

Guidelines and Membership Information for the PM Measurement Group

May 13, 2016

- Criteria to Guide the PM Workgroup
 - How is measured PM defined - operationally?
 - Increased and quantifiable test precision and accuracy – what level of precision is needed/practical
 - Test results should be relevant to PM emitted in real world operations
 - Include as much SVM as practical and still have reproducible tests
 - Level of test lab effort / expertise is needed to achieve reproducible tests
 - Harmonize test method with ambient PM (FRM) where practical

- Key issues to review
 - Filter type (GF, Emfab)
 - Filter mass loss over post-sample time
 - What is the right measurement to use – day 0, day 1, final stabilized, 2-h in desiccant chamber?
 - Filter equilibration for water: 40% RH, desiccant chamber, other
 - How to minimize loss of SVM over run duration but keep method practical
 - Dilution tunnel temperature/RH issues:
 - avoid condensing RH in tunnel?
 - Need to record tunnel RH?
 - Dilution tunnel flow and residence time constraints
 - Weighing room temperature and humidity control, static control
 - Filter desiccant chamber (if used): calcium sulfate (Drierite) or silica gel
 - Lab air (PM in dilution tunnel makeup air is more important for clean devices and higher dilution flows)
 - Filter blanks (weighing room and test lab)
 - Scale resolution (0.1 mg, 0.01 mg) and stability (vibration)
 - Filter collection temperature and RH (lab T, constant heated 85F, other)
 - Filter face velocity impacts on SVM loss
 - PM Sample Flow Measurements (DTM, in-line MFM, external certified flow checks)
 - Impact of varying stack height/diameter of test installation (residence time in the stack before dilution)
 - Relevance of the test results for characterizing PM concentrations in ambient winter air
 - Other issues that should invalidate a run or a test

- Develop specific recommendations for additional research needed to be able to resolve outstanding important issues
 - Example: filter mass loss during equilibration: how to determine if SVM and/or water?

- Characterize potential impacts of recommendations
 - How does a change impact the test result relative to the current regulatory method?
 - How does a change impact cost or ease of use of test method?
 - How does a change impact the accuracy, precision and expected between-lab reproducibility?
 - Effect of method on comparability with international/European methods (optional)

- Workgroup Process
 - Chair nominated and decided Steering Committee

- Committee participant description:
 - Atmospheric chemist
 - Lab representatives
 - Analytical chemist
 - PM measurement expert
- Current membership
 - George Allen, NESCAUM, chair
 - Stef Johnson, EPA OAQPS
 - Amanda Aldridge, EPA OAQPS
 - Dr. Jay Turner, Washington University
 - Dr. Allen Robinson, Carnegie Mellon
 - Dr. Jamie Schauer, University of Wisconsin-Madison
 - Dr. John Watson, Desert Research Institute
 - Dr. Phil Hopke, Clarkson University
- Additional participants may be named later – TBD
- Timeline
 - Late summer preliminary list of issues/recommendations to present at EPA lab meeting
 - Fall 2016 review lab recommendations and data; revise recommendations
 - Winter/Spring 2017 meetings with EPA to present/discuss recommendations
 - Summer 2017 continued discussions with EPA , if needed

PM Measurement Workgroup

Dr. John G. Watson

- Research Professor
- Atmospheric Science at the Desert Research Institute (DRI), the environmental research arm of the Nevada System of Higher Education.
- Dr. Watson's recent research includes: 1) evaluating, characterizing, and advancing methods to measure carbonaceous material in suspended particles; 2) developing and applying real world, multipollutant emission measurement technologies; and 3) designing and conducting aerosol characterization and source apportionment studies. He is currently participating in studies on the emissions in the oil sands region of northern Canada, engine exhaust characterization in Hong Kong, and commercialization of a multi wavelength thermal/optical aerosol carbon analyzer. These projects involve supervision and mentoring of graduate students and post-doctoral fellows.

Dr. Watson was principal investigator or co-investigator for more than 120 major and minor air quality studies. These include: 1) real world emissions characterization in the Athabasca Oils Sands Region of Canada; 2) the Fresno Supersite; 3) the California Regional PM10/PM2.5 Air Quality Study (CRPAQS); 4) the Department of Defense (SERDP) diesel source characterization study; 5) the San Joaquin Valley Air Quality Study and Atmospheric Utilities Signatures, Predictions and Experiments; 6) the Imperial Valley/Mexicali Cross Border PM10 Transport Study; 7) the Mt. Zirkel Visibility Study; 8) the Northern Front Range Air Quality Study; 9) the Mexico City aerosol characterization study, and numerous smaller studies. He has participated in PM2.5 and PM10 control strategy development in various western states. He developed EPA's Chemical Mass Balance receptor modeling software and prepared EPA monitoring guidelines for PM2.5 and PM10. National Ambient Air Quality Standards.

- Dr. Watson has authored or co-authored more than 325 journal publications, more than 120 book chapters, and more than 250 full technical reports. He is one of 250 highly cited authors in the energy and environment section of ISI Highly Cited.com with more than 9800 citations to his work. Dr. Watson co-chaired the National Academy of Engineering panel on Energy Futures and Urban Air Pollution Challenges for China and the United States and was a member of the National Academy of Science panel on A New Source Review for Stationary Sources of Air Pollution. He authored the Air & Waste Management Association (A&WMA) 2002 critical review on Visibility: Science and Regulation, and has served on the A&WMA Critical Review committee since 1982. Dr. Watson is fluent in the English and Spanish languages

Prior to joining DRI, Dr. Watson was a Senior Environmental Scientist at Environmental Research and Technology, Inc. (ERT) (now ENSR Consulting and Engineering), where he played a major role in the Electric Power Research Institute's Eastern Regional Air Quality Studies (ERAQS), the Sulfate Regional Experiment (SURE), the 1978 Denver Winter Haze Study, and the interpretation of data from EPA's Inhalable Particulate Network. He also organized and conducted the Quail Roost I Receptor Model Workshop, sponsored by the U.S. Environmental Protection Agency.

Dr. Watson was a Research Fellow at the Oregon Graduate Center, where he was technical manager of the Portland Aerosol Characterization Study (PACS). During this time, he developed cost effective procedures for sequential aerosol sampling systems, as well as better procedures for applying x ray fluorescence, neutron activation, ion chromatography, and carbon analysis techniques to examination of aerosol samples. Prior to returning to graduate school, Dr. Watson taught Physics, Mathematics, and Chemistry to prospective and in-service teachers in Chiclayo, Peru, as a volunteer in the U.S. Peace Corps.

Research Areas

- Source Apportionment
- Visibility
- Particle Sampling and Analysis
- Field Study Design and Management
- Motor Vehicle and Fugitive Dust Emissions

Laboratory

- Environmental Analysis Facility
- Source Characterization Laboratory

Dr. Philip K. Hopke

Dr. Philip K. Hopke is the Bayard D. Clarkson Distinguished Professor Emeritus at Clarkson University, and former Director of the Center for Air Resources Engineering and Science (CARES), and former Director of the Institute for a Sustainable Environment (ISE). He also holds an adjunct professorship in the Department of Public Health Sciences at the University of Rochester Medical Center. Dr. Hopke is a past Chair of EPA's Clean Air Scientific Advisory Committee (CASAC), and has served on the EPA Science Advisory Board (SAB). Professor Hopke is a Past President of the American Association for Aerosol Research (AAAR), and was a member of the more than a dozen National Research Council committees. He is a member of the NRC's Board of Environmental Studies and Toxicology. He is a fellow of the International Aerosol Research Assembly, the American Association for the Advancement of Science and the American Association for Aerosol Research. He is an elected member of the International Statistics Institute and was the recipient of the Eastern Analytical Symposium Award in Chemometrics and the Chemometrics in Analytical Chemistry Conference Lifetime Achievement Award. He is also a recipient of the David Sinclair Award of the AAAR. He served as a Jefferson Science Fellow at the U.S. Department of State during the 2008-09 academic year. Professor Hopke received his B.S. in Chemistry from Trinity College (Hartford) and his M.A. and Ph.D. degrees in chemistry from Princeton University. After a post-doctoral appointment at M.I.T. and four years as an assistant professor at the State University College at Fredonia, NY, Dr. Hopke joined the University of Illinois at Urbana-Champaign, rising to the rank of professor of environmental chemistry, and subsequently came to Clarkson in 1989 as the first Robert A. Plane Professor with a principal appointment in the Department of Chemistry. He moved his principal appointment to the Department of Chemical and Biomolecular Engineering in 2000. In 2002, he became the Clarkson Professor and Director of CARES. On July 1, 2010, he became Director of ISE that houses Clarkson's undergraduate and graduate environmental science degree programs as well as managing its sustainability initiatives. In May 2016 he moved to emeritus status.

Dr. James Jay (Jamie) Schauer

Dr. James Jay Schauer is the Peterson-Rader-Hawnn Professor of Civil and Environmental Engineering at the University of Wisconsin-Madison and serves as Director of the Water Science and Engineering Laboratory and a Program Director at the Wisconsin State Laboratory of Hygiene at the University of Wisconsin-Madison. He holds a B.S. in Chemical and Petroleum Refining Engineering from the Colorado School of Mines, an M.S. in Environmental Engineering from the University of California at Berkeley, a Ph.D. from the California Institute of Technology and received his MBA from the University of Wisconsin-Whitewater. Dr. Schauer's research focuses on the development and application of air pollution sampling methods and advanced chemical analysis methods to understand the sources and impacts of air pollution. He is applying these tools in urban air pollution studies, human health studies, and climate studies. He has extensive expertise in the measurement and data analysis of measurements of organic aerosols, trace elements in particulate matter and atmospheric mercury. Dr.

Schauer has led and participated in numerous monitoring studies and source testing projects throughout the United States and in Asia, Europe, and the Middle East. Dr. Schauer's research has been supported by grants from both government agencies and private companies, with core grant research support primarily being from the federal government (U.S. Environmental Protection Agency, National Science Foundation, U.S. Department of Energy, National Oceanic and Atmospheric Administration), private industry consortia (Electric Power Research Institute, Water Environmental Research Foundation), and state and regional air quality management authorities, with additional grant support from state and local governments, industry, and foundations. He is a Guest Professor at Peking University (Beijing, China) and served as a Lead Author for the International Panel on Climate Change (IPCC) 5th Assessment Report, Working Group III: Mitigation. He has authored and co-authored over 300 peer-reviewed scientific publications that have been highly cited in the peer-reviewed literature. Prof. Schauer is a registered Professional Engineer in the State of Colorado and the State of Illinois. Jay Turner

Dr. Jay Turner

Dr. Jay Turner is an Associate Professor of Energy, Environmental and Chemical Engineering at Washington University in St. Louis. Dr. Turner holds B.S. and M.S. degrees from UCLA (1987) and a D.Sc. from Washington University (1993), all in Chemical Engineering. Following his M.S. studies, he spent two years at the University of Duisburg, Germany, where he was a DAAD Fellow. Following his D.Sc. studies, Dr. Turner spent eight months on assignment with the Federal Highway Administration, U.S. Department of Transportation, as an Air Quality Specialist. He subsequently joined the Washington University faculty in 1994 as an Assistant Professor of Engineering & Policy. Dr. Turner's research primarily focuses on air quality characterization and control with emphasis on field measurements and data analysis to support a variety of applications in the atmospheric science, regulation and policy, and health studies arenas. He was the Principal Investigator of the St. Louis B Midwest Fine Particulate Matter Supersite. He manages a field site in East St. Louis that has hosted several Federal Equivalent Method testing campaigns and was recently one of two U.S. Environmental Protection Agency (EPA) coarse particulate matter pilot speciation study sites. Current and recent research projects include estimating lead emissions from piston engine aircraft, source apportionment of ambient particulate matter in Hong Kong, assessing intraurban variability of air toxics metals, long term fence line monitoring for gaseous air toxics and particulate matter species at an industrial facility, and air quality measurements to support health studies. Recent consulting activities include monitoring guidance and/or data analyses for agencies in four states in support of State Implementation Plan development. He is currently Washington University lead investigator on a contract from the Airport Cooperative Research Program (ACRP) to Sierra Research, Inc. to develop approaches to mitigate lead concentration hot spots at general aviation airports, and Co PI on an NIH grant to examine relationships between air pollution and neurodegenerative disease. His consulting work is currently funded by The Organization for Economic Cooperation and Development (OECD) to assess the state of air quality monitoring in 51 countries and develop a framework for estimating air quality indicators, and by the Hong Kong Environmental Protection Department through Hong Kong University of Science and Technology to develop a conceptual model for particulate matter air quality over the Pearl River Delta. Dr. Turner has served on several state and local air quality related advisory committees and the Science and Technical Support Workgroup of the Federal Advisory Committee Act (FACA) Subcommittee for Ozone, Particulate Matter, and Regional Haze Implementation Programs. He currently serves on EPA's chartered Science Advisory Board (SAB), the Ambient Monitoring and Methods Subcommittee (AMMS) of EPA's Clean Air Scientific Advisory Committee (CASAC), and the Independent Technical Advisory Committee of the Texas Air Quality Research Program. He recently served on the Science and Technology Achievement Awards (STAA) Committee of the EPA Science Advisory Board and on the Health Effects Institute project panel for the National Particle Components Toxicity Initiative. Dr. Turner was general chair for the 2007 Annual Conference of the American Association for Aerosol Research (AAAR) and is the immediate past president of AAAR. He is a Visiting Scientist at the Harvard T.H. Chan School of Public Health for the period January July 2016. He previously served on

the Science and Technology Achievement Awards (STAA) Committee of the EPA Science Advisory Board (term 2012 2015).

Dr. Allen Robinson

Dr. Allen L. Robinson is the Raymond J. Lane Distinguished Professor and Head of the Department of Mechanical Engineering, and Professor within the Department of Engineering and Public Policy at Carnegie Mellon University. He holds a B.S. in Civil Engineering from Stanford University (1990), and an M.S. (1993) and Ph.D. (1996) in Mechanical Engineering from the University of California at Berkeley. Dr. Robinson's research examines the impact of emissions from energy systems on air quality and climate. His activities include process-oriented field and laboratory experiments, development of mathematical models to describe atmospheric processes, model evaluation with field measurements, and the application of models for policy analysis and decision making. Dr. Robinson has extensive experience characterizing fine particle emissions from major sources such as on- and off-road diesel and gasoline sources, biomass combustion, gas turbines, cookstoves and other energy systems using techniques such as dilution samplers, thermodenuders, gas chromatography, and mass spectrometry. He investigates the physical and chemical aging of these emissions in the atmosphere using smog chambers and flow reactors. He parametrizes the new emissions and chemistry data for use regional and global chemical transport models. Finally, Dr. Robinson develops approaches to construct highly spatially resolved maps of pollutant concentrations in order to better understand the contribution of local sources and topography to human exposures. He joined Carnegie Mellon in 1998 after working for two years as a Postdoctoral Fellow at the Combustion Research Facility at Sandia National Laboratories. In 2009-2010, Dr Robinson was a visiting faculty fellow to the Cooperative Institute for Research in Environmental Science, University of Colorado and NOAA. Dr. Robinson received the American Geophysical Union ASCENT Award in 2015, the Raymond J. Lane Distinguished Professor in Mechanical Engineering in 2013, the Carnegie Institute of Technology Outstanding Research Award in 2010, the Ahrens Career Development Chair in Mechanical Engineering in 2005, and the George Tallman Ladd Outstanding Young Faculty Award in 2000. He has authored or co-authored over 140 peer-reviewed archival journal papers that have been cited over 6,600 times according to the Institute of Scientific Information Science Citation Index. Dr. Robinson is the director of the EPA-funded Center for Air, Climate, and Energy Solutions (CACES), which involves a multi-disciplinary team of researchers from 8 universities investigating the problems at the intersection of air pollution, climate and energy. Dr. Robinson is the Vice President of the American Association for Aerosol Research, a member of the Research Committee of the Health Effects Institute, and a member of the EPA Clean Air Scientific Advisory Committee (CASAC) Air Monitoring and Methods Subcommittee (AMMS). Dr. Robinson's research has been supported by grants from both government agencies and private companies, with core grant research support primarily being from the federal government (U.S. Environmental Protection Agency, U.S. Department of Energy, the National Science Foundation, and the U.S. Department of Defense) with additional grant support from state and local governments, industry, and foundations.

Workgroup Coordinator: Mr. George Allen

Mr. George Allen is a Senior Scientist at NESCAUM (Northeast States for Coordinated Air Use Management), an interagency association of the eight Northeastern States. He holds a B.S. in Electrical Engineering from Tufts University (1974). At NESCAUM, Mr. Allen is responsible for monitoring and exposure assessment activities across a range of wide range of air topics, including regional haze, air toxics, on and off-road diesel, wood smoke, and continuous aerosol measurement technologies. He is the author or co-author of more than 30 peer reviewed journal papers on development and evaluation of measurement methods, exposure assessment, and air pollution health effects. Before joining NESCAUM in 2002, Mr. Allen was on the professional staff at the Harvard School of Public Health (HSPH) in Boston for more than 20 years, working on a wide range of U.S. Environmental Protection Agency (EPA) and National Institutes of Health funded air pollution studies. While at HSPH, he developed several new techniques for real time aerosol measurements. Currently, Mr. Allen is serving as the lead

for the NESCAUM Monitoring and Assessment Committee. He also represents states interests to EPA in the National Association of Clean Air Agencies (NACAA) Monitoring Steering Committee and is a member of the EPA AIRNow Steering Committee. Mr. Allen's current and pending research support pertains to scientific, technical, analytical, and policy support for NESCAUM states= air quality and climate programs, with a focus on air pollution exposure assessment and measurement methods development. These funders include New York State Energy Research and Development Authority (NYSERDA) (characterization of biomass air pollution), Massachusetts Department of Environmental Protection (spatial and temporal trends of black carbon), NESCAUM member states and Federal Land Managers (CAMNET visibility network), NESCAUM member states and US EPA (support member states= air quality programs).

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