BEFORE THE ILLINOIS POLLUTION CONTROL BOARD

IN THE MATTER OF:	)	
	)	R 15-21
AMENDMENTS TO 35 ILL. ADM. CODE	)	(Rulemaking-Air)
PART 214, SULFUR LIMITATIONS, PART	)	
217, NITROGEN OXIDES EMISSIONS,	)	
AND PART 225, CONTROL OF EMISSIONS	)	
FROM LARGE COMBUSTION SOURCES	)	

NOTICE OF FILING

To: John Therriault,
Assistant Clerk
Illinois Pollution Control Board
James R. Thompson Center
100 West Randolph, Suite 11-500
Chicago, Illinois 60601-3218

Please take notice that on the 24th day of July, 2015, I have filed with the Office of the Clerk of the Pollution Control Board the Pre-filed Testimony of H. Andrew Gray on behalf of Sierra Club and Environmental Law & Policy Center. Copies of the documents are attached hereto and served upon the persons listed on the attached service list.

Respectfully submitted,

By: /s/ Faith Bugel

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BEFORE THE ILLINOIS POLLUTION CONTROL BOARD

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PRE-FILED TESTIMONY OF H. ANDREW GRAY ON BEHALF OF SIERRA CLUB AND ENVIRONMENTAL LAW AND POLICY CENTER

My name is H. Andrew Gray of Gray Sky Solutions. I have over 30 years of experience in air quality research. My full qualifications are set forth in the curriculum vitae that appears at the end of this report.

On April 28, 2015, the Illinois Environmental Protection Agency (Agency) filed a rulemaking generally proposing to control emissions of sulfur dioxide (SO_2) in and around areas designated as nonattainment with respect to the 2010 SO_2 National Ambient Air Quality Standard (NAAQS). The rulemaking is intended to satisfy Illinois' obligation to submit a State Implementation Plan (SIP) to the United States Environmental Protection Agency (USEPA) to address requirements under Sections 172, 191, and 192 of the CAA for sources of SO_2 emissions in areas designated as nonattainment with respect to the 2010 SO_2 NAAQS. The Agency states that the proposed rule will 1) establish sulfur content limitations for liquid fuels used by fuel combustion emission units throughout the State; 2) establish SO_2 emission limitations for specific sources impacting an SO_2 nonattainment area; 3) address the conversion of certain coal-fired electric generating units (EGUs) located in or near an SO_2 nonattainment area to fuel other than coal; and 4) correct or update various existing provisions.

The Agency's plan for controlling SO_2 emissions in and around the Lemont and Pekin nonattainment areas is incomplete. It is missing key elements required of a SIP process, including a documented modeling analysis to support the demonstration of attainment.

USEPA's guidance document for 1-hour S02 nonattainment area SIPs[1] makes clear the required elements of the SIP:

> "The attainment plan for the affected area should also demonstrate, through the use of air quality dispersion modeling, using allowable emissions and supplemental analyses as appropriate, that the area will attain the standard by its attainment date…
>
> The air agency, through the use of air quality dispersion modeling, should adopt and implement control measures that are necessary to ensure expeditious attainment in the affected nonattainment area."

The Agency's proposed plan includes requirements for (1) low sulfur fuels throughout the State and (2) specific emission reductions for eight facilities that are impacting the two SO2 nonattainment areas (Lemont and Pekin). Although the Agency's modeling scenarios appear to have included emission reductions associated with the low sulfur fuel requirements, there is no documentation that demonstrates that the modeled emission rates represent allowable (or permitted) emission levels, as required.

The Agency's plan is missing its supporting documentation. Although dispersion modeling was used (as required by USEPA) to demonstrate attainment with a set of proposed emission reductions, the only accompanying material that has been published to-date regarding the modeling is the input and output files, and summary spreadsheets. Many of the assumptions and data requirements for the modeling were not adequately documented, including the selection and adequacy of meteorological data, modeling domain and definition of receptor networks, facility emission rate and stack data sources, building downwash parameters, urban vs. rural designations, background concentrations, and control strategy approach. The result is that it is not possible to determine the adequacy and reliability of the model results, and the appropriateness of the Agency's proposed emission reduction plan.

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[1] Guidance for 1-Hour SO_2 Nonattainment Area Sip Submissions. USEPA OAQPS. April 2014. http://www.epa.gov/oaqps001/sulfurdioxide/pdfs/20140423guidance.pdf.

The Agency made judgments regarding their proposed emission control strategy without sufficient technical support to justify such judgments. For example, in their proposed rulemaking the Agency asserts:[2]

> "Midwest Generation intends to continue combusting coal at Unit 4 at the Will County station, and requested from the Agency that the unit be exempted from the requirement to install flue gas desulfurization equipment on or before December 31, 2018. The Agency states that, in light of the SO_2 emission reductions that will result from the conversion of [Units 6, 7, and 8 at Midwest Generation's Joliet station and Unit 3 at its Will County station], it proposes implementing Midwest Generation's request in Part 225 and in the proposed emission limitations applicable to Will County Unit 4 in Part 214."

Examination of the Agency's modeling shows that Will County Unit 4 accounts for the overwhelming majority of the modeled concentration at the peak receptor (over 150 µg/m3 out the total modeled concentration of 191.5 µg/m3). The conversion to fuels other than coal for Unit 3 at Will County and Units 6, 7 and 8 at Joliet may result in SO2 emission reductions at these units; however these units combined account for only 4.6 µg/m3 at the peak modeled receptor. The attainment demonstration requires a 28 percent emission reduction of SO2 at Will County Unit 4. If emission reductions occur at these other units instead, the modeling will not demonstrate attainment (i.e., emission are not interchangeable in terms of their concentration impacts at peak modeled receptors). According to their own model results, the Agency's proposed decision to allow Will County Unit 4 to continue operating without SO2 control equipment (such as FGD) will have a significant affect on the ability of the area to reach attainment with the 1-hr SO2 NAAQS.

Another required element of the SIP process that is lacking in the Agency's current proposal is the clear definition of baseline and controlled emission projections. Emission calculations must be used to demonstrate that the proposed controls will achieve the necessary emission reductions. The starting point for these calculations is a set of projected baseline allowable emission levels (they may be no different than current allowable levels).

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[2] Proposed rulemaking, pg 3.

These baseline emission levels are then to be revised to account for specific enforceable control measures and the set of controlled emissions can be modeled to demonstrate attainment with the proposed control scenario. Although the Agency modeled an "allowable" Lemont emission scenario (Scenario 1, which showed numerous violations of the NAAQS; peak modeled design value concentration = 2690 μg/m3), they did not document how these allowable emissions would be reduced to achieve their next modeled emission scenario (Scenario 2; peak modeled design value concentration = 923 μg/m3).

There may be more than one set of emission controls that will demonstrate attainment with the NAAQS. Without sufficient documentation on the modeling and how it was used to develop a proposed control plan (or in the Agency's case, a proposed "emission reduction" plan), it is unclear that the proposed plan is the most sensible approach. In other words, there may be a "better" strategy of emission reductions for which the collection of sources can demonstrate attainment with the NAAQS. For example, using a different set of sources and/or controls may also demonstrate attainment at a lower cost. The reasons and justifications for the Agency's selected emission reduction plan remain unclear.

Although the Agency's dispersion modeling effort cannot be adequately examined without the requisite documentation, the available input and output files indicate that modeling was performed for a number of emission scenarios that showed attainment of the NAAQS at both Lemont and Pekin. The modeled emission rates, however, were reduced from the allowable emission rates at hundreds of individual sources, without any explanation (or accompanying calculations). For these reasons, it was not possible to not possible to determine the adequacy and reliability of the model results, and the appropriateness of the Agency's proposed emission reduction plan.

Thank you for the opportunity to present testimony in this proceeding.

DATED: July 24, 2015.

Respectfully submitted,

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H. ANDREW GRAY

EDUCATION

Ph.D. environmental engineering science, California Institute of Technology, Pasadena, California, 1986

M.S. environmental engineering science, California Institute of Technology, Pasadena, California, 1980

B.S. civil engineering/engineering and public policy, Carnegie-Mellon University, Pittsburgh, Pennsylvania, 1979

EXPERIENCE

Dr. H. Andrew Gray has been performing research in air pollution for over 35 years, within academic, governmental, and consulting environments. He has made significant contributions in the areas of airborne particles and visibility, including the development and application of computer-based air quality models. His areas of expertise are air pollution control strategy design and evaluation, computer modeling of the atmosphere, characterization of ambient air quality and air pollutant source emissions, aerosol monitoring and modeling, visibility analysis, receptor modeling, statistical data analysis, mathematical programming, numerical methods, and analysis of environmental public policy. Dr. Gray is currently an independent contractor focusing on particulate matter and visibility related research issues. Previous Gray Sky Solutions projects include assessment of Clean Air Act and other regulations on visibility in Class I (park and wilderness) areas, development of air pollution control plans and emission inventories for tribal lands, review and development of guidelines for modeling long-range transport impacts using the CALPUFF model, evaluation of particulate air quality impacts associated with diesel exhaust emissions, air quality management plan modeling protocol review, a critical review of Clean Air Mercury Rule (CAMR) documents, and assessment of the regional air quality impacts of power plant emissions. Dr. Gray has performed dispersion modeling studies to determine the impacts associated with mercury emissions in the Chesapeake Bay region, and has evaluated the air quality, visibility and health impacts of numerous electric generating facilities, industrial sources, and container ship traffic. Most recently, Dr. Gray worked with a team of researchers to evaluate the health effects due to coal-fired power plant emissions throughout China. Dr. Gray was invited by the Royal Institute of International Affairs to participate in the "Balancing Global Energy Policy Objectives: A High-Level Roundtable" meeting in April 2014.

Before starting Gray Sky Solutions, Dr. Gray was the manager of the PM_{10} and Visibility Program at Systems Applications International (SAI / ICF Inc.). At SAI, Dr. Gray conducted and managed a number of varied air pollution research projects. In the early 1990s, Dr. Gray directed a large (over $1 million) air-quality modeling program to determine the impact of SO_2 emissions from a large coal-fired power plant on Grand Canyon sulfate and visibility levels. He managed projects to develop carbon particle emission data for the Denver area, designed a PM_{10} monitoring and modeling program for the El Paso area, determined the appropriate tradeoffs between direct PM_{10} emissions and emissions of PM_{10} precursors, estimated the visibility effects in federal Class I areas due to the 1990 Clean Air Act Amendments (results of which were incorporated into EPA's 1993 Report to Congress on the expected visibility consequences of the 1990 Clean Air Act Amendments), and provided

assistance to EPA Region VIII's tribal air programs. Other projects include emission inventory development for Sacramento and carbon monoxide modeling of Phoenix, Arizona to support federal and regional implementation plans in those regions, systematic evaluation of the Interagency Workgroup on Air Quality Modeling (IWAQM) recommendations for the use of MESOPUFF II, a critical assessment of exposures to particulate diesel exhaust in California, and an evaluation of $PM_{2.5}$ and PM_{10} air quality data in support of EPA's review of the federal particulate matter air quality standards. Later projects included a study of micrometeorology and modeling of low wind speed stable conditions in the San Joaquin Valley (CA), an assessment of the reductions in nationwide ambient particulate nitrate exposures due to mobile source NO_X emission reductions, an evaluation of visibility conditions in the Southern Appalachian Mountains region, a review of cotton ginning emission factors, and a critical review and assessment of the PM_{10} Attainment Demonstration Plan for the San Joaquin Valley. Dr. Gray was a member of the modeling subcommittee of the technical committee of the Grand Canyon Visibility Transport Commission.

Previous to his tenure at SAI, Dr. Gray was responsible for the PM_{10} and visibility programs at the South Coast Air Quality Management District which involved directing monitoring, analysis, and modeling efforts to support the design of air pollution control strategies for the South Coast Air Basin of California. He developed and applied the methodologies for assessing PM_{10} concentrations that have continued to be used by the District through numerous subsequent air quality management plan revisions. Dr. Gray authored portions of the 1989 Air Quality Management Plan issued by the District that describe the results of modeling and data analyses used to evaluate particulate matter control strategies. Dr. Gray was instrumental in promoting the development and application of state-of-science models for predicting particulate matter concentrations. His responsibilities included direction and oversight of numerous aerosol-related contracts, including development of the SEQUILIB and SAFER models, construction of an ammonia emission database, and development of sulfate, nitrate and organic chemical mechanisms. In addition, Dr. Gray was responsible for initiating the District's visibility control program.

In research performed at the California Institute of Technology, Dr. Gray studied control of atmospheric fine primary carbon particle concentrations and performed computer programming tasks for acquisition and analysis of real-time experimental data. He designed, constructed, and operated the first long-term fine particle monitoring network in Southern California in the early 1980s. He also developed and applied deterministic models to predict source contributions to fine primary carbon particle concentrations and constructed objective optimization procedures for control strategy design. In research carried out for the Department of Mechanical Engineering at Carnegie-Mellon University, Dr. Gray developed fuel use data for input to an emission simulation model for the northeastern United States.

Specialized Professional Competence

- Air pollution control strategy design
- Atmospheric air quality characterization
- Aerosols and visibility
- Computer modeling and data analysis

- Dispersion modeling for particulate matter and visibility
- Receptor modeling including Chemical Mass Balance (CMB) and factor analysis
- Analysis of environmental public policy

Professional Experience

- Systems Applications International (SAI)—PM_{10} and visibility program manager—participated in and managed numerous air quality modeling and analysis projects for public and private sector clients, with emphasis on particulate matter and visibility research
- South Coast Air Quality Management District, El Monte, California—air quality specialist—developed and applied air quality modeling analyses to support air pollution control strategy design for the South Coast Air Basin of California
- California Institute of Technology, Pasadena, California—research assistant—Ph.D. candidate in environmental engineering science. Thesis: Control of atmospheric fine primary carbon particle concentrations (thesis advisors: Dr. Glen Cass, Dr. John Seinfeld, and Dr. Richard Flagan)
- California Institute of Technology, Pasadena, California—laboratory assistant—performed computer programming tasks for acquisition and analysis of real-time experimental data
- Department of Mechanical Engineering, Carnegie-Mellon University, Pittsburgh, Pennsylvania—research assistant—developed fuel use data for an emissions simulation model for the northeastern United States. Grant from the U.S. Department of Energy for evaluation of national energy policy
- Department of Civil Engineering, Carnegie-Mellon University, Pittsburgh, Pennsylvania—consultant—analyzed structural retrofit design for Ferrari Dino import automobile for United States five mph crash test

HONORS AND AWARDS

Harold Allen Thomas Scholarship Award, Carnegie-Mellon University

University Honors, Carnegie-Mellon University

PROFESSIONAL AFFILIATIONS

Air and Waste Management Association

American Association for Aerosol Research

SELECTED PUBLICATIONS AND PRESENTATIONS

The Deposition of Airborne Mercury within the Chesapeake Bay Region from Coal-fired Power Plant Emission in Pennsylvania, in press (2011)

Peer Review of the Interagency Workgroup On Air Quality Modeling Phase 2 Summary Report And Recommendations For Modeling Long Range Transport Impacts (with others), Report compiled by: John S. Irwin, Air Policy Support Branch, Atmospheric Sciences Modeling Division, U.S. Environmental Protection Agency Research Triangle Park, NC 27711 (1999)

Source Contributions to Atmospheric Fine Carbon Particle Concentrations (with G.R. Cass), *Atmospheric Environment*, 32:3805-3825 (1998)

"Monitoring and Analysis of the Surface Layer at Low Wind Speeds in Stable PBL's in the Southern San Joaquin Valley of California" (with others), presented at the American Meteorological Society's 12th Symposium on Boundary Layers and Turbulence, Vancouver, British Columbia (July 1997)

"Estimation of Current and Future Year NOx to Nitrate Conversion for Various Regions of the United States" (with A. Kuklin), presented at the 90th Meeting of the Air and Waste Management Association, Toronto, Ontario (June 1997)

Integrated Monitoring Study (IMS) 1995: Characterization of Micrometeorological Phenomena: Mixing and Diffusion in Low Wind Speed Stable Conditions: Study Design and Preliminary Results (with others), in *Measurement of Toxic and Related Air Pollutants*, Air and Waste Management Association, Pittsburgh, Pennsylvania, pp. 484-500 (1996)

Regional Emissions and Atmospheric Concentrations of Diesel Engine Particulate Matter: Los Angeles as a Case Study (with G.R. Cass), in *Diesel Exhaust: A Critical Analysis of Emissions, Exposure, and Health Effects*, Health Effects Institute, Cambridge, Massachusetts, pp. 125-137 (1995)

"Assessment of the Effects of the 1990 Clean Air Act Amendments on Visibility in Class I Areas", presented at the 86th Annual Meeting & Exhibition of the Air and Waste Management Association, Denver, Colorado (June 1993)

"Source Contributions to Atmospheric Carbon Particle Concentrations" (with others), presented at the Southern California Air Quality Study Data Analysis Conference, Los Angeles, California (July 1992)

"Modeling Wintertime Sulfate Production in the Southwestern United States" (with M. Ligocki), presented at the AWMA/EPA International Specialty Conference on PM10 Standards and Nontraditional Particulate Source Controls, Scottsdale, Arizona (January 1992)

"Deterministic Modeling for the Navajo Generating Station Visibility Impairment Study: An Overview," presented at the 84th Meeting of the Air and Waste Management Association, Vancouver, British Columbia (June 1991)

"Receptor and Dispersion Modeling of Aluminum Smelter Contributions to Elevated PM10 Concentrations" (with R. G. Ireson and A. B. Hudischewskyj), presented at the 84th Meeting of the Air and Waste Management Association, Vancouver, British Columbia (June 1991)

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Atmospheric carbon particles and the Los Angeles visibility problem (with others), *Aerosol Sci. Technol.*, 10:118-130 (1989)

Receptor modeling for PM10 source apportionment in the South Coast Air Basin of California (with others), in *PM-10: Implementation of Standards*, Air Pollution Control Association, Pittsburgh, Pennsylvania, pp. 399-418 (1988)

Optimization of PM10 control strategy in the South Coast Air Basin (with others), in *PM-10: Implementation of Standards*, Air Pollution Control Association, Pittsburgh, Pennsylvania, pp. 589-600 (1988)

Quantitative high-resolution gas chromatography and high-resolution gas chromatography/mass spectrometry analyses of carbonaceous fine aerosol particles (with others), *Int. J. Environ. Anal. Chem.*, 29:119-139 (1987)

"Development of an Objective Ozone Forecast Model for the South Coast Air Basin" (with others), presented at the 80th Meeting of the Air Pollution Control Association, New York (June 1987)

"PM10 Modeling in the South Coast Air Basin of California" (with others), presented at the 79th Annual Meeting of the Air Pollution Control Association, Minneapolis, Minnesota (1986)

Characteristics of atmospheric organic and elemental carbon particle concentrations in Los Angeles (with others), *Environ. Sci. Technol.*, 20:580-589 (1986)

"Chemical Speciation of Extractable Organic Matter in the Fine Aerosol Fraction" (with others), presented at the 1984 International Chemical Congress of Pacific Basin Societies, Honolulu, Hawaii (1984)

"Source Contributions to Atmospheric Carbon Particle Concentrations" (with others), presented at the First International Aerosol Conference, Minneapolis, Minnesota (1984)

Elemental and organic carbon particle concentrations: A long term perspective (with others), *Sci. Total Environ.*, 36:17-25 (1984)

"Meteorological and Chemical Potential for Oxidant Formation" (with others), presented at the Conference on Air Quality Trends in the South Coast Air Basin, California Institute of Technology, Pasadena, California (1980)

Containing recombinant DNA: How to reduce the risk of escape (with others), *Nature*, 281:421-423 (1979)

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Review of Illinois 2014 SO_2 Ambient Air Monitoring Network, prepared on behalf of Sierra Club, San Francisco, CA (2015)

Review of Missouri's 2014 SO_2 Ambient Air Monitoring Network, prepared on behalf of Sierra Club, San Francisco, CA (2014)

Review of Michigan's 2014 SO_2 Ambient Air Monitoring Network, prepared on behalf of Sierra Club, San Francisco, CA (2014)

Atmospheric Dispersion Modeling of Coal-Fired Power Plant Emissions in China, prepared on behalf of Greenpeace International (2013)

Modeling the Air Quality Impacts of Shipping Emissions, prepared on behalf of Kelley Drye and Warren (2012)

"Cypress Creek Power Plant Modeling: Pollutant Deposition to the Chesapeake Bay and Sensitive Watersheds within the Commonwealth of Virginia," prepared on behalf of the Chesapeake Bay Foundation, Annapolis, MD (2009)

"Virginia City Power Plant Modeling," prepared on behalf of the Chesapeake Bay Foundation, Annapolis, MD (2008)

"Chesterfield Power Plant Modeling," prepared on behalf of the Chesapeake Bay Foundation, Annapolis, MD (2008)

"The Deposition of Airborne Mercury in Pennsylvania," prepared on behalf of the Chesapeake Bay Foundation, Annapolis, MD (2007)

"The Deposition of Airborne Mercury in Virginia," prepared on behalf of the Chesapeake Bay Foundation, Annapolis, MD (2007)

"Pollutant Deposition from Maryland Sources," prepared on behalf of the Chesapeake Bay Foundation, Annapolis, MD (2006)

"Air Quality Modeling and Visibility Impacts Associated with Sammis Power Plant Emissions," prepared on behalf of the United States of America, Washington, D.C. (2003)

"Air Quality Modeling and Visibility Impacts Associated with Baldwin Power Plant Emissions," prepared on behalf of the United States of America, Washington, D.C. (2002)

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"California Regional PM10 Air Quality Study: *1995 Integrated Monitoring Study Data Analysis: Time and Length Scales for Mixing Secondary Aerosols During Stagnation Periods"* (with others), prepared for California Air Resources Board, Sacramento (1997)

"San Joaquin Valley Regional PM10 Study*: Characterizing Micrometeorological Phenomena: Mixing and Diffusion in Low Wind Speed Conditions Phase III: Monitoring and Data Analysis"* (with others), prepared for California Air Resources Board, Sacramento (1997)

"Cotton Gin Particulate Emission Factors," prepared for U.S. Environmental Protection Agency, Region VIII, San Francisco, California (1997)

"Benefits of Mobile Source NOx Related Particulate Matter Reductions" (with A. Kuklin), SYSAPP-96/61, prepared for Office of Mobile Sources, U.S. Environmental Protection Agency, Ann Arbor, Michigan (1996)

"Evaluation of Existing Information on the Effects of Air Pollutants on Visibility in the Southern Appalachians" (with D. Kleinhesselink), SYSAPP-96-95/060, prepared for Southern Appalachian Mountains Initiative, Asheville, North Carolina (1996)

"Statistical Support for the Particulate Matter NAAQS" (with others), SYSAPP-96-95/039, prepared for Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, North Carolina (1996)

"San Joaquin Valley Regional PM10 Study Support Study 5A: *Characterizing Micrometeorological Phenomena: Mixing and Diffusion in Low Wind Speed Conditions Phase II: Detailed Recommendations for Experimental Plans*" (with others), prepared for California Air Resources Board, Sacramento (1995)

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"Class I Grouping for Subsequent Assessment of Regional Haze Rules" (with others), SYSAPP-94/129, prepared for Air Quality Strategies and Standards Division, Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, North Carolina (1994)

"Retrospective Analysis of the Impact of the Clean Air Act on Urban Visibility in the Southwestern United States" (with C. Emery and T.E. Stoeckenius), SYSAPP-94/108, prepared for Office of Policy Analysis and Review, Office of Air and Radiation, U.S. Environmental Protection Agency, Washington, D.C. (1994)

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"Assessment of the Effects of the 1990 Clean Air Act Amendments on Visibility in Class I Areas" (with others), SYSAPP-93/162, prepared for Ambient Standards Branch, Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, North Carolina (1994)

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"Air Quality Modeling of Carbon Monoxide Concentrations in Support of the Federal Implementation Plan for Phoenix, Arizona" (with others), SYSAPP-93/039, prepared for Pacific Environmental Services, North Carolina, and U.S. Environmental Protection Agency, Region IX, San Francisco, California (1993)

"Base Case Carbon Monoxide Emission Inventory Development for Maricopa County, Arizona" (with others), SYSAPP-93/077, prepared for Maricopa Association of Governments, Phoenix, Arizona (1993)

"Sacramento FIP Modeling 3: Future Emissions Inventory" (with others), SYSAPP-93/036, prepared for Pacific Environmental Services, Inc., North Carolina and U.S. Environmental Protection Agency, San Francisco (1993)

"Emissions Inventory Development for the Tribal Air Program" (with M. Causley and S. Reid), SYSAPP-92/146, prepared for U.S. Environmental Protection Agency, Region VIII, Denver, Colorado (1992)

"Carbon Particle Emissions Inventory for Denver Brown Cloud II: Development and Assessment" (with S. B. Reid and L. R. Chinkin), prepared for Colorado Department of Health, Denver, Colorado (1992)

"Analysis to Determine the Appropriate Trade-off Ratios Between NO_x, SO_x, and PM10 Emissions for the Shell Martinez Refinery" (with M. Ligocki), SYSAPP-92/006, prepared for Shell Oil Co., Martinez, California (1992)

"Modeling Program for PM-10 State Implementation Plan Development for the El Paso/Ciudad Juarez Airshed" (with C. Emery and M. Ligocki), SYSAPP-91/134, prepared for U.S. Environmental Protection Agency, Dallas Texas (1991)

"Deterministic Modeling for Navajo Generating Station Visibility Study. Volume I. Technical Report" (with others), SYSAPP-91/045a, prepared for Salt River Project, Phoenix, Arizona (1991)

"Deterministic Modeling in the Navajo Generating Station Visibility Study" (with others), SYSAPP-91/004, prepared for Salt River Project, Phoenix, Arizona (1991)

"Analysis of Contributions to PM10 Concentrations During Episodic Conditions" (with A. B. Hudischewskyj and R. G. Ireson), SYSAPP-90/072, prepared for Kaiser Aluminum and Chemical Corporation (1990)

"Preparation of Elemental and Organic Carbon Particle Emission Inventories for the Denver Area: Work Plan" (with L. R. Chinkin), SYSAPP-90/068, prepared for Colorado Department of Health (1990)

"Evaluation of Control Strategies for PM10 Concentrations in the South Coast Air Basin," Air Quality Management Plan: 1988 Revision, Appendix V-O. South Coast Air Quality Management District, El Monte, California (1988)

"Annual PM10 Dispersion Model Development and Application in the South Coast Air Basin," Air Quality Management Plan: 1988 Revision, Appendix V-L. South Coast Air Quality Management District, El Monte, California (1988)

"PM10 Modeling Approach" (with others), 1987 AQMP Revision Working Paper No. 2, South Coast Air Quality Management District, El Monte, California (1986)

"Workplan for Air Quality Modeling and Analysis," 1987 AQMP Revision Working Paper No. 5, Planning Division, South Coast Air Quality Management District, El Monte, California (1986)

"Control of Atmospheric Fine Primary Carbon Particle Concentrations," (EQL report No. 23), Ph.D. thesis, California Institute of Technology, Pasadena, California (1986)

"Policy on Recombinant DNA Activities: Relaxing Guidelines While Increasing Safety," project report, Department of Engineering and Public Policy, Carnegie-Mellon University, Pittsburgh, Pennsylvania (1978)

"Air Pollution Control Analyses for State Implementation Plan Revisions in Allegheny County," project report, Department of Engineering and Public Policy, Carnegie-Mellon University, Pittsburgh, Pennsylvania (1978)

BEFORE THE ILLINOIS POLLUTION CONTROL BOARD

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	)	(Rulemaking- Air)
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AND PART 225, CONTROL OF EMISSIONS	)	
FROM LARGE COMBUSTION SOURCES	)	

CERTIFICATE OF SERVICE

I, Faith E. Bugel, the undersigned, hereby certify that I have served Sierra Club and Environmental Law & Policy Center's Pre-Filed Questions upon:

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