Dr. Paolo Zannetti, QEP

Dr. Paolo Zannetti is the President and Founder of EnviroComp Consulting, Inc.[1] and the non-profit EnviroComp Institute[2]. Dr. Zannetti has performed studies and scientific research in environmental sciences for more than 30 years. His activities have covered pure research in the fields of atmospheric diffusion and numerical computation, written publications, seminars and courses, project management, environmental consulting, editorial productions, and expert testimony. His major field of investigation and competence is air pollution. He has written more than 300 publications, including the book "Air Pollution Modeling"[3], completed in 1990, which was the first comprehensive book in the field, and is still today a widely used textbook. A multi-volume, multi-author, revised and expanded edition of this book is being published[4] under Dr. Zannetti's direction and editorial management. The first volume was published in late-2003; the second volume in summer 2005. The third volume is expected in mid-2007.

Dr. Zannetti has studied air quality problems all over the world, often using computer models to simulate the transport and fate of atmospheric chemicals. In most of these cases, he simulated the ambient concentrations caused by the emissions using his own computer models and/or those developed and recommended by government agencies, such as the US Environmental Protection Agency (US EPA).

In additions to his academic and scientific achievements, Dr. Zannetti is very familiar with litigation cases and has provided testimony at depositions and trials in more than 30 cases.

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[1] http://www.envirocomp.com.
[2] http://www.envirocomp.org.
[3] Zannetti, P. (1990): Air Pollution Modeling – Theories, Computational Methods, and Available Software. Computational Mechanics Publications, Southampton, and Van Nostrand Reinhold, New York. 450pp. http://www.ecampus.com/book/0442308051.
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EDUCATION AND TITLES

- *Qualified Environmental Professional (QEP),* Institute of Professional Environmental Practice (IPEP) www.ipep.org
  Certificate #029440029 (2/1994) – Recertified on 7/2007
- *Doctoral Degree in Physics*, University of Padua, Italy (12/1970)
  www.unipd.it
- *Diploma of Maturita' Scientifica*, Scientific Lyceum Ippolito Nievo, Padua, Italy (7/1965)

PROFESSIONAL EXPERIENCE

- ***President*, EnviroComp Consulting, Inc. (4/2001 – present)**
  www.envirocomp.com

  - *President and Founder*, EnviroComp Institute (10/1996-present) www.envirocomp.org

  - *Regional Coordinator* for the Institute of Professional Environmental Practice (IPEP) in the San Francisco Bay Area (9/1997- present); www.ipep.org

  - *Visiting Professor*, Wessex Institute of Technology, Southampton, UK (1991-present); www.wessex.ac.uk

  - *Visiting Professor*, Polytechnic University of Bari-Taranto, Italy (1999 – present)
    www.poliba.it/Taranto/TARAS_1.htm

  - *Peer-Reviewer*, Kuwait Institute of Scientific Research, Kuwait. Wessex Institute of Technology, Southampton, UK (2002-present); http://www.kisr.edu.kw/

- ***Principal Scientist*, Exponent, Inc., Menlo Park, California (11/1991-4/2001)**
  www.exponent.com

  - *Instructor*, University Extension, University of California, Berkeley (10/1992-7/1997); www.unex.berkeley.edu:4243

- ***Department Manager*, AeroVironment, Inc., Pasadena/Monrovia, California (10/1979-11/1991)**
  www.aerovironment.com

  - *Consultant*, IBM Semea, Milan, Italy (1-10/1991; on leave of absence from AeroVironment)

  - *Head, Environmental Sciences*, IBM Scientific Center, Bergen, Norway and *Leader, Environmental Sciences Activities of IBM Europe* (3-12/1990; on leave of absence from AeroVironment)

  - *Consultant*, Research Center of the Italian National Electric Power Company (CRTN/ENEL), Milan, Italy. (3-10/1984; on leave of absence from AeroVironment)

  - *Project Manager*, Kuwait Institute for Scientific Research (KISR), Kuwait

(2/1982-2/1984; on leave of absence from AeroVironment); www.kisr.edu.kw

- ***Researcher,* IBM Scientific Center, Venice, Italy (8/1971-10/1979)**
  - *Visiting Scientist,* Department of Statistics, Stanford University, California (1/1978-3/1979; on assignment from IBM Italy)
  - *Visiting Scientist,* IBM Scientific Center, Palo Alto, California (1/1978-3/1979; on assignment from IBM Italy)
  - *Assistant Professor,* Department of Civil Engineering, University of Padua, Italy (1974-78); www.unipd.it
- ***Systems Analyst*, UNIVAC/Sperry Rand, Milano, Italy (3-7/1971)**

EDITORIAL RESPONSIBILITY

- Editor of the Book Series "Environmental Sciences and Environmental Computing"
  www.envirocomp.org/esec
- Editor and co-Author of the Book Series "Air Quality Modeling - Theories, Methodologies, Computational Techniques, and Available Databases and Software"
  www.envirocomp.org/aqm
- Member of the Editorial Board of "Environmental Forensics" (AEHS) (2003-present)
- Founder and President (since 1996) of the EnviroComp Institute - The International Institute of Environmental Sciences and Environmental Computing (www.envirocomp.org)
- Founder and Editor-in-Chief (1986-93) of the quarterly journal *Environmental Software*, published by Computational Mechanics Publications since June 1986 and by Elsevier Applied Science since September 1991. Currently Founding Editor.
- Founder and Director of the biennial ENVIROSOFT Conference - Computer Techniques in Environmental Studies (conferences have been held every two years since 1986).
- Founder and Co-Director of the first two AIR POLLUTION Conferences - Computer Techniques in Environmental Studies (1993-94). Currently Member of the Conference Board.

- Associate Editor/Member of the Editorial Board, *Atmospheric Environment*, published by Pergamon Press (1987-1999).

- Member of the Editorial Board, *Ecological Modeling*, published by Elsevier Applied Science (since 1992).

- Member of the Editorial Board, *ENVIRONews*, published by FiatLux Publications (1993-1998); www.envirocomp.org/html/news/flpub.htm

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MEMBERSHIPS

- Member, International Scientific Advisory Committee, AIR POLLUTION Conference Cycle, Wessex Institute of Technology, UK. (since 2000)

- Member of the "SATURN Specialist Group" (http://aix.meng.auth.gr/lhtee/saturn.html), subproject of EUROTRAC-2 (http://www.gsf.de/eurotrac) dealing with urban air pollution (since 1998)

- San Francisco Bay Area Regional Coordinator for the Institute of Professional Environmental Practice (IPEP) (since 1997)

- Athens 2004 Committee (1997-2000)

- Reviewer group for the Center for Indoor Air Research (CIAR), 1995-1999.

- International Scientific Advisory Committee, Environmental Engineering and Management Conference, Barcelona, Spain. October 1998.

- International Scientific Advisory Committee, Environmental Engineering, Education and Training Conference (EEET96), Southampton, UK, April 1996.

- Scientific Advisory Board, International Congress on Modelling and Simulation (MODSIM 93 and MODSIM 95), Modeling and Simulation Society of Australia Inc.

- International Federation for Information Processing (IFIP), Working Group WG 5.11 (Computers and Environment), (1992-1997)

- ISATA Programme Committee (1992-1994)

- Scientific Committee of the Technological Consortium THETIS (Venice, Italy), (1991)

- Board of Directors, MONDOMETANO, published by RES Editrice srl. (1989-92).

- European Association for the Science of Air Pollution (EURASAP), (1987-94)

- EPA-ASRL pool for the review of U.S. Environmental Protection Agency publications, (1987-96)
- American Meteorological Society (AMS) (1978-1985)
- Air and Waste Management Association (AWMA), since 1978 (originally Air Pollution Control Association, APCA)

MISCELLANEA

- Italian Citizen by birth. U.S. Citizen since 1989.
- Languages: English, Italian, French, plus understanding of Spanish

HONORS

- Medal award from Computational Mechanics, Ashurst, England, in recognition of contribution to the development of Environmental Modeling (11/1994)
- Plaque award from the South Coast Air Quality Management District, in recognition of contribution to the Toxic Symposium at Caltech, Pasadena, California (7/1986)

PUBLICATIONS

Books

B.23 Zannetti, P., D. Al-Ajmi, and S. Al-Rashied, Eds. (2007) AMBIENT AIR POLLUTION. Published by The Arab School for Science and Technology (ASST) and The EnviroComp Institute. (www.envirocmp.org/asst)

B.22 Zannetti, P., Ed. (2005) Air Quality Modeling - Theories, Methodologies, Computational Techniques, and Available Databases and Software. Vol II – Advanced Topics. Book Series published by the EnviroComp Institute and the Air & Waste Management Association. (www.envirocomp.org/aqm)

B.21 Zannetti, P., Ed. (2004) Environmental Sciences and Environmental Computing, Vol II. Electronic book (on CD-ROM), The EnviroComp Institute (www.envirocomp.org/esec)

B.20 Zannetti, P., Ed. (2003) Air Quality Modeling - Theories, Methodologies, Computational Techniques, and Available Databases and Software. Vol I – Fundamentals. Book Series published by the EnviroComp Institute and the Air &

Waste Management Association. (www.envirocomp.org/aqm)

B.19 C. A. Brebbia and P. Zannetti, Eds. (2002) Development and Application of Computer Techniques to Environmental Studies IX. WIT Press (www.witpress.com).

B.18 Ibarra-Berastegi, G., C.A. Brebbia, and P. Zannetti, Eds. (2000) Development and Application of Computer Techniques to Environmental Studies VIII. WIT Press (www.witpress.com).

B.17 Zannetti, P. and Y.Q. Zhang, Eds. (1998) Environmental Sciences and Environmental Computing, Vol I. Electronic book (on CD-ROM), FiatLux Publications and EnviroComp Institute (www.envirocomp.org/esec)

B.16 Pepper, D.W., C.A. Brebbia, and P. Zannetti, Eds. (1998) Development and Application of Computer Techniques to Environmental Studies. Proceedings of the ENVIROSOFT 98 Conference, Las Vegas, Nevada, November. WIT Press - Computational Mechanics Publications, Southampton.

B.15 Zannetti, P., Ed. (1996) *ENVIRONMENTAL MODELING - Computer Methods and Software for Simulating Environmental Pollution and its Adverse Effects - Volume III*. Computational Mechanics Publications, Southampton.

B.14 Zannetti, P. and C. Brebbia, Eds. (1996) *Development and Application of Computer Techniques to Environmental Studies VI*. Proceedings of the ENVIROSOFT 96 Conference, Como, Italy, September. Computational Mechanics Publications, Southampton.

B.13 Zannetti, P., Ed. (1994) *Pollution Modeling*. Volume I of the Proceedings of the ENVIROSOFT 94 Conference, San Francisco, November. Computational Mechanics Publications, Southampton.

B.12 Zannetti, P., Ed. (1994) *Environmental Systems*. Volume II of the Proceedings of the ENVIROSOFT 94 Conference, San Francisco, November. Computational Mechanics Publications, Southampton.

B.11 Baldasano, J.M., C.A. Brebbia, H. Power, and P. Zannetti, Eds. (1994) *Computer Simulation*. Volume 1 of the Proceedings of the Second International AIR POLLUTION Conference, Barcelona, Spain, September 1994. Computational Mechanics Publications, Southampton.

B.10 Baldasano, J.M., C.A. Brebbia, H. Power, and P. Zannetti, Eds. (1994) *Pollution Control and Monitoring*. Volume 2 of the Proceedings of the Second International AIR POLLUTION Conference, Barcelona, Spain, September 1994. Computational Mechanics Publications, Southampton.

B.9 Zannetti, P., Ed. (1994) *ENVIRONMENTAL MODELING - Computer Methods and Software for Simulating Environmental Pollution and its Adverse Effects - Volume*

II. Computational Mechanics Publications, Southampton.

B.8 Zannetti, P., C.A. Brebbia, J.E. Garcia Gardea and G. Ayala Milian, Eds. (1993) *Air Pollution*. First International Conference on Air Pollution, Monterrey, Mexico, February. Computational Mechanics Publications, Southampton, and Elsevier Science Publishers, London.

B.7 Zannetti, P., Ed. (1993) *ENVIRONMENTAL MODELING - Computer Methods and Software for Simulating Environmental Pollution and its Adverse Effects - Volume I*. Computational Mechanics Publications, Southampton, and Elsevier Science Publishers, London.

B.6 Zannetti, P., Ed. (1992): *Computer Techniques in Environmental Studies IV*. Proceedings of the Fourth International Conference ENVIROSOFT 92. Computational Mechanics Publications, Southampton, and Elsevier Applied Science, London.

B.5 Melli, P. and P. Zannetti, Eds. (1992): *Environmental Modelling*. Computational Mechanics Publications, Southampton, and Elsevier Applied Science, London.

B.4 Zannetti, P. (1990): *Air Pollution Modeling - Theories, Computational Methods and Available Software*. Computational Mechanics Publications, Southampton, and Van Nostrand Reinhold, New York. 450 pp.
(http://www.amazon.com/Pollution-Modeling-Theories-Computational-Available/dp/0442308051)

B.3 Zannetti, P., Ed. (1990): *Computer Techniques in Environmental Studies III*. Proceedings of the Third International Conference ENVIROSOFT 90. Computational Mechanics Publications, Southampton, U.K.

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B.1 Zannetti, P., Ed. (1986): *ENVIROSOFT 86*. Proceedings of the International Conference on Development and Application of Computer Techniques to Environmental Studies, Los Angeles, USA, November 1986. Ashurst, United Kingdom: Computational Mechanics Publications.

Book Chapters

BC.14 Freedman, F. and P. Zannetti. 2007. Global Warming and Climate Change: State of the Science. Chapter 5 of AMBIENT AIR POLLUTION (P. Zannetti, D. Al-Ajmi, and S. Al-Rashied, Editors). Published by The Arab School for Science and Technology (ASST) and The EnviroComp Institute
(http://www.envirocomp.org/)

BC.13 Daly, A. and P. Zannetti. 2007. Air Pollution Modeling – An Overview. Chapter 2

of AMBIENT AIR POLLUTION (P. Zannetti, D. Al-Ajmi, and S. Al-Rashied, Editors). Published by The Arab School for Science and Technology (ASST) and The EnviroComp Institute. (http://www.envirocomp.org/asst)

BC.12 Daly, A. and P. Zannetti. 2007. An Introduction to Air Pollution – Definitions, Classifications, and History. Chapter 1 of AMBIENT AIR POLLUTION (P. Zannetti, D. Al-Ajmi, and S. Al-Rashied, Editors). Published by The Arab School for Science and Technology (ASST) and The EnviroComp Institute (http://www.envirocomp.org/asst)

BC.11 Byun, Daewon W., Avraham Lacser, Robert Yamartino, and Paolo Zannetti (2005) Eulerian Dispersion Models. Chapter 10 of AIR QUALITY MODELING - Theories, Methodologies, Computational Techniques, and Available Databases and Software. Vol. I - Fundamentals (P. Zannetti, Editor). Published by The EnviroComp Institute and the Air & Waste Management Association. (www.envirocomp.org/aqm)

BC.10 Zannetti, P. (2004) Air Pollution Dispersion Modeling. Section 16.6 of The CRC Handbook of Mechanical Engineering, Second Edition, Eds., Kreith, F. and D. Yogi Goswami. CRC Press.

BC.9 Calamari, D., K. Jones, K Kannan, A. Lecloux, M. Olsson, M. Thurman, P. Zannetti (2000) Monitoring as an Indicator of Persistence and Long-Range Transport. Chapter 6 of Evaluation of Persistence and Long=Range Transport of Organic Chemicals in the Environment, Edited by G. Klecka et al. – SETAC Press (www.setac.org).

BC.8 Zannetti, P. (1998) Air Pollution Dispersion Modeling. Section 16.6 of The CRC Handbook of Mechanical Engineering, Ed., Kreith, F. CRC Press

BC.7 Zannetti, P. (1996) Environmental Modeling: Today and Tomorrow. Chapter 1 of *ENVIRONMENTAL MODELING - Computer Methods and Software for Simulating Environmental Pollution and its Adverse Effects - Volume III*, Zannetti, P., Ed., Computational Mechanics Publications, Southampton.

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BC.4 Zannetti, P. (1993) Numerical Simulation Modeling of Air Pollution: An Overview. Section of *Ecological Physical Chemistry*, Bonati, L., U. Cosentino, M. Lasagni, G. Moro, D. Pitea, and A. Schiraldi, Eds., Elsevier Science Publishers, London. Also

published in *Air Pollution*, Zannetti, P., C.A. Brebbia, J.E. Garcia Gardea and G. Ayala Milian, Eds. (1993), First International Conference on Air Pollution, Monterrey, Mexico, February. Computational Mechanics Publications, Southampton, and Elsevier Science Publishers, London.

BC.3 Zannetti, P. (1992) Particle Modeling and its Application for Simulating Air Pollution Phenomena. Chapter 11 of *Environmental Modelling*, Melli, P. and P. Zannetti, Eds., Computational Mechanics Publications, Southampton, and Elsevier Applied Science, London.

BC.2 Zannetti, P. (1989): Simulating Short-Term, Short-Range Air Quality Dispersion Phenomena. Chapter V of *Library of Environmental Control Technology*, Volume 2, Air Pollution Control, P.N. Cheremisinoff, Ed., Houston, Texas: Gulf Publishing.

BC.1 Zannetti, P., G. Carboni and A. Ceriani (1986): AVACTA II model simulations of worst-case air pollution scenarios in Northern Italy. Section of *Air Pollution Modeling and Its Application*, C. De Wispelaere, F. A. Schiermeider and N. V. Gillani, Eds., Plenum Press, New York.

Journal articles

JA.24 Liberti, L., Michele Notarnicola, Roberto Primerano, and Paolo Zannetti (2006) Air Pollution from a Large Steel Factory: Polycyclic Aromatic Hydrocarbon Emissions from Coke-Oven Batteries. ISSN 1047-3289 J. Air & Waste Manage. Assoc. 56:255–260.

JA.23 Zannetti, P. (1996) Modeling Danger – Computer Simulations Analyze Pollution Effects, Forecast Problems. *Contingency Magazine*, March/April, pp 73-75.

JA.22 Boybeyi Z., S. Raman and P. Zannetti (1995): Numerical Investigation of Possible Role of Local Meteorology in Bophal Gas Accident. *Atmospheric Environment (Urban Atmosphere)*, Vol. **29**, No. 4, pp 479-496.

JA.21 Zannetti, P., I. Tombach, S. Cvencek and W. Balson (1993): Calculation of visual range improvements from SO_2 emission controls - II. An application to the Estern United States. *Atmospheric Environment*, **27A**:1479-1490.

JA.20 Zannetti, P., I. Tombach and W. Balson (1990): Calculation of visual range improvements from SO_2 emission controls - I. Semi-empirical methodology. *Atmospheric Environment*, **24A**:2361-2368.

JA.19 Zannetti, P., I.H. Tombach, and S. Cvencek (1989): An analysis of visual range in the eastern United States under different meteorological regimes. *Journal of the Air & Waste Management Association*, **39**:200-203.

JA.18 Brusasca, G., G. Tinarelli, D. Anfossi, P. Zannetti (1987): Particle modeling simulation of atmospheric dispersion using the MC-LAGPAR package. *Environmental Software,* **2**(3):151-158.

JA.17 Zannetti, P. (1986b): A new mixed segment-puff approach for dispersion modeling. *Atmospheric Environment,* **20**(6):1121-1130.

JA.16 Zannetti, P. (1986a): Monte-Carlo simulation of auto- and cross-correlated turbulent velocity fluctuations (MC-LAGPAR II model). *Environmental Software,* **1**(1):26-30.

JA.15 Tirabassi, T., M. Tagliazucca and P. Zannetti (1986): KAPPA-G, a non-Gaussian plume dispersion model: description and evaluation against tracer measurements. *Journal of the Air Pollution Control Association,* **36**:592-596.

JA.14 Zannetti, P. (1984): New Monte Carlo scheme for simulating Lagrangian particle diffusion with wind shear effects. *Applied Mathematical Modeling,* **8**:188-192.

JA.13 Zannetti, P. (1982): Il "Controlled Trading" negli Stati Uniti [Controlled Trading of pollution emissions in the US]. *Note di Inforrnatica,* **1**:71-83. IBM Italia (also in *Inquinamento,* **25**(7/8):61-64, Etas Kompass, 1983).

JA.12 Zannetti, P. (1981b): Scommessa con il sole [Solar Challenger]. *Scienza e Vita Nuova,* **3**(7):16-21, Rusconi Editore.

JA.11 Zannetti, P. (1982a): E' la anidride carbonica nella almosfera uno dei futuri maggiori pericoli per l' umanita'?[Is the increase of atmospheric CO_2 one of the most serious future problems for the human beings?]. *Inquinamento,* **24**(3):59-62, Etas Kompass.

JA.10 Zannetti, P. (1981a): An improved puff algorithm for plume dispersion simulation. *Journal of Applied Meteorology,* **20**(10):1203-1211.

JA.9 Zannetti, P. (1980-81): Problemi energetici ed ambientali negli USA. [Energy and environmental problems in the US] *Inquinamento,* **22**(12):65-69 and **23**(1):63-66, Etas Kompass.

JA.8 Finzi, G., P. Zannetti, G. Fronza and S. Rinaldi (1979): Real time prediction of SO_2 concentration in the Venetian Lagoon area. *Atmospheric Environment,* **13**:1249-1255.

JA.7 Runca, E., P. Zannetti and P. Melli (1978): A computer-oriented emissions inventory procedure for urban and industrial sources. *Journal of the Air Pollution Control Association,* **28**(6):584-588.

JA.6 Zannetti, P. (1977): Metodiche adottate nell'analisi dei dati misurati nelle reti di monitoraggio dell'area veneziana. [Analysis of atmospheric monitored data in the

Venitian region] Tavola Rotonda su "La gestione operativa di una rete di monitoraggio dell'inquinamento atmosferico," Venice, Italy, June 1976. Annex to *Inquinamento,* **19**(6), Etas Kompass.

JA.5 Zannetti, P., P. Melli and E. Runca (1977): Meteorological factors affecting SO_2-pollution level in Venice. *Atmospheric Environment,* **11**:605-616.

JA.4 Zannetti, P. (1977): Stabilita' atmosferica e livelli di SO_2 in Venezia: limiti del modello gaussiano. [Atmospheric stability and SO_2 levels in Venice - the limitations of the Gaussian model] *Inquinamento,* **19**(3):49-53, Etas Kompass.

JA.3 Runca, E., and P. Zannetti (1976): Applicazione di un metodo per il censimento degli scarichi gassosi di origine industriale nell'area Veneziana. [A method based on optical reading for the inventory of air pollution emissions in the Venetian area] *Inquinamento,* **18**(11):13-17, Etas Kompass.

JA.2 Runca, E., P. Melli and P. Zannetti (1976): Computation of long-term average SO_2 concentration in the Venetian area. *Applied Mathematical Modeling,* 1:9-15.

JA.1 Zannetti, P., and E. Runca (1975): Validita' della applicazione di un modello gaussiano di tipo climatologico nell'area veneziana. [Validity of the climatological Gaussian model in the Venetian area] *Inquinamento,* **17**(5):9-13, Etas Kompass.

Proceedings (papers presented by the underlined author)

P.49 Mongia, R., W. Qin, J. Belanger, A. Reza, and P. Zannetti (2002) Effect of exhaust stack geometry on the amount of liquid condensate during plant start-up. Paper #453000 in the Proceedings of the AWMA (Air & Waste Management Association) 95th Annual Conference, Baltimore, Maryland, June 23-27, 2002.

P.48 Zannetti, P. (2000) Environmental data, software, information, and resources on the Internet – a review. Keynote address in the Proceedings of ENVIROSOFT 2000, June, Bilbao, Spain. [Published as: Ibarra-Berastegi, G., C.A. Brebbia, and P. Zannetti (2000) Development and Application of Computer Techniques to Environmental Studies VIII. WIT Press (www.witpress.com)]

P.47 Zannetti, P. and R. Sire (1999) MONTECARLO - A New, Fully-Integrated PC Software for the 3D Simulation and Visualization of Air Pollution Dispersion Using Monte Carlo Lagrangian Particle (MCLP) Techniques. AIR POLLUTION 99, Stanford, California, July. WIT Publications, Ashurst, UK.

P.46 Canepa, E., C.F. Ratto, and P. Zannetti (1999) Calibration of the dispersion code SAFE_AIR using a release in nocturnal low wind conditions. AIR POLLUTION 99, Stanford, California, July. WIT Publications, Ashurst, UK.

P.45 Canepa, E., F. C. Ratto, and P. Zannetti (1998) Calibration of the dispersion code

SAFE_AIR against measurements in a complex coastal area. AIR POLLUTION 98, Genova, Italy, September. Computational Mechanics Publications, Ashurst, UK.

P.44 Jackson, J. and P. Zannetti (1997) Design of a Supplemental Control Program for SO2 Episodes in the Region of Ilo, Peru. Proceedings of AIR POLLUTION 97, Bologna, Italy, September. Computational Mechanics Publications, Southampton, UK.

P.43 Fox, D., K. McDonald, P. Zannetti, and Z. Nejedley (1997) Impact of north-western emission changes on visibility in the Rocky Montains parks. Air & Waste Management Association 90th Annual Meeting & Exibition. Toronto, Canada, June.

P.42 Zannetti, P. (1996) Environmental Modeling - The Next Generation (keynote address). Proceedings of ENVIROSOFT 96 - Development and Application of Computer Techniques to Environmental Studies VI. Como, Italy, September.

P.41 Zannetti, P. (1995) Environmental Modeling - Past, Present and Future (keynote address). Proceedings of MODSIM 95 - International Congress on Modelling and Simulation 1995. University of Newcastle, Newcastle, New South Wales, Australia, November.

P.40 Hansen, D.A., P. Zannetti, J.M. Hales (1995) Design of a Framework for the Next Generation of Air Quality Modeling System. Proceedings of AIR POLLUTION 95, Porto Carras, Greece. Computational Mechanics Publications, Southampton, UK, September.

P.39 Zannetti, P. (1995) Is Virtual Reality the Future of Air Pollution Modelling? (keynote address). Proceedings of AIR POLLUTION 95, Porto Carras, Greece. Computational Mechanics Publications, Southampton, UK, September

P.38 Zannetti, P. (1994) Computer Modeling of Air Pollution: Science, Art, or Fiction? Special keynote address in *Computer Simulation,* Volume 1 of the Proceedings of the Second International AIR POLLUTION Conference, Barcelona, Spain, September 1994, Baldasano, J.M., C.A. Brebbia, H. Power, and P. Zannetti, Eds., Computational Mechanics Publications, Southampton.

P.37 Boybeyi, Z., S. Raman, and P. Zannetti (1993): A coupled model applied to the Bophal gas accident. International Conference on Sustainable Development Strategies and Global/Regional/Local Impacts on Atmospheric Composition and Climate. Indian Institute of Technolofy, New Delhi, India, January.

P.36 Zannetti, P., and I. Tombach (1989): Intercomparison of numerical techniques for the simulation of visibility improvements from SO_2 emission controls in the eastern United States. AWMA/EPA International Specialty Conference on Visibility and Fine Particles. Estes Park, Colorado, October.

P.35 Zannetti, P. (1989): Can we continue to apply dispersion models without a proper linkage with meteorological models? Paper 89-43.1, presented at the 82nd Annual AWMA Meeting, Anaheim, California, June.

P.34 Brusasca, G., G. Tinarelli, J. Moussafir, P. Biscay, P. Zannetti and D. Anfossi (1988): Development of a portable FORTRAN 77 code for Monte Carlo particle modeling of atmospheric diffusion (MCLAGPAR II) - Validation against analytical solutions and tracer experiments. ENVIROSOFT 88 Computer techniques in environmental studies. 2nd International Conference Porto Carras, Greece, September. Computational Mechanics Publications, Southampton.

P.33 Zannetti, P., I. Tombach, and S. Cvencek (1988): Semi-empirical analysis of the potential visibility improvements from SO_2 emission controls in the eastern United States. Proceedings of the 81st Annual Air Pollution Control Association Meeting, Dallas, Texas, June 19-24.

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DRAFT REPORT

PROPOSED EASTSHORE ENERGY CENTER POWER STATION

INITIAL COMMENTS AND CONSIDERATIONS

Expert Report
Prepared by

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6 December 2007

Project: EC-07-014
Report: 07-12-06

Table of Contents

1 Introduction and Overview

Alameda County[1] has retained the services of Dr. Paolo Zannetti and his company EnviroComp Consulting, Inc.[2] for this project. Under this retention, Dr. Zannetti and his associates were asked to examine air quality issues related to the proposed EASTSHORE ENERGY CENTER POWER STATION in Hayward, CA.

We read and review relevant documents and reports and examined the technical reports and computer files submitted to us. We present in this report our preliminary comments and considerations.

Dr. Zannetti has performed studies and scientific research in air pollution and environmental sciences for more than 30 years. His activities have covered pure research in the fields of atmospheric diffusion and numerical computation, written publications, seminars and courses, project management, environmental consulting, editorial productions, and expert testimony. His major field of investigation and competence is air pollution. He has written more than 300 publications, including the book "Air Pollution Modeling"[3] completed in 1990, which was the first comprehensive book in the field and is - still today - a widely used textbook[4]. Dr. Zannetti's CV has been separately submitted.

Dr. Zannetti has studied air quality problems and managed air pollution studies all over the world, often using computer models to simulate the transport and fate of atmospheric chemicals, including indoor air pollution studies. In most of these cases, he simulated the ambient concentrations caused by the emissions using his own computer models and/or those developed

[1] http://www.acgov.org.
[2] http://www.envirocomp.com.
[3] Zannetti, P. (1990): *Air Pollution Modeling – Theories, Computational Methods, and Available Software.* Computational Mechanics Publications, Southampton, and Van Nostrand Reinhold, New York. 450pp. http://www.ecampus.com/book/0442308051.
[4] A multi-volume, multi-author, revised and expanded edition of this book is being published under Dr. Zannetti's direction and editorial management. The first volume was published in late 2003; the second volume in summer 2005. The third volume is in press. http://www.envirocomp.org/aqm.

and recommended by government agencies, such as the US Environmental Protection Agency (EPA).

This report presents the current results of our scientific work and our preliminary opinions, which are based upon the materials reviewed so far. Our work has been performed during a very limited period of about a week. Because of this, all comments and results presented here should be considered a draft work product for discussion, since this report has not been fully reviewed under our company policies of quality assurance/quality control. We reserve the right to supplement the report in the event new information is presented.

2 Comments on Emissions of Nitrogen Oxides (NOx) and the Use of Selective Catalytic Reduction (SCR) Control Device

Selective Catalytic Reduction (SCR) is the name for the control device used to reduce NOx emissions. It requires ammonia gas to react with the NOx to form nitrogen gas. There will be an SCR device on each of the 14 natural gas generators.

Our points of concern are as follows:

1) To our knowledge, there is sparse history of use of SCR in the United States. The reports do not adequately answer the following questions regarding SCR: How well does it work in actual operation? How often does it malfunction? How often is maintenance required, and does this process require the engines to be shut off for any length of time? A malfunction/maintenance problem can result in significant emissions of unmitigated NOx, as well as unreacted ammonia.

2) The air modeling results we examined are very close to exceeding the state 1-hour NO2 standard, and therefore small inaccuracies in the air modeling inputs may potentially, once corrected and remodeled, exceed the 1-hour standard. Potential inaccuracies include incorporation of start-up emissions and inappropriate choice of background concentration value. Also, any elevated NOx emissions due to malfunction/maintenance problem of the SCR device are not accounted for.

3) Emission Reduction Credits (ERC) and offsets are to be purchased to mitigate elevated ozone concentrations due to the NOx emissions. The ERCs and offsets, however, are on POC emissions (POC = precursor organic compounds, practically identical to VOC). Offsets of NOx for the purpose of reducing NO2 concentrations directly, however, do not appear to be planned, despite the recommendation for this by CEC (see Page 4-1-1 of Final Staff Assessment document).

Additional discussion and questions are presented below.

2.1 Emissions of NOx and use of SCR

Basis of Emission Calculations

The engines are scheduled for operation on an average of 11 hours per day during the year, indicating they will be started at least once per day. Have the emissions been calculated on the basis of the start period plus normal operation or strictly on normal operation?

SCR Start-up Protocol

The SCR systems are typically required to be at a minimum temperature to support the reaction of NH3 with NOx. What is the protocol during the start-up period to increase the temperature to the operating level? Is NH3 feed rate at reduced levels during the warm-up period or are both materials leaving the system at elevated values?

2.2 Operation of SCR System

Alternate Ammonia Source

Has urea been considered as an alternate NH3 source for operation of the SCR system? If so, on what basis has it been rejected?

NH3/NOx Feed Rate

There is normally a balance between the NH3/NOx ratio, the amount of NOx reacted, and the NH3 slip rate. (See below):

Ammonia or NH3/NO mole ratio distribution upstream of the first catalyst layer

In general, the higher the NH3:NO-ratio for a given SCR system, the better the NOx-reduction efficiency, however, the corresponding ammonia slip increases exponentially as shown in Figure 4. The ammonia slip reaches extremes when the NH3:NO-ratio exceeds 1.0 Even for NH3:NO-ratios between the design value and 1.0, the ammonia slip reaches unacceptable concentrations very quickly.

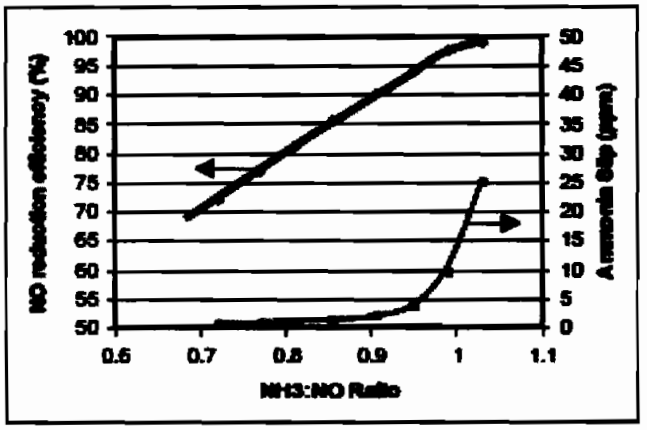


Figure 4: NO reduction efficiency and ammonia slip as a function of NH3:NO ratio

Data from: Sigling, R. and Khalaf, C. Enhance Ammonia Distribution for Maximum SCR Performance, Institute of Clean Air Companies Forum 2003, Nashville, Tennessee, 14 – 15OCT03.

Have the emission rates for NOx and NH3 been calculated on a specified basis of NH3/NOx to maximize NOx reaction while minimizing NH3 slip? Has the TCAPCD operation in Tehama county been contacted to determine why their SCR process has not met the original specifications, so that a remedy can be incorporated in later installations?

2.3 Calculation methods

Emission Units

The values for ppmvd and gm/bhp-hr seem to be inconsistent. In Table8.1F-5, the values are listed in gm/bhp with no time unit; which makes it difficult to correlate these values with operations.

Flue Gas Rate

There is a value provided for the Dry Flue Gas of 8,743 scf/MM BTU, for which a basis of calculation is not provided.

Total Annual NOx Rate = 54.35 ton/yr

The basis for this calculation is not clear, and the following questions should be answered: For each unit, how many start-ups annually, and what start-up duration is assumed? How many units are anticipated to be in operation at various times during the year to meet the anticipated power demand? Must the full complement of units always be used, or could a lesser number of units be used on days of lower demand? Is it possible that on days of low demand, few or none of the units could be started?

2.4 Ammonia Storage

Ammonia Handling Emissions

The ammonia transfer operations have not been discussed in detail. Is the solution be to delivered to the site at the 19% NH3 concentration or will there be some type of dilution process carried out on site?

Vapors from Storage Tank

What methods will be used to limit and contain NH3 releases from the storage tank and pumping/piping systems?

3 Comments on Onsite Storage and Handling of Ammonia

Ammonia for use in the SCR will be stored in two 10,000 gallon storage tanks located onsite. The stored ammonia will be a 19% aqueous solution.

Our points of concern are as follows:

1) What is the potential for an accident whereby most or all of the ammonia is spilled and released to the atmosphere? What would be the resulting concentrations and health risks associated with such an accident? Such spills can occur anywhere along the transport line of ammonia, including truck transport to the facility, storage tank rupture, line breaks to the SCR, and other places; our primary concern would be a release locally, most likely at the site during liquid transfer, or in the event of major trauma such as an earthquake or impact by an aircraft.

2) Air modeling with the model SLAB was proposed to address the concern in item 1, however to date the results of this modeling have not been presented (see Appendix 12A of AFC Volume 2).

3) On page 8.1.42 of the AFC, Volume 1, there appears to be a requirement to plan for "accidental releases of acutely hazardous air emissions. Compliance is established through the CALARP program, which is administered by the local administration agency, the City of Hayward Fire Department". Ammonia releases would be an example of acutely hazardous air emission. What are the details and what is the progress made on this compliance issue? Has the City of Hayward Fire Department verified its ability or responsibility to administer this program for this type and quantity of material?

4) It is possible that urea, rather than aqueous ammonia, is a safer storage media for ammonia. The document should state definitively why urea has not been chosen as the material of choice for this process.

4 Method of Incorporating Startup Emissions into Air Modeling

In the permitting work we examined, no separate analysis was done to directly model air concentrations from start-up emissions, but rather start-up emissions were incorporated into worse-case 1-hour emissions. This is done by defining the worse case 1-hour emissions as a ½ hour start-up plus a ½ hour worse-case normal operation. This applies to NO2 modeling, for which there is a State of California 1-hour standard.

This approach may be flawed because it assumes that the stack parameters of ~ 630 degrees K release temperature and 20 m/s exit velocity apply to the whole hour. Rather, separate stack parameters should apply the ½ hour start-up and ½ hour normal operation. Temperature, in particular, would probably be much lower during start-up, thereby producing much lower plume rise and increased surface concentrations.

In the computer modeling files available to us that we examined, the EPA-approved ISC3 model was used to evaluate the air-quality impacts from the proposed Eastshore Energy Center construction in Hayward, CA. Meteorological data obtained from the Union City station with 600m mixing heights were utilized in the model runs. From numerous runs it was found that meteorological data on June 4 1990, hour 11 produced the highest 1-hr average concentrations East of the proposed project site.

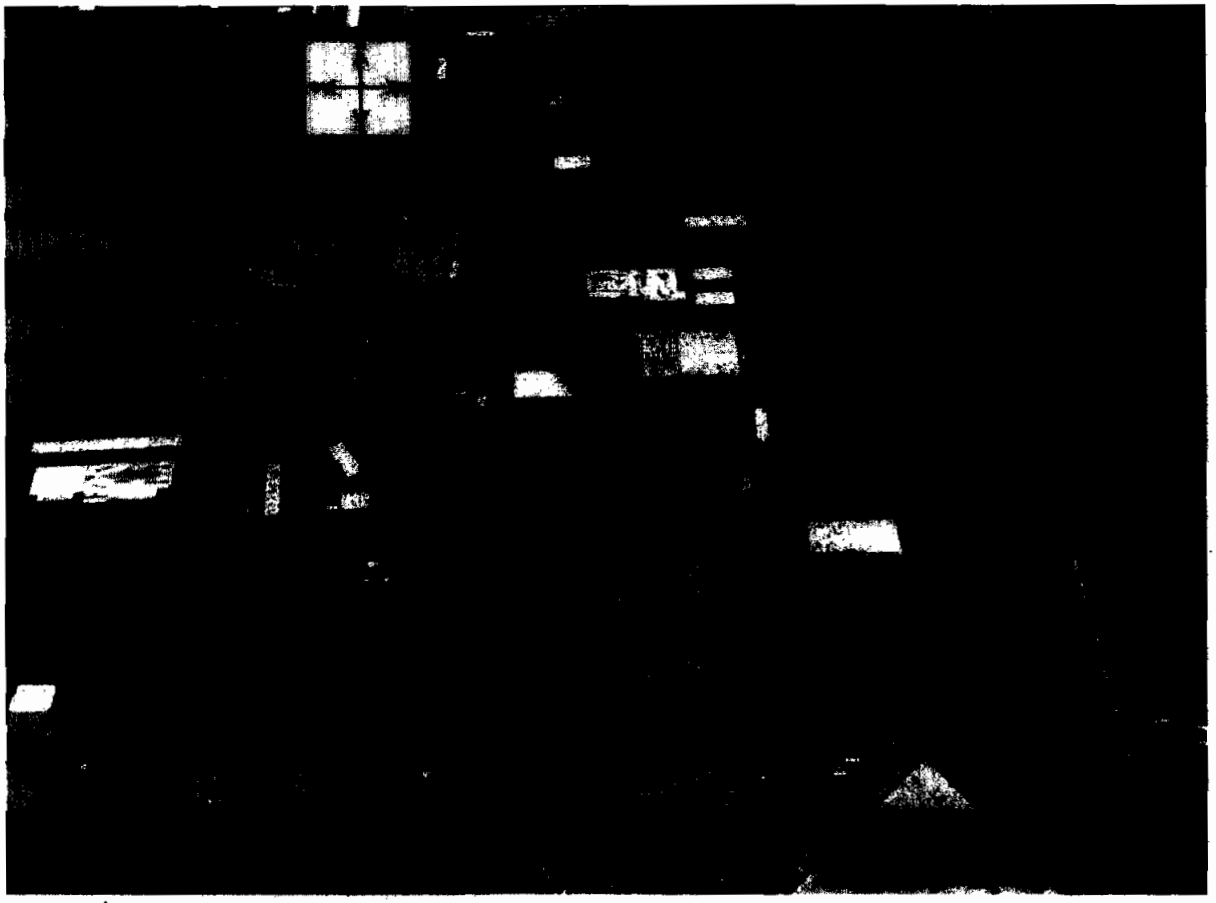
To better simulate start-up conditions, we broke up Hour 11 into four 15-minute periods, where each 15-minute period was examined. The first 15-minute period allows for the electrical generators to "warm-up" and an average gas exit temperature of 314.4 K, and exit velocity of 14.8 m/s was assumed. For the last three 15-minute periods, a gas exit temperature of 628.71 K and exit velocity of 22.42 m/s were used as the generators would be warmed up.

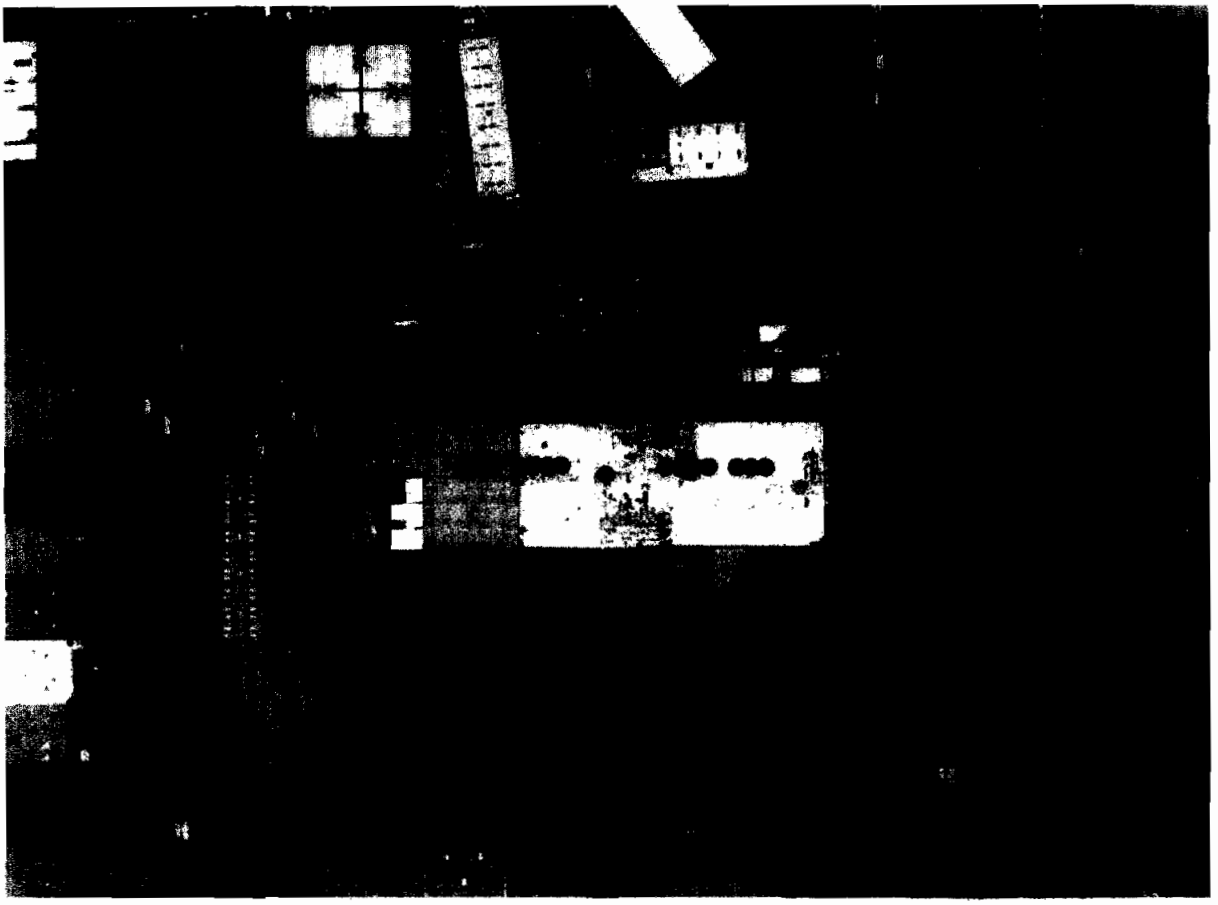
From previous calculations it was shown that during the first half hour of operation 9.17 lbs of NOx will be emitted. For the last half hour, 0.69 lbs of NOx will be emitted.

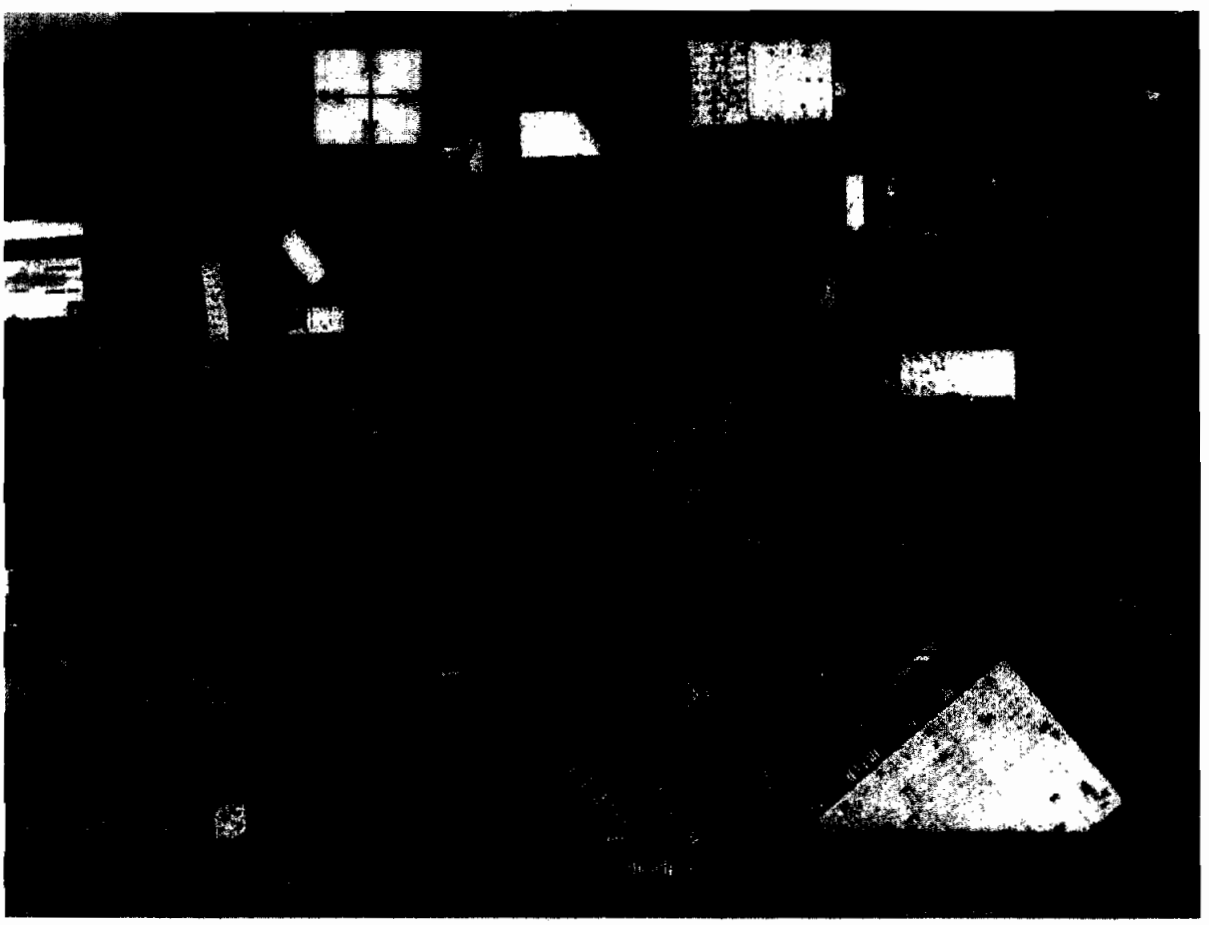
In order to correctly simulate a worst-case 1-hr scenario, we run a four-hour ISC simulation, where each "hour" of the simulation represents a period of 15 minutes of "real time". A four-hour average was calculated by ISC3 at the end of the simulation, to represent a 1-hr "real-time" average. For the entire simulation period, the meteorological data on June 4, 1990, hour 11, were used. To correctly calculate the emissions, a value of 9.17 lbs of NOx in the first half hour was used, thus giving an emission rate of 18.34 lbs/hr for the first two periods of the simulation, which represents a half hour of real time. Emission rates of 1.38 lbs/hr were applied to the sources for the last 2 periods of the simulation.

In our computer simulation, therefore, we took some account of the warm up period by modifying emission rate, exit temperature, and exit velocity. Our results show a worst-case scenario generating a maximum 1-h ambient average NOx concentration of 431.104 μg/m3. When added to the background NOx concentration observed in the area (143 μg/m3), we obtain a total concentration of 574.104 μg/m3, which is exceeding the California air quality standard for NOx of 470 μg/m3.

We present below a few figures illustrating the area of interest and the concentration impact we calculated (worse hour with start-up conditions). These results are presented for discussion purposes; i.e., to illustrate that start-up condition may be important and deserve a more accurate analysis and simulation to ascertain their actual air quality impact.







5 Particulate Emissions

Emissions of PM10/PM2.5 used in the permitting work, as well as for most of the other species, rely on vendor data and vendor guarantees. Little, if any, back-up documentation however is provided to cross-check their emissions. We would prefer that the applicant for this project provide far better substantiation of the important data to allow effective independent review of the results.

6 Mitigation and Offset Programs

Offsets are required for NOx, POC and PM10/PM2.5.

It appears that NOx and POC will be offset through purchase of Emission Reduction Credits through BAAQMD or other vendors. The main purpose of this action is to reduce potential ozone impacts, which provides the conventional justification for purchasing these offsets *regionally* since ozone is a regional problem. However, we do not necessarily agree with this – ultimately this is a local problem since the source that is producing the need for offset is a local source and therefore local people are affected, regardless of pollutant.

Emission Reduction Credits (ERC) and offsets are to be purchased to mitigate elevated ozone concentrations due to the NOx emissions. The ERCs and offsets, however, are exclusively on POC emissions (POC = precursor organic compounds, practically identical to VOC). Offsets of NOx for the purpose of reducing NO2 concentrations directly, however, do not appear to be planned, despite the well-considered recommendation for this by CEC (see Page 4-1-1 of Final Staff Assessment document).

PM10/PM2.5 emissions are proposed to be offset through purchases of credits and the initiation of a fireplace retrofit program. The original intent of the fireplace retrofit program was to implement it locally, however recent documents (see pdf files entitled Tierra*.pdf, there are four of them) appear to show the company (Tierra energy) wants the option to implement regionally if needed. Further, it is not clear that this largely voluntary method would be effective, since it does not include adequate provisions to ensure that the form of mitigation is both fully funded by the applicant and fully implemented. Since this process is supposed to be the equivalent of a CEQA analysis, which would need to provide better assurances of mitigation and compliance, we strongly recommend that this program, and all measures, be made as strong as possible and mandatory in order to provide true mitigation of this potentially harmful particulate emission impact.

7 Conclusions

We have presented our preliminary comments related to the proposed EASTSHORE ENERGY CENTER POWER STATION in Hayward, CA. Considerations and questions are presented. The most important issue, at this point, seems to be the proper modeling of the start-up conditions. Our ISC3 simulations seem to indicate that NO2 air quality standards could be exceeded.

Dr. Paolo Zannetti, QEP
President
EnviroComp Consulting, Inc.

DECLARATION OF
Dr. Paolo Zannetti

I, **Dr. Paolo Zannetti**, declare as follows:

1. I am presently employed as the President of EnviroComp Consulting, Inc.
2. A copy of my professional qualifications and experience is attached hereto and incorporated by reference herein.
3. I prepared the attached document entitled "PROPOSED EASTSHORE ENERGY CENTER POWER STATION - INITIAL COMMENTS AND CONSIDERATIONS" to serve as my testimony on the issue of Air Quality for the Eastshore Energy Center project, based on my analysis of available documents, reports, modeling runs, data from reliable documents and sources, and the professional experience and knowledge of my associates and myself.
4. It is my professional opinion that the prepared testimony is valid and accurate with respect to the issue addressed therein.
5. I am personally familiar with the facts and conclusions related in the testimony and if called as a witness could testify competently thereto.

I declare under penalty of perjury that the foregoing is true and correct to the best of my knowledge and belief.

Dated: 5 December 2007 Signed: 

At: Fremont, CA