

Introduction to the Air & Waste Management Association's 30th Annual Critical Review



Pratim Biswas

This marks the 30th year of the Air & Waste Management Association's Critical Review Program. The Critical Review is a feature of A&WMA's Annual Conference, and is directed by the Critical Review Committee. The committee evaluates several topics each year, selects

the best for presentation, and invites an individual (or group) to prepare the Critical Review Paper. This paper is thoroughly reviewed by the committee members and a panel of experts. After presentation of the review by the authors (typically on the Wednesday of the Annual Conference), there is a panel discussion and question-and-answer session. Panel members are invited to prepare their comments on the Critical Review, which, along with audience comments and the author's closing statements, are published in the *Journal*.

Many individuals assist in the selection and organization of a Critical Review presentation. A list of the Critical Review Committee chairs is provided in Table 1. The chairperson is responsible for formulation of the committee and communication with the author(s) and *Journal* staff, and serves as liaison with A&WMA. It should be noted that the chair has the responsibility of keeping authors apprised of deadlines and ensuring that the Review is completed and presented according to schedule.

PAST CRITICAL REVIEW PRESENTATIONS

The first presentation of the Critical Review was in 1971 (Table 2). A description of the history of the program and the initial 25 reviews has been outlined by Watson.¹ The

topics of the first 15 years focused on air pollution issues, with primary emphasis on the criteria pollutants. After the mid-1980s, the topics expanded to other environmental media, such as land and water. Furthermore, the air pollution issues were also extended to regional and global scales, in addition to the urban scale. Many of the reviews also corresponded to the promulgation of major federal regulation.

Review topics have often been revisited or closely related, and have thereby provided timely updates to the reader. It should be noted that the Critical Review is an excellent introduction for the non-expert and the student who intends to focus on a given topic area. The references contained in each Critical Review are extensive—typically in the hundreds—covering a wide range of journals, technical reports, and regulatory documents.

THE 2000 CRITICAL REVIEW

This year's Critical Review, "Combustion Aerosols: Factors Governing Their Size and Composition and Implications to Human Health," will be presented by Drs. Lighty, Veranth, and Sarofim of the University of Utah. The review examines emissions from stationary sources such as coal, oil, waste, diesel, and spark ignition engine combustors. These are known to be the major contributors to the submicrometer primary particulate matter (PM) loading in urban atmospheres. The subject matter is very topical, due to the indications that these fine particles probably result in enhanced deleterious health effects.

The review is comprehensive, and starts with a brief tutorial on particle formation mechanisms. The authors emphasize the importance of the size distribution and the composition of the particles. The size distribution is a critical factor for establishing the overall collection efficiency of control devices. The performance of commonly used devices is also discussed, as are specific combustion systems and the resulting particle emissions to the atmosphere. Systems discussed include residential and commercial boilers and furnaces, coal-fired steam generation boilers, large-scale biomass combustors, domestic combustors, wildfire and agricultural burning, oil pool fires, incinerators, internal combustion engines, and aircraft engines.

The authors then examine the fate of the primary PM emissions and provide an elegant review of ambient PM characteristics. The concept of source apportionment modeling to unravel the PM sources is also briefly discussed.

Table 1. Chairpersons of the A&WMA Critical Review Committee.

| Duration | Name |
|-----------|----------------|
| 1973–1975 | Victor Sussman |
| 1976–1978 | Harry Hovey |
| 1979–1982 | Melvin First |
| 1983–1984 | Paul Lioy |
| 1985–1988 | Howard Ellis |
| 1989–1991 | Ron Harker |
| 1992–1993 | Ron Berglund |
| 1994–1997 | John Watson |
| 1998–2000 | Pratim Biswas |

Table 2. List of Critical Review topics.

| Year | Review Title | Author(s) |
|------|--------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------|
| 1971 | National Air Quality Standards for Automotive Pollutants | Heuss, J.M.; Nebel G.J.; Colucci, J.M. (1971, 21, 535-544) |
| 1972 | Solutions for Feedlot Odor Control Problems | Bethea, R.M. (1972, 22, 765-771) |
| 1973 | Regulations for Control of Sulfur Dioxide Emissions | Engdahl, R.B. (1973, 23, 365-375) |
| 1973 | Regulations for Control of Particulate Matter Emissions | Hemeon, W.C.L. (1973, 23, 376-387) |
| 1974 | Regulations for Control of Odors | Leonardos, G. (1974, 24, 456-468) |
| 1974 | Regulations for the Control of Hydrocarbon Emissions from Stationary Sources | Feldstein, M. (1974, 24, 469-478) |
| 1975 | Effect of Air Pollution Control Regulations on Land Use Planning | Roberts, J.J.; Croke, E.J.; Booras, S. (1975, 25, 500-520) |
| 1976 | Air Pollution Index Systems in the United States and Canada | Ott, W.R.; Thom, G.C. (1976, 26, 460-470) |
| 1976 | Status Report on Federal Regulations for New Source Performance Standards | High, M.D. (1976, 26, 471-479) |
| 1977 | Prevention of Significant Deterioration | Stern, A.C. (1977, 27, 450-453) |
| 1978 | Health Effects of Exposure to Low Levels of Regulated Air Pollutants | Ferris, B.G. (1978, 28, 481-497) |
| 1979 | Atmospheric Dispersion Modeling | Turner, D.B. (1979, 29, 502-519) |
| 1980 | Advances in the Analysis of Air Contaminants | Katz, M. (1980, 30, 528-557) |
| 1981 | Motor Vehicle Inspection/Maintenance Programs | Elston, J.C. (1981, 31, 524-547) |
| 1982 | Indoor/Outdoor Air Quality Relationships | Yocom, J.E. (1982, 32, 500-520) |
| 1983 | Toxic Substances in the Atmospheric Environment | Glodstein, B.D. (1983, 33, 464-482) |
| 1984 | Source-Receptor Relationships for Acid Deposition: Pure and Simple? | Hidy, G.M. (1984, 34, 518-531) |
| 1985 | Effects of Air Pollution on Forests | McLaughlin, S.B. (1985, 35, 511-534) |
| 1986 | The Regulation of Toxic Air Pollutants | Cannon, J.A. (1986, 36, 562-573) |
| 1987 | Incineration of Hazardous Waste | Oppelt, E.T. (1987, 37, 558-586) |
| 1988 | Ozone Air Quality Models | Seinfeld, J.H. (1988, 38, 616-645) |
| 1989 | Health Effects of Ozone | Lippman, M. (1989, 39, 672-695) |
| 1990 | Soil Remediation: Techniques in Uncontrolled Hazardous Waste Sites | Sims, R.C. (1990, 40, 704-732) |
| 1991 | Increasing the Efficiency and Effectiveness of Environmental Decisions: Benefit Cost Analysis and Effluent Fees | Lave, L.; Gruenspecht, H. (1991, 41, 680-693) |
| 1992 | Industrial Pollution Prevention | Freeman, H.; Harten, T.; Springer, J.; Randall, P.; Curran, M.A.; Stone, K. (1992, 42, 618-656) |
| 1993 | Global Climate Change and Sustainable Development | Frior, J.; Jacobsen, J.E. (1993, 43, 707-722) |
| 1994 | Sustainable Development by Design: Review of Life Cycle Design and Related Approaches | Keoleain, G.A.; Menery, D. (1994, 44, 645-668) |
| 1995 | Measurement Methods to Determine Compliance with Ambient Air Quality Standards for Suspended Particles | Chow, J.C. (1995, 45, 320-382) |
| 1996 | Physical/Chemical Treatment of Organically Contaminated Soils and Sediments | Fox, R.D. (1996, 46, 391-413) |
| 1997 | Ambient Particles and Health: Lines that Divide | Vedal, S. (1997, 47, 551-581) |
| 1998 | Assessment of Risk from Multimedia Exposures of Children to Environmental Chemicals | Mukerjee, D. (1998, 48, 483-501) |
| 1999 | Mercury Measurement and Control: What We Know, Have Learned, and Need to Further Investigate | Brown, T.D.; Smith, D.N.; Hargis, R.A.; O'Dowd, W.J. (1999, 49, 628-640) |
| 2000 | Combustion Aerosols: Factors Governing Their Size and Composition and Implications to Human Health | Lighty, J.S.; Veranth, J.; Sarofim, A.F. (2000, 50, 1565-1618) |

The importance of the morphology and structure of ambient PM is then addressed. This is followed by a discussion of ongoing PM health effects research. Topics covered include epidemiology, respiration and particle inhalation, controlled studies of concentrated ambient particles, laboratory studies with surrogate particles, cardiopulmonary effects of particles, and biochemical signaling and processes. A description of synergistic effects and the role of ultrafine particles is also presented. The review proceeds to discuss recent regulations and measurement methodologies. Particularly useful is the section on future needs for PM measurements.

ABOUT THE AUTHORS



JoAnn Lighty

Dr. JoAnn Lighty is associate dean for academic affairs, College of Engineering, University of Utah; professor, Department of Chemical & Fuels Engineering, University of Utah; and special assistant to the senior vice president, University of Utah. She has been on the faculty at the University of Utah since 1988. Prior to entering graduate school, Dr. Lighty was a project engineer for Northwest Pipeline Corporation. She is a member of American Institute of Chemical Engineers and has held the positions

of secretary and director for the Environmental Division. She is also a member of the Society of Women Engineers and the Combustion Institute. In 1990, she received the National Science Foundation's Presidential Young Investigator Award. She has over 20 publications and 30 conference presentations and has contributed to several books and documents. Dr. Lighty received B.S. and Ph.D. degrees in chemical engineering from the University of Utah. Her research interests include incineration, fate of metals and organics during thermal treatment, fluidized bed combustion, biomass combustion, air pollution problems along the U.S./Mexico border, and fine PM characterization from combustion systems.



John Veranth

Dr. John Veranth is research assistant professor in the Department of Chemical and Fuels Engineering at the University of Utah. He received a Ph.D. from the University of Utah, and is currently associated with the Combustion Research Group. He is the environmental group's representative on the State of Utah Air Quality Board and is active on the Western Regional Air Partnership Fire Emissions Forum. Prior to returning to graduate school, he worked for 22 years as an engineer in smokestack industries, including coal-fired power plants, magnesium metal production, and hazardous waste incineration. He received an M.S. from MIT in 1974 and a B.S. in mechanical engineering from MIT in 1971.

He is the corresponding author of the Critical Review, and may be reached at Department of Chemical and Fuels Engineering, 1495 East 100 South, 109 KENN B, University of Utah, Salt Lake City, UT 84112; e-mail:john.veranth@m.cc.utah.edu.



Adel F. Sarofim

Dr. Adel F. Sarofim is presidential professor in the College of Engineering, University of Utah, and senior technical advisor to Reaction Engineering International in Salt Lake City. He was affiliated with MIT from 1958 to 1996 as an instructor in chemical engineering in 1958 and 1960; assistant professor in chemical engineering from

1961 to 1967; associate professor from 1967 to 1972; and full professor in chemical engineering since 1972. He held the position of Lamot du Pont Professor of Chemical Engineering at MIT from 1989 to 1996, Emeritus from October 1, 1996. Dr. Sarofim has been a visiting professor at Sheffield University, England; the University of Naples, Italy; and the California Institute of Technology.

Dr. Sarofim is the author and co-author of over 200 papers on the subjects of radiative heat transfer, furnace design, circulation patterns in glass melts, the freeze process for desalination, nitric oxide formation in combustion systems, combustion-generated aerosols, soot and polycyclic aromatic hydrocarbon formation, and the characterization of carbon structure and reactivity. He received the Sir Alfred Egerton Gold Medal from the Combustion Institute in 1984; the Kuwait Prize for Petrochemical Engineering in 1983; the Walter Ahlström Environmental Prize of the Finnish Academies of Technology in 1993; the Senior Thermal Engineering and the Towend-BCURA Awards of the Institute of Energy in 1994; the University of Pittsburgh's 1995 Award for Innovation in Coal Conversion; the U.S. Department of Energy's 1996 Homer H. Lowry Award in Fossil Energy; the Coal Division of the American Institute of Mining, Metallurgical, and Petroleum Engineers; the American Society of Mechanical Engineers' 1996 Percy Nicholls Award; the 1998 Lawrence K. Cecil Award of the Environmental Division of the American Institute of Chemical Engineers; and an honorary doctorate in chemical engineering from the University of Naples "Federico II" in 1998. He was the Hoyt C. Hottel Lecturer at the Combustion Institute in 1986 and the Lacey Lecturer at the California Institute of Technology in 1987.

REFERENCES

1. Watson, J.G. *J. Air & Waste Manage. Assoc.* 1995, 45(5), 316-319.

Critical Review Committee Members:

Pratim Biswas, Chairman, Washington University, St. Louis
Ronald L. Berglund, Harding Lawson Associates
Judy Chow, Desert Research Institute
Jim Price, Texas Natural Resource Conservation Commission
John Watson, Desert Research Institute
Chang-Yu Wu, University of Florida, Gainesville