operating permit for U.S. Navy facilities in San Diego. Principal emission units included chrome plating, lead furnaces, IC engines, solvent usage, aerospace coating and marine coating operations. For each device category in use at the facility, federal MACT requirements were integrated with District requirements in user friendly tables that summarized permit conditions and compliance status.

Title V Permit Application Device Templates - Oil and Gas Production Industry. Project manager and lead engineer to prepare Title V permit application “templates” for the Western States Petroleum Association (WSPA). The template approach was chosen by WSPA to minimize the administrative burden associated with listing permit conditions for a large number of similar devices located at the same oil and gas production facility. Templates are being developed for device types common to oil and gas production operations. Device types include: boilers, steam generators, process heaters, gas turbines, IC engines, fixed-roof storage tanks, fugitive components, flares, and cooling towers. These templates will serve as the core of Title V permit applications prepared for oil and gas production operations in California.

Title V Permit Application - Aluminum Rolling Mill. Project manager and lead engineer for Title V permit application prepared for largest aluminum rolling mill in the western U.S. Responsible for the overall direction of the permit application project, development of a monitoring plan for significant emission units, and development of a hazardous air pollutant (HAP) emissions inventory. The project involved extensive onsite data gathering, frequent interaction with the plant's technical and operating staff, and coordination with legal counsel and subcontractors. The permit application was completed on time and in budget.

Title V Model Permit - Oil and Gas Production Industry. Project manager and lead engineer for the comparative analysis of regional and federal requirements affecting oil and gas production industry sources located in the San Joaquin Valley. Sources included gas turbines, IC engines, steam generators, storage tanks, and process fugitives. From this analysis, a model applicable requirements table was developed for a sample device type (storage tanks) that covered the entire population of storage tanks operated by the industry. The U.S. EPA has tentatively approved this model permit approach, and work is ongoing to develop comprehensive applicable requirements tables for each major category of sources operated by the oil and gas industry in the San Joaquin Valley.

Title V Enhanced Monitoring Evaluation of Oil and Gas Production Sources. Lead engineer to identify differences in proposed EPA Title V enhanced monitoring protocols and the current monitoring requirements for oil and gas production sources in the San Joaquin Valley. The device types evaluated included: steam generators, stationary ICEs, gas turbines, fugitives, fixed roof storage tanks, and thermally enhanced oil recovery (TEOR) well vents. Principal areas of difference included: more stringent Title V O&M requirements for parameter monitors (such as temperature, fuel flow, and O₂), and more extensive Title V recordkeeping requirements.

RACT/BARCT/BACT EVALUATIONS

BACT Evaluation of Wool Fiberglass Insulation Production Line. Project manager and lead engineer for BACT evaluation of a wool fiberglass insulation production facility. The BACT evaluation was performed as a component of a PSD permit application. The BACT evaluation included a detailed analysis of the available control options for forming, curing and cooling sections of the production line. Binder formulations, wet electrostatic precipitators, wet scrubbers, and thermal oxidizers were evaluated as potential PM10 and VOC control options. Low NOx burner options and combustion control modifications were examined as potential NOx control techniques for the curing oven burners. Recommendations included use of a proprietary binder formulation to achieve PM10 and VOC BACT, and use of low-NOx burners in the curing ovens to achieve NOx BACT. The PSD application is currently undergoing review by EPA Region 9.

RACT/BARCT Reverse Jet Scrubber/Fiberbed Mist Eliminator Retrofit Evaluation. Project manager and lead engineer on project to address the inability of existing wet electrostatic precipitators (ESPs) and atomized mist scrubbers to adequately remove low concentration submicron particulate from high volume recovery boiler exhaust gas at the Alaska Pulp Corporation mill in Sitka, AK. The project involved thorough on-site inspections of existing control equipment, detailed review of maintenance and performance records, and a detailed evaluation of potential replacement technologies. These technologies included a wide variety of scrubbing technologies where manufacturers claimed high removal efficiencies on submicron particulate in high humidity exhaust gas. Packed tower scrubbers, venturi scrubbers, reverse jet scrubbers, fiberbed mist eliminators and wet ESPs were evaluated. Final recommendations included replacement of atomized mist scrubber with reverse jet scrubber and upgrading of the existing wet ESPs. The paper describing this project was published in the May 1992 TAPPI Journal.

Aluminum Smelter RACT Evaluation - Prebake. Project manager and technical lead for CO and PM10 RACT evaluation for prebake facility. Retrofit control options for CO emissions from the anode bake furnace, potline dry scrubbers and the potroom roof vents were evaluated. PM10 emissions from the coke kiln, potline dry scrubbers, potroom roof vents, and miscellaneous potroom fugitive sources were addressed. Four CO control technologies were identified as technologically feasible for potline CO emissions: potline current efficiency improvement through the addition of underhung busswork and automated puncher/feeders, catalytic incineration, recuperative incineration and regenerative incineration. Current efficiency improvement was identified as probable CO RACT if onsite test program demonstrated the effectiveness of this approach. Five PM10 control technologies were identified as technologically feasible: increased potline hooding efficiency through redesign of shields, the addition of a dense-phase conveying system, increased potline air evacuation rate, wet scrubbing of roof vent emissions, and fabric filter control of roof vent emissions. The cost of these potential PM10 RACT controls exceeded regulatory guidelines for cost effectiveness, though testing of modified shield configurations and dense-phase conveying is being conducted under a separate regulatory compliance order.

RACT/BACT Testing/Evaluation of PM10 Mist Eliminators on Five-Stand Cold Mill. Project manager and lead engineer for fiberbed mist eliminator and mesh pad mist eliminator comparative pilot test program on mixed phase aerosol (PM10)/gaseous hydrocarbon emissions from aluminum high speed cold rolling mill. Utilized modified EPA Method 5 sampling train with portion of sample gas diverted (after particulate filter) to Ratfish 55 VOC analyzer. This was done to permit simultaneous quantification of aerosol and gaseous hydrocarbon emissions in the exhaust gas. The mesh pad mist eliminator demonstrated good control of PM10 emissions, though test results indicated that the majority of captured PM10 evaporated in the mesh pad and was emitted as VOC.

Aluminum Remelt Furnace/Rolling Mill RACT Evaluations. Lead engineer for comprehensive CO and PM10 RACT evaluation for the largest aluminum sheet and plate rolling mill in western U.S. Significant sources of CO emissions from the facility included the remelt furnaces and the coater line. The potential CO RACT options for the remelt furnaces included: enhanced maintenance practices, preheating combustion air, installation of fully automated combustion controls, and energy efficiency modifications. The coater line was

equipped with an afterburner for VOC and CO destruction prior to the initiation of the RACT study. It was determined that the afterburner meets or exceeds RACT requirements for the coater line. Significant sources of PM10 emissions included the remelt furnaces and the 80-inch hot rolling mill. Chlorine fluxing in the melting and holding furnaces was identified as the principal source of PM10 emissions from the remelt furnaces. The facility is in the process of minimizing/eliminating fluxing in the melting furnaces, and exhaust gases generated in holding furnaces during fluxing will be ducted to a baghouse for PM10 control. These modifications are being performed under a separate compliance order, and were determined to exceed RACT requirements. A water-based emulsion coolant and inertial separators are currently in use on the 80-inch hot mill for PM10 control. Current practices were determined to meet/exceed PM10 RACT for the hot mill. Tray tower absorption/recovery systems were also evaluated to control PM10 emissions from the hot mill, though it was determined that the technical/cost feasibility of using this approach on an emulsion-based coolant had not yet been adequately demonstrated.

BARCT Low NOx Burner Conversion – Industrial Boilers. Lead engineer for evaluation of low NOx burner options for natural gas-fired industrial boilers. Also evaluated methanol and propane as stand-by fuels to replace existing diesel stand-by fuel system. Evaluated replacement of steam boilers with gas turbine cogeneration system.

BACT Packed Tower Scrubber/Mist Eliminator Performance Evaluations. Project manager and lead engineer for Navy-wide plating shop air pollution control technology evaluation and emissions testing program. Mist eliminators and packed tower scrubbers controlling metal plating processes, which included hard chrome, nickel, copper, cadmium and precious metals plating, were extensively tested at three Navy plating shops. Chemical cleaning and stripping tanks, including hydrochloric acid, sulfuric acid, chromic acid and caustic, were also tested. The final product of this program was a military design specification for plating and chemical cleaning shop air pollution control systems. The hydrochloric acid mist sampling procedure developed during this program received a protected patent.

BACT Packed Tower Scrubber/UV Oxidation System Pilot Test Program. Technical advisor for pilot test program of packed tower scrubber/ultraviolet (UV) light VOC oxidation system controlling VOC emissions from microchip manufacturing facility in Los Angeles. The testing was sponsored in part by the SCAQMD's Innovative Technology Demonstration Program, to demonstrate this innovative control technology as BACT for microchip manufacturing operations. The target compounds were acetone, methylethylketone (MEK) and 1,1,1-trichloroethane, and compound concentrations ranged from 10-100 ppmv. The single stage packed tower scrubber consistently achieved greater than 90% removal efficiency on the target compounds. The residence time required in the UV oxidation system for effective oxidation of the target compounds proved significantly longer than the residence time predicted by the manufacturer.

BACT Pilot Testing of Venturi Scrubber on Gas/Aerosol VOC Emission Source. Technical advisor for project to evaluate venturi scrubber as BACT for mixed phase aerosol/gaseous hydrocarbon emissions from deep fat fryer. Venturi scrubber demonstrated high removal efficiency on aerosol, low efficiency on VOC emissions. A number of VOC tests indicated negative removal efficiency. This anomaly was traced to a high hydrocarbon concentration in the scrubber water. The pilot unit had been shipped directly to the jobsite from another test location by the manufacturer without any cleaning or inspection of the pilot unit.

Pulp Mill Recovery Boiler BACT Evaluation. Lead engineer for BACT analysis for control of SO₂, NO_x, CO, TNMHC, TRS and particulate emissions from the proposed addition of a new recovery furnace at a kraft pulp mill in Washington. A "top down" approach was used to evaluate potential control technologies for each of the pollutants considered in the evaluation.

Air Pollution Control Equipment Design Specification Development. Lead engineer for the development of detailed Navy design specifications for wet scrubbers and mist eliminators. Design specifications were based on

field performance evaluations conducted at the Long Beach Naval Shipyard, Norfolk Naval Shipyard, and Jacksonville Naval Air Station. This work was performed for the U.S. Navy to provide generic design specifications to assist naval facility engineering divisions with air pollution control equipment selection. Also served as project engineer for the development of Navy design specifications for ESPs and fabric filters.

CONTINUOUS EMISSION MONITOR (CEM) PROJECT EXPERIENCE

Process Heater CO and NO_x CEM Relative Accuracy Testing. Project manager and lead engineer for process heater CO and NO_x analyzer relative accuracy test program at petrochemical manufacturing facility. Objective of test program was to demonstrate that performance of onsite CO and NO_x CEMs was in compliance with U.S. EPA "Boiler and Industrial Furnace" hazardous waste co-firing regulations. A TECO Model 48 CO analyzer and a TECO Model 10 NO_x analyzer were utilized during the test program to provide +1 ppm measurement accuracy, and all test data was recorded by an automated data acquisition system. One of the two process heater CEM systems tested failed the initial test due to leaks in the gas conditioning system. Troubleshooting was performed using O₂ analyzers, and the leaking component was identified and replaced. This CEM system met all CEM relative accuracy requirements during the subsequent retest.

Performance Audit of NO_x and SO₂ CEMs at Coal-Fired Power Plant. Lead engineer on system audit and challenge gas performance audit of NO_x and SO₂ CEMs at a coal-fired power plant in southern Nevada. Dynamic and instrument calibration checks were performed on the CEMs. A detailed visual inspection of the CEM system, from the gas sampling probes at the stack to the CEM sample gas outlet tubing in the CEM trailer, was also conducted. The CEMs passed the dynamic and instrument calibration requirements specified in EPA's Performance Specification Test - 2 (NO_x and SO₂) alternative relative accuracy requirements.

LATIN AMERICA ENVIRONMENTAL PROJECT EXPERIENCE

Preliminary Design of Ambient Air Quality Monitoring Network Lima, Peru. Project leader for project to prepare specifications for a fourteen station ambient air quality monitoring network for the municipality of Lima, Peru. Network includes four complete gaseous pollutant, particulate, and meteorological parameter monitoring stations, as well as eight PM₁₀ and TSP monitoring stations.

Evaluation of Proposed Ambient Air Quality Network Modernization Project Venezuela. Analyzed a plan to modernize and expand the ambient air monitoring network in Venezuela. Project was performed for the U.S. Trade and Development Agency. Direct interaction with policy makers at the Ministerio del Ambiente y de los Recursos Naturales Renovables (MARNR) in Caracas was a major component of this project.

Evaluation of U.S.-Mexico Border Region Copper Smelter Compliance with Treaty Obligations Mexico. Project manager and lead engineer to evaluate compliance of U.S. and Mexican border region copper smelters with the SO₂ monitoring, recordkeeping and reporting requirements in Annex IV [Copper Smelters] of the La Paz Environmental Treaty. Identified potential problems with current ambient and stack monitoring practices that could result in underestimating the impact of SO₂ emissions from some of these copper smelters. Identified additional source types, including hazardous waste incinerators and power plants, that should be considered for inclusion in the La Paz Treaty process.

Development of Air Emission Limits for ICE Cogeneration Plant - Panamá. Lead engineer assisting U.S. cogeneration plant developer to permit an ICE cogeneration plant at a hotel/casino complex in Panama. Recommended the use of modified draft World Bank NO_x and PM limits for ICE power plants. The modification consisted of adding a thermal efficiency factor adjustment to the draft World Bank NO_x and PM limits. These proposed ICE emission limits are currently being reviewed by Panamanian environmental authorities.

Mercury Emissions Inventory for Stationary Sources in Northern Mexico. Project manager and lead engineer to estimate mercury emissions from stationary sources in Northern Mexico. Major potential sources

of mercury emissions include solid- and liquid-fueled power plants, cement kilns co-firing hazardous waste, and non-ferrous metal smelters. Emission estimates were provided for approximately eighty of these sources located in Northern Mexico. Coordinated efforts of two Mexican subcontractors, located in Mexico City and Hermosillo, to obtain process throughput data for each source included in the inventory.

Translation of U.S. EPA Scrap Tire Combustion Emissions Estimation Document ~ Mexico. Evaluated the Translated a U.S. EPA scrap tire combustion emissions estimation document from English to Spanish for use by Latin American environmental professionals.

Environmental Audit of Aluminum Production Facilities ~ Venezuela. Evaluated the capabilities of existing air, wastewater and solid/hazardous waste control systems used by the aluminum industry in eastern Venezuela. This industry will be privatized in the near future. Estimated the cost to bring these control systems into compliance with air, wastewater and solid/hazardous waste standards recently promulgated in Venezuela. Also served as technical translator for team of U.S. environmental engineers involved in the due diligence assessment.

Assessment of Environmental Improvement Projects ~ Chile and Peru. Evaluated potential air, water, soil remediation and waste recycling projects in Lima, Peru and Santiago, Chile for feasibility study funding by the U.S. Trade and Development Agency. Project required onsite interaction with in-country decisionmakers (in Spanish). Projects recommended for feasibility study funding included: 1) an air quality technical support project for the Santiago, Chile region, and 2) soil remediation/metals recovery projects at two copper mine/smelter sites in Peru.

Air Pollution Control Training Course ~ Mexico. Conducted two-day Spanish language air quality training course for environmental managers of assembly plants in Mexicali, Mexico. Spanish-language course manual prepared by Powers Engineering. Practical laboratory included training in use of combustion gas analyzer, flame ionization detector (FID), photoionization detector (PID), and occupational sampling.

Stationary Source Emissions Inventory ~ Mexico. Developed a comprehensive air emissions inventory for stationary sources in Nogales, Sonora. This project requires frequent interaction with Mexican state and federal environmental authorities. The principal Powers Engineering subcontractor on this project is a Mexican firm located in Hermosillo, Sonora.

VOC Measurement Program ~ Mexico. Performed a comprehensive volatile organic compound (VOC) measurements program at a health products fabrication plant in Mexicali, Mexico. An FID and PID were used to quantify VOCs from five processes at the facility. Occupational exposures were also measured. Worker exposure levels were above allowable levels at several points in the main assembly area.

Renewable Energy Resource Assessment Proposal ~ Panama. Translated and managed winning bid to evaluate wind energy potential in Panama. Direct interaction with the director of development at the national utility monopoly (IRHE) was a key component of this project.

Comprehensive Air Emissions Testing at Assembly Plant ~ Mexico. Project manager and field supervisor of emissions testing for particulates, NO_x, SO₂ and CO at turbocharger/air cooler assembly plant in Mexicali, Mexico. Source specific emission rates were developed for each point source at the facility during the test program. Translated test report into Spanish for review by the Mexican federal environmental agency (SEMARNAP).

Air Pollution Control Equipment Retrofit Evaluation ~ Mexico. Project manager and lead engineer for comprehensive evaluation of air pollution control equipment and industrial ventilation systems in use at assembly plant consisting of four major facilities. Equipment evaluated included fabric filters controlling blast

booth emissions, electrostatic precipitator controlling welding fumes, and industrial ventilation systems controlling welding fumes, chemical cleaning tank emissions, and hot combustion gas emissions. Recommendations included modifications to fabric filter cleaning cycle, preventative maintenance program for the electrostatic precipitator, and redesign of the industrial ventilation system exhaust hoods to improve capture efficiency.

Comprehensive Air Emissions Testing at Assembly Plant Mexico. Project manager and field supervisor of emissions testing for particulates, NO_x, SO₂ and CO at automotive components assembly plant in Acuña, Mexico. Source-specific emission rates were developed for each point source at the facility during the test program. Translated test report into Spanish.

Fluent in Spanish. Studied at the Universidad de Michoacán in Morelia, Mexico, 1993, and at the Colegio de España in Salamanca, Spain, 1987-88. Have lectured (in Spanish) on air monitoring and control equipment at the Instituto Tecnológico de Tijuana. Maintain contact with Comisión Federal de Electricidad engineers responsible for operation of wind and geothermal power plants in Mexico, and am comfortable operating in the Mexican business environment.

EXPERT TESTIMONY

- On behalf of Attorney General of Iowa, In re Application of Interstate Power and Light Company for a Generating Facility Siting Certificate, Docket No. GCU-07-01, Iowa Utilities Board, November 9, 2007. Nature of testimony - IGCC with CO₂ control as alternative to pulverized coal-fired boiler.

- On behalf of individuals, the National Parks Conservation Association and Group Against Smog and Pollution, In the Matter of Greene Energy Resource Recovery Project, Plan Approval PA-30-00150A, Pennsylvania Department of Environmental Protection, June 2006. Nature of testimony – best available NO_x control for CFB boiler.

- On behalf of the Consumer Advocate Division of the Public Service Commission of West Virginia, Appalachian Power Company, Application for a Certificate of Public Convenience and Necessity to construct a 600 MW Integrated Gasification Combined Cycle Generating Station in Mason County, Public Service Commission of West Virginia, Case No. 06-0033-E-CN, November 19, 2007. Nature of testimony – challenges of converting IGCC designed without CO₂ capture for later retrofit to CO₂ capture.

- On behalf of Sierra Club, Sierra Club vs. Environment and Public Protection Cabinet and East Kentucky Power Cooperative, Inc., File No. DAQ-27974-037, October 30, 2006. Nature of testimony – best available NO_x control for CFB boiler.

- On behalf of Californians for Renewable Energy, In the Matter of Southern California Edison Company (U 338-E) for Approval of Results of Summer 2007 Track of its New Generation Request for Offers and for Cost Recovery, Application 06-11-007, Public Utilities Commission of California, November 30, 2006. Nature of testimony – cost to ratepayers of peaking gas turbines.

- On behalf of Utility Consumers' Action Network (UCAN), In the Matter of the Application of San Diego Gas & Electric Company (U 902-E) for a Certification of Public Convenience and Necessity for the Sunrise Powerlink Transmission Project, Application 06-08-010, Public Utilities Commission of California, May 2008. Nature of testimony – advantages of distributed generation alternative to new transmission line.

- On behalf of Environmental Health Coalition, In the Matter of: the Application for Certification for the Chula Vista Energy Upgrade Project, Docket No. 07-AFC-4, California Energy Resources

Conservation and Development Commission, September 17, 2008. Nature of testimony – cost viability of distributed photovoltaics alternative to peaking gas turbine.

- On behalf of Sierra Club, *Sierra Club v. Tennessee Valley Authority*, Case No. CV-02-J-2279-NW (N.D. Ala. 2008). Nature of testimony – opacity issues and particulate controls for existing coal-fired boiler.

- In the PSD Air Quality Permit Application of Hyperion Energy Center South Dakota Department of Environment and Natural Resources, Board of Minerals and Environment, June 25, 2009. Nature of testimony – air emissions from proposed petroleum refinery and best available control technology.

- On behalf of Sierra Club and the National Audubon Society, *In The Matter Of Southwestern Electric Power Company (SWEPCO) – Turk Power Plant*, Docket No. 08-006-P, Arkansas Pollution Control and Ecology Commission. March 6, 2009. Nature of testimony – best available SO₂ and PM controls for proposed coal-fired boiler.

- On Behalf of Protestant Annie Mae Shelton, *In the Matter of Applications of Aspen Power, LLC for TCEQ Air Quality Permit No. 81706, Prevention of Significant Deterioration Air Quality Permit PSD-TX-1089, and HAP 12, SOAH Docket No. 582-09-0636, TCEQ Docket No. 2008-1145-AIR*, Before the Texas State Office of Administrative Hearings, March 3, 2009. Nature of testimony – best available NO_x, PM, and CO/VOC controls for biomass boiler.

- On Behalf of Sierra Club and No Coal Coalition, *in the Matter of Applications of White Stallion Energy Center, LLC for State Air Quality Permit 86088; Prevention of Significant Deterioration Air Quality Permit Psd-Tx-1160 and for Hazardous Air Pollutant Major Source [FCAA § 112 (G)] Permit Hap-28 and Plant-wide Applicability Limit Pal-48*, Texas State Office of Administrative Hearings, November 2, 2009. Nature of testimony – best available NO_x, PM, SO₂, and CO/VOC controls for CFB boilers.

- On behalf of Montana Environmental Information Center and Citizens for Clean Energy, *In the Matter of: Southern Montana Electric Generation & Transmission Cooperative – Highwood Generating Station Air Quality Permit No. 3423-00, Montana Board of Environmental Review, Case No. BER 2007-07-AQ, October 2, 2007*. Nature of testimony – IGCC with CO₂ control as alternative to coal-fired CFB boiler.

- On behalf of NRDC, *Natural Resources Defense Council, Inc., v. Chris Korleski*, Erac No. 996266, Erac No. 996267, *State of Ohio Environmental Review Appeals Commission*, May 11, 2010. Nature of testimony – best available air emission control levels for proposed coal-to-liquids plant.

- On Behalf of Save The Dunes Council, Inc., et al., *In The Matter of Objection to the Issuance Of Significant Source Modification Permit No. 089-25484-00453 to BP Products North America Inc. Whiting Business Unit*, Cause No. 08-A-J-4115. Nature of testimony – estimation of air emissions from proposed petroleum refinery expansion.

- On behalf of North Carolina Waste Awareness Reduction Network Inc., *North Carolina Waste Awareness Reduction Network Inc. v. N.C. Department of Environment and Natural Resources, Division of Air Quality*, 08-Ehr-0771, 0835 & 0836, 09-Ehr-3102, 3174 & 3176, *North Carolina Office of Administrative Hearings*, March 1, 2010. Nature of testimony – best available SO₂ and PM emission controls for proposed pulverized coal-fired boiler.

PUBLICATIONS

Bill Powers, “*San Diego Smart Energy 2020 – The 21st Century Alternative*,” San Diego, October 2007.

Bill Powers, "Energy, the Environment, and the California – Baja California Border Region," *Electricity Journal*, Vol. 18, Issue 6, July 2005, pp. 77-84.

W.E. Powers, "Peak and Annual Average Energy Efficiency Penalty of Optimized Air-Cooled Condenser on 515 MW Fossil Fuel-Fired Utility Boiler," presented at California Energy Commission/Electric Power Research Institute Advanced Cooling Technologies Symposium, Sacramento, California, June 2005.

W.E. Powers, R. Wydrum, P. Morris, "Design and Performance of Optimized Air-Cooled Condenser at Crockett Cogeneration Plant," presented at EPA Symposium on Technologies for Protecting Aquatic Organisms from Cooling Water Intake Structures, Washington, DC, May 2003.

P. Pai, D. Niemi, W.E. Powers, "A North American Anthropogenic Inventory of Mercury Emissions," presented at Air & Waste Management Association Annual Conference in Salt Lake City, UT, June 2000.

P.J. Blau and W.E. Powers, "Control of Hazardous Air Emissions from Secondary Aluminum Casting Furnace Operations Through a Combination of: Upstream Pollution Prevention Measures, Process Modifications and End-of-Pipe Controls," presented at 1997 AWMA/EPA Emerging Solutions to VOC & Air Toxics Control Conference, San Diego, CA, February 1997.

W.E. Powers, et. al., "Hazardous Air Pollutant Emission Inventory for Stationary Sources in Nogales, Sonora, Mexico," presented at 1995 AWMA/EPA Emissions Inventory Specialty Conference, RTP, NC, October 1995.

W.E. Powers, "Develop of a Parametric Emissions Monitoring System to Predict NOx Emissions from Industrial Gas Turbines," presented at 1995 AWMA Golden West Chapter Air Pollution Control Specialty Conference, Ventura, California, March 1995.

W. E. Powers, et. al., "Retrofit Control Options for Particulate Emissions from Magnesium Sulfite Recovery Boilers," presented at 1992 TAPPI Envr. Conference, April 1992. Published in *TAPPI Journal*, July 1992.

S. S. Parmar, M. Short, W. E. Powers, "Determination of Total Gaseous Hydrocarbon Emissions from an Aluminum Rolling Mill Using Methods 25, 25A, and an Oxidation Technique," presented at U.S. EPA Measurement of Toxic and Related Air Pollutants Conference, May 1992.

N. Meeks, W. E. Powers, "Air Toxics Emissions from Gas-Fired Internal Combustion Engines," presented at AIChE Summer Meeting, August 1990.

W. E. Powers, "Air Pollution Control of Plating Shop Processes," presented at 7th AES/EPA Conference on Pollution Control in the Electroplating Industry, January 1986. Published in *Plating and Surface Finishing* magazine, July 1986.

H. M. Davenport, W. E. Powers, "Affect of Low Cost Modifications on the Performance of an Undersized Electrostatic Precipitator," presented at 79th Air Pollution Control Association Conference, June 1986.

AWARDS

Engineer of the Year, 1991 – ENSR Consulting and Engineering, Camarillo
Engineer of the Year, 1986 – Naval Energy and Environmental Support Activity, Port Hueneme
Productivity Excellence Award, 1985 – U. S. Department of Defense

PATENTS

Sedimentation Chamber for Sizing Acid Mist, Navy Case Number 70094