M. SAM MANNAN, PhD, PE, CSP, DHC

Regents Professor of Chemical Engineering
T. Michael O'Connor Chair I and Professor
Chemical Engineering Department
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Mary Kay O'Connor Process Safety Center
Texas A&M University System
College Station, TX 77843-3122
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EDUCATION

Ph.D., 1986, Chemical Engineering, University of Oklahoma, Norman, Oklahoma.

M.S., 1983, Chemical Engineering, University of Oklahoma, Norman, Oklahoma.

B.S., 1978, Chemical Engineering, University of Engineering and Technology, Dhaka, Bangladesh.

POSITIONS HELD

Regents Professor of Chemical Engineering, Texas A&M University System, 2008-todate

Professor of Chemical Engineering and Director of the Mary Kay O'Connor Process Safety Center, Texas A&M University, September 2001-todate.

Associate Professor of Chemical Engineering and Director of the Mary Kay O'Connor Process Safety Center, Texas A&M University, August 1997-August 2001.

Vice President, RMT, Inc., Austin, Texas; June 1994 - July 1997.

Division Director, RMT, Inc., Austin, Texas; February 1990 - May 1994.

Assistant Professor; School of Chemical Engineering and Materials Science, University of Oklahoma, Norman, Oklahoma; March, 1986 - February, 1990.

Graduate Research Assistant; School of Chemical Engineering and Materials Science, University of Oklahoma, Norman, Oklahoma; August, 1981 - February, 1986.

Chemical Engineer; Department of Pollution Control, Ministry of Municipalities, Agedabia, Libya; May, 1980 - July, 1981.

Chemical Engineer; Power and Desalination Plant, Zweitina, Libya; July, 1978 - April, 1980.

Engineer; Engineering Department, Bangladesh Development Bank, Dhaka, Bangladesh; March, 1978 - June, 1978.

REGISTRATIONS/CERTIFICATIONS

Professional Engineer, Texas, No. 68339

Professional Engineer, Louisiana, No. 24388

Certified Safety Professional, No. 12534

Professional Process Safety Engineer, IChemE, UK

PROFESSIONAL AFFILIATIONS

American Institute of Chemical Engineers

American Society of Safety Engineers

Institution of Chemical Engineers, United Kingdom

International Institute of Ammonia Refrigeration

National Fire Protection Association

Society for Risk Analysis

OTHER ACHIEVEMENTS

M.A. Naser Chair, Bangladesh University of Engineering and Technology, Dhaka, Bangladesh, 2015-2016.

Fellow, Institution of Chemical Engineers, United Kingdom, 2015-

Distinguished Visiting Professor, SINOPEC Research Institute of Safety Engineering, Qing Dao, China, 2014-.

Guest Professor, Tianjin University, Tianjin, China, 2014-2016.

Texas A&M Engineering Experiment Station, 2014 Engineering Genesis Award.

Texas A&M Engineering Experiment Station, TEES Senior Fellow, 2013-2014.

Charles W. Crawford Service Award, Dwight Look College of Engineering, Texas A&M University, 2013-2014.

Advisory Committee, Texas Sea Grants Commission, January 1, 2014 to December 31, 2017.

Written Testimony on, "West Fertilizer, Off the Grid: The Problem of Unidentified Chemical Facilities," before the Subcommittee on Cybersecurity, Infrastructure Protection and Security Technologies of the Committee on Homeland Security, United States House of Representatives, Washington, DC, August 1, 2013.

Written and Oral Testimony on the, "Oversight of Federal Risk Management and Emergency Planning Programs to Prevent and Address Chemical Threats, Including the Events Leading Up to the Explosions in West, TX and Geismar, LA," before the Environment and Public Works Committee, United States Senate, Washington, DC, June 27, 2013.

Distinguished Honorary Professor, Rajiv Gandhi University of Petroleum Technology, Rae Bareli, India, March 2013 -.

Member, Search Committee, Vice Chancellor and Dean of Engineering, Texas A&M University System, 2012-2013.

Guest Professor, China University of Petroleum, Qing Dao, May 2012 -.

Bush Excellence Award for Faculty in Public Service, April 18, 2012

Guest Professor, Nanjing University of Technology, China, March 2012 -.

Doctoris Honoris Causa, Technical University of Łódź, Poland, September 20, 2011.

Written and Oral Testimony on "Preventing Chemical Terrorism: Building a Foundation of Security at our Nation's Chemical Facilities," before the Subcommittee on Cybersecurity, Infrastructure Protection and Security Technologies for the House Committee on Homeland Security, United States House of Representatives, Washington, DC, February 11, 2011.

Chemical Engineering Advisory Board, Worcester Polytechnic Institute, 2010-2013.

The Cedomir "Cheddy" Sliepcevich Trailblazer Award, Steering Committee, Mary Kay O'Connor Process Safety Center, October 2010.

Written Testimony on the, "U.S. Department of Homeland Security's Reauthorization of Chemical Facility Anti-Terrorism Standards," before the Homeland Security and Governmental Affairs Committee, United States Senate, Washington, DC, March 3, 2010.

Member, Presidential Council on Climate and Diversity, Texas A&M University, 2009-

Norton H. Walton/Russell L. Miller Award in Safety/Loss Prevention, American Institute of Chemical Engineers, 2009.

Medal of Honor, Technical University of Lodz, Poland, December 2008.

Editorial Advisory Board, Encyclopedia of Chemical Processing, 2008-.

Editor, Special Issue, Journal of Loss Prevention in the Process Industries, 2007-

Written and Oral Testimony on the "U.S. Department of Homeland Security's Chemical Facility Anti-Terrorism Act of 2008," before the Subcommittee on Transportation Security and Infrastructure Protection of the Committee on Homeland Security, United States House of Representatives, Washington, DC, December 12, 2007.

Fellow, American Institute of Chemical Engineers, 2007-

Senator, The Faculty Senate, Texas A&M University, 2007-

Member, Independent Advisory Panel on Chemical Security, Dow Chemical Company, 2006.

Reviewer, "Terrorism and the Chemical Infrastructure: Protecting People and Reducing Vulnerabilities," National Academy of Sciences, 2006.

Accident Investigation Committee, Korea Gas Safety Corporation, 2005-

Editor, Special Issue–Modeling of Complex Processes, Computers and Chemical Engineering, vol. 29, Issues 11-12, October 15, 2005.

National Academy of Science, Committee on Mustard Processing at Tooele Chemical Agent Disposal Facility, 2004-2005.

Presidential Task Force on University Apartment Fire, Texas A&M University, 2004.

Texas Engineering Experiment Station, Research Fellow, 2004.

Member, Advisory Council, Institute for Food Science and Engineering, Texas A&M University, September 2004 –

Expert Panel, Peer Review, Hazardous Substances Emergency Events Surveillance Program, Agency for Toxic Substances and Disease Registry, Centers for Disease Control, Atlanta, Georgia, 2004.

George Armistead, Jr. ’23 Fellow, 2004-2005, Dwight Look College of Engineering, Texas A&M University.

Distinguished Achievement Award for Teaching, The Association of Former Students, Texas A&M University, 2003.

George Armistead, Jr. ’23 Fellow, 2003-2004, Dwight Look College of Engineering, Texas A&M University.

Consultant to Columbia Accident Investigation Board, 2003.

Editorial Board, Process Safety and Environmental Protection, Transactions of the Institution of Chemical Engineers, 2003-

Editor, F.P. Lees’ Loss Prevention for the Process Industries, vol. I-III.

Editor, Special Issue, Journal of Hazardous Materials, 2002-

Texas Engineering Experiment Station, Research Fellow, 2002.

Who’s Who in America, 55th Edition, 2001.

Editorial Review Board, Process Safety Progress, 2001-

Service to Society, 2000 Award from the American Institute of Chemical Engineers.

Outstanding Young Men of America, 1988.

Instructor of AIChE short course entitled *Process Equipment Integrity*, 1993-1997.

Instructor of AIChE short course entitled *Role of Operations and Maintenance in the Implementation of Process Safety Management Programs*, 1996-1998.

"Certificate of Recognition," from the American Institute of Chemical Engineers for serving as Chair of the Continuing Education Advisory Committee, 1995-1997.

Advisor on technology transfer for process safety standards and practices for the Petroleum Association of Japan, 1998-present.

Chair, Peer Review Panel, US Environmental Protection Agency, Powell-Duffryn Incident Investigation, 1998-1999.

Conoco President's Safety, Health, and Environment Awards Committee, 1998-2001.

Quality Recognition Award from PPG Industries, Inc. The award recognizes the untiring dedication to envision, create, nourish, and implement a highly successful "Beyond

Regulatory Compliance: Making Safety Second Nature" Symposium, 1998.

External Examiner, National University of Singapore for process safety curriculum and Master's program in chemical engineering, 1998-present.

American Institute of Chemical Engineers 11A Committee, "Process Safety and Loss Prevention," 1998-present.

Director, Safety & Health Division, American Institute of Chemical Engineers, 1999-2002.

STUDENTS AND POSTDOCTORAL SCHOLARS

*indicates student was co-advised

Doctoral Students

Dr. Mannan has chaired 43 PhD and co-chaired 3 PhD students. Of the total 46 PhD graduates, the demographics of this group included: 21 female students (7 Hispanic) and 25 male students (3 Hispanic). The demographics of the current 29 PhD students include 16 male students (1 Hispanic) and 13 female (3 Hispanic). Below is a listing of current PhD students as well as the graduated students with their dissertation information and graduation date.

Current

PhD

1. Monir Ahammad, PhD CHEN, Estimated Graduation: May 2016
2. Lubna Ahmed, PhD CHEN, Estimated Graduation: May 2018
3. Pranav Bagaria, PhD CHEN, Estimated Graduation: May 2019
4. Purvali Chaudhari, PhD CHEN, Estimated Graduation: May 2019
5. Tatiana Flechas, PhD, CHEN, Estimated Graduation: May 2018
6. Ning Gan, PhD CHEN, Estimated Graduation: May 2017
7. Nirupama Gopalaswami, PhD CHEN, Estimated Graduation: August 2015
8. Richard Gustafson, PhD, MSEN, Estimated Graduation: May 2015
9. Zohra Halim, PhD, CHEN, Estimated Graduation: May 2019
10. Zhe Han, PhD, CHEN, Estimated Graduation: December 2015
11. Brian Harding, PhD, CHEN, Estimated Graduation: May 2016
12. Logan Hatanaka, PhD, CHEN, Estimated Graduation: August 2015
13. Yizhi Hong, PhD CHEN, Estimated Graduation: August 2016
14. Akshay Jain, PhD, CHEN, Estimated Graduation: May 2019
15. Prerna Jain, PhD CHEN, Estimated Graduation: May 2018
16. Sunder Janardanan, PhD CHEN, Estimated Graduation: December 2016
17. Pranav Kannan*, PhD, CHEN, Estimated Graduation: May 2018
18. Susmitha Kotu*, PhD CHEN, Estimated Graduation: May 2018
19. Yan-Ru Lin, PhD, CHEN, Estimated Graduation: December 2015
20. Ruochen Liu, PhD, CHEN, Estimated Graduation: May 2015
21. Edna Mendez, PhD, CHEN, Estimated Graduation: December 2019
22. Olga Reyes, PhD, MSEN, Estimated Graduation: December 2015
23. Nitin Roy, PhD CHEN, Estimated Graduation: August 2016
24. Camilo Rosas, PhD, MSEN, Estimated Graduation: December 2015
25. Yue Sun, PhD, CHEN, Estimated Graduation: May 2019
26. Nafiz Tamim, PhD, CHEN, Estimated Graduation: May 2018

27. Jiaqi Zhang, PhD, CHEN, Estimated Graduation: December 2015
28. Jiayong Zhu, PhD, CHEN, Estimated Graduation: May 2019
29. Wen Zhu, PhD CHEN, Estimated Graduation: May 2018

Graduated

1. Dr. Abdulrehman A. Aldeeb, December 2003. Dissertation title: "Systematic Approach for Chemical Reactivity Evaluation.
2. Dr. Alberto J. Bennavides-Serrano*, December 2014. Dissertation title: "Mathematical Programming Formulations for the Optimal Placement of Imperfect Detectors With Applications to Flammable Gas Detection and Mitigation Systems." (co-advised with C.D. Laird).
3. Dr. Diana Castellanos, August 2013. "Dissertation title: The Effects of Particle Size and Crystallinity on the Combustion Behavior of Particulated Solids."
4. Dr. Victor H. Carreto-Vazquez, December 2010. Dissertation title: "Design and Operation of Membrane μ-Calorimeters for Thermal Screening of Highly Energetic Materials."
5. Dr. Amira Y. Chowdhury*, August 2015. Dissertation title: "Shock Interaction with Dust Layers."
6. Dr. Lizbeth O. Cisneros, August 2002. Dissertation title: "Adiabatic Calorimetric Studies of Hydroxylamine Compounds."
7. Dr. Benjamin R. Cormier, August 2008. Dissertation title: "Computational Fluid Dynamics for LNG Vapor Dispersion Modeling: A Key Parameters Study."
8. Dr. Linh T.T. Dinh, December 2011. Dissertation title: "Safety-Oriented Resilience Evaluation in Chemical Processes."
9. Dr. Michela Gentile, August 2004. Dissertation title: "Development of a Hierarchical Fuzzy Model for the Evaluation of Inherent Safety."
10. Dr. Szu-Ying Huang, December 2013. Dissertation title: "High Flash-Point Fluid Flow System Aerosol Flammability Study and Combustion Mechanism Analysis."
11. Dr. Seungho Jung, December 2010. Dissertation title: "Facility Siting and Layout Optimization Based on Process Safety."
12. Dr. Nir Keren, December 2003. Dissertation title: "Models for Multi-Strata Safety Performance Measurements in the Process Industry."
13. Dr. Byung Kim, August 2013. Dissertation title: "Application of Computational Fluid Dynamics in the Forced Dispersion Modeling of LNG Vapor Clouds"
14. Dr. Kiran Krishna, December 2003. Dissertation title: "Measurement and Prediction of Aerosol Formation for the Safe Utilization of Industrial Fluids."
15. Dr. Jiaojun Jiang, December 2015. Dissertation title: "Study of Dust-Gas Hybrid Mixture Explosions."
16. Dr. Hai Le, December 2013. "Dissertation title: Flammability Characteristics of Hydrogen and Its Mixtures With Light Hydrocarbons at Atmospheric and Sub-Atmospheric Pressures"
17. Dr. Peng Lian, August 2011. Dissertation title: "Flammability and Combustion Behaviors in Aerosols Formed by Industrial Heat Transfer Fluids Produced by the Electrospray Method."
18. Dr. Lijun Liu, August 2009. Dissertation title: "The Safe Storage Study of Autocatalytic Reactive Chemicals."
19. Dr. Yen-Shan Liu, December 2006. Dissertation title: "Development of an Advanced Nanocalorimetry System for Rapid Material Characterization."

20. Dr. Yuan Lu, December 2011. Dissertation title: "Integrating Chemical Hazard Assessment into the Design of Inherently Safer Processes."
21. Dr. Andres Mejia*, August 2013. Dissertation title: "Discotic Colloids." (co-advised with Z. Cheng).
22. Dr. Susan M. Mitchell, May 2007. Dissertation title: "Resilient Engineered Systems: The Development of an Inherent System Property."
23. Dr. Carmen Osorio, August 2013. Dissertation title: "Experimental and Computational Study of Flame Inhibition Mechanisms in C1-C3 Alkanes Flames"
24. Dr. Suhani J. Patel, August 2010. Dissertation title: "Integrating Safety Issues in Optimizing Solvent Selection and Process Design."
25. Dr. Alba Pineda, May 2014. Dissertation title: Design of Inherently Safer Complex Reactive Processes: Application on the N-Oxidation of Alkylpyridines."
26. Dr. William C. Pittman, August 2015. Dissertation title: "Study of the Phase Behavior of Mono-Nitrated Poly-Substituted Aromatic Nitrocompounds."
27. Dr. Katherine P. Prem, December 2010. Dissertation title: "Risk Measures Constituting Risk Metrics for Decision Making in the Chemical Process Industry."
28. Dr. Ruifeng Qi, August 2011. Dissertation title: "Liquefied Natural Gas (LNG) Vapor Dispersion Modeling With Computational Fluid Dynamics Codes."
29. Dr. Yuanhua Qiao, May 2006. Dissertation title: "Quantitative Transportation Risk Analysis Based on Available Data/Databases: Decision Support Tools for Hazardous Materials Transportation."
30. Dr. Srinivasan Rajaraman, May 2006. Dissertation title: "Robust Model Based Fault Diagnosis for Chemical Process Systems."
31. Dr. Morshed A. Rana, December 2009. Dissertation title: "Forced Dispersion of Liquefied Natural Gas Vapor Clouds With Water Spray Curtain Application.
32. Dr. Joshua P. Richardson, August 2015. Dissertation title: "Facility Siting and Layout Optimization for Risk Reduction of Offshore Operations."
33. Dr. Tony Rocha-Valadez*, December 2014. Dissertation title: "Well Integrity Diagnostics for Sustained Casing Pressure and Faulty Gas-Lift Valves Based on Pressure Transient Modeling." (co-advised with A.R. Hasan).
34. Dr. Lina R. Saenz Noval, December 2011. Dissertation title: "Evaluation of Alternatives for Safer and Efficient Reactions: A Study of the *N*-Oxidation of Alkylpyridines."
35. Dr. Anisa Safitri, May 2011. Dissertation title: "Infrared Optical Imaging Techniques for Gas Visualization and Measurement."
36. Dr. Sanjeev R. Saraf, December 2003. Dissertation title: "Molecular Characterization of Energetic Materials."
37. Dr. Jaffee A. Suardin, August 2008. Dissertation title: "The Application of Expansion Foam on Liquefied Natural Gas (LNG) to Suppress LNG Vapor and LNG Pool Fire Thermal Radiation."
38. Dr. Migvia del Carmen Vidal Vazquez, August 2005. Dissertation title: "Binary Mixture Flammability Characteristics for Hazard Assessment."
39. Dr. Qingsheng Wang, August 2010. Dissertation title: "Theoretical and Experimental Evaluation of Chemical Reactivity."
40. Dr. Yanjun Wang, December 2004. Dissertation title: "Computer-Aided Fault Tree Synthesis for Quantitative Risk Analysis in the Chemical Process Industry."
41. Dr. Chunyang Wei, August 2005. Dissertation title: "Thermal Runaway Reaction Hazard and

Mechanism of Hydroxylamine System."
42. Dr. Xiaole Yang, May 2010. Dissertation title: "The Development of Dynamic Operational Risk Assessment in Oil/Gas and Chemical Industries."
43. Dr. Geunwoong Yun, August 2010. Dissertation title: "Control of Vapor Dispersion and Pool Fire of Liquefied Natural Gas (LNG) With Expansion Foam."
44. Dr. Bin Zhang, December 2015. Dissertation title: "Liquefied Natural Gas (LNG) Hazards Mitigation With High Expansion Foam."
45. Dr. Fuman Zhao, December 2011. Dissertation title: "Inert Gas Dilution Effect on the Flammability Limits of Hydrocarbon Mixtures."
46. Dr. Yifeng Zhou, August 2004, Dissertation title: "Data Driven Process Monitoring Based on Neural Networks and Classification Trees."

Masters Students

Dr. Mannan has chaired 47 masters students of which 44 were with thesis and 3 were non-thesis. In addition, he has co-chaired 7 masters students with thesis. Of the total 54 masters students he has chaired and co-chaired, demographics of this student group included: 16 female students (2 African American; 3 Hispanic) and 38 male students (1 African American; 4 Hispanic). The demographics of the current students include 15 male students (3 Hispanic) and 5 female (2 Hispanic). Below is a listing of current MS students as well as the graduated students with their thesis information and graduation date.

Current

1. Cassio Ahumada, MS CHEN, Estimated Graduation: May 2016
2. Pakorn Chaiwat, MS SENG, Estimated Graduation: May 2016
3. Guido Lamus, MS SENG, Estimated Graduation: August 2014
4. Yashfin Mahid, MS SENG, Estimated Graduation: May 2016
5. Changwon Son, MS SENG, Estimated Graduation: May 2016

Distance Learning

6. Aracely Acevedo, MS SENG, Estimated Graduation: December 2015
7. Sean Classen, MS SENG, Estimated Graduation: May 2017
8. Jeff Fox, MS SENG, Estimated Graduation: December 2017
9. Gary Houghton, MS SENG, Estimated Graduation: December 2018
10. Mohammad Kazmi, MS SENG, Estimated Graduation: May 2017
11. Ryan Morton, MS SENG, Estimated Graduation: December 2014
12. Moataz Nour, MS SENG, Estimated Graduation: December 2015
13. Courtney Pierce, MS SENG, Estimated Graduation May 2017
14. Anthony Radesky, MS SENG, Estimated Graduation: May 2017
15. Byron Schneidau, MS SENG, Estimated Graduation: December 2017
16. Colin Stuart, MS SENG, Estimated Graduation: December 2014
17. Ping Zhao, MS SENG, Estimated Graduation, May 2015

Graduated

1. Mohammed I. AlNashwan, August 2015. Thesis title: "Developing Process Safety Leading Indicators for Organizational Factors in Petrochemical Industries."
2. Bibian H. Amaya, August 2015. Thesis title: "Study of the Influence of the Main Input

Parameters on Toxic Consequence Calculation for a Formaldehyde Release."

3. Jehova Arena-Reyes, December 2015. Thesis title: "Human Factors in the Selection of New Technology for the Oil and Gas Industries."
4. Adewale Awoniyi, May 2014 MEN CHEN Non-thesis.
5. Salem S. Alghamdi, August 2011. Thesis title: "Development of a Vapor Cloud Explosion Risk Analysis Tool Using Exceedance Methodology."
6. Fahad Al-Qurashi, December 2000. Thesis title: "Development of a Relational Chemical Process Safety Database and Applications to Safety Improvements."
7. Sumit Anand, August 2005. Thesis title: "Novel Applications of Data Mining Methodologies to Incident Databases."
8. Sk. Ali Ashfaque, May 2008. Thesis title: "Engineering Sustainability Development and its Application In Fuel Cell Operated Stationary Power Plant Systems."
9. Shubharthi Barua, August 2012. Thesis title: "Dynamic Operational Risk Assessment With Bayesian Network."
10. Omar Basha*, August 2012. Thesis title: "Modeling of LNG Pool Spreading and Vaporization." (co-advised with L. Vechot).
11. Linh T.T. Dinh, May 2008. Thesis title: "Reactivity of Ethylene Oxide in Contact With Contaminants."
12. Marwa Hamdy El-Said*, December 2014. Thesis title: "A Holistic Approach to Safety Assessment in the Life Cycle of Bio-Diesel Industry." (co-advised with M.M. El-Halwagi).
13. Jayming S. Fang, August 2006. Thesis title: "Making the Business Case for Process Safety Using Value-at-Risk Concepts."
14. Rendra Haristyawan, MS CHEN-non-thesis option, August 2015.
15. Emrah Harputlu, December 2012. Thesis title: "A Human Performance Modeling System for Process Safety Operations."
16. Lady Carolina Herrera-Gomez, May 2011. Thesis title: "Experiments for the Measurement of LNG Mass Burning Rates."
17. Phillip R. Hodge, December 2011. Thesis title: "Determining Bounds for a Pressure Hazard Rating to Augment the NFPA 704 Standard."
18. Bilkis Islam, August 2015. Thesis title: "Risk Management Strategy for Road Transportation of LNG."
19. Howard G. Johnston*, December 2015. Thesis title: "Experimental Effects of Coal-Limestone Mixtures on Dust-Layer Dispersion Behind a Moving Shock Wave." (co-advised with E. Petersen).
20. Sara S. Khan, August 2010. Thesis title: "Active and Knowledge-Based Process Incident Retrieval System."
21. Jinsek Kim, August 2014. "Identifying and Managing the Health and Safety Hazards of Nanomaterials in Laboratories."
22. Kiran Krishna, May 2001. Thesis title: "Non-Intrusive Characterization of Heat Transfer Fluid Aerosol Formation."
23. Armando Lara, May 1999. Thesis title: "Reaction Mechanism of Cumene Hydroperoxide Decomposition in Cumene and Evaluation of its Reactivity Hazards."
24. Wendy Lim, December 2013. Non-thesis.
25. Yuan Lu, August 2008. Thesis title: "Dense Gas Dispersion Modeling for Aqueous Releases.
26. Mahdiyati, May 2011. Thesis title: "Analysis of the Hazardous Substances Emergency

Events Surveillance (HSEES) Database Using Data and Text Mining Methodologies."
27. Brandon Marks*, August 2013. Thesis title: " A New Facility for Studying Shock Wave Passage over Dust Layers." (co-advised with E. Petersen).
28. Eboni McCray, May 2000. Thesis title: "Chemical Accident Databases: What They Tell Us and How They Can be Improved to Establish National Chemical Safety Goals."
29. Adithyaram Narayan*, December 2015. Thesis title: "Theoretical and Experimental Characterization of Dicyclopentadiene Reactivity." (co-advised with Z. Cheng).
30. Divya Narayanan, May 2007. Thesis title: "Engineering for Sustainable Development for Bio-Diesel Production."
31. Jeremy Nelson, August 2014. "Methods to Improve Process Safety Performance Through Flange Connection Leak Prediction and Control."
32. Sally S. Nicola, August 2012. Thesis title: "Corrosion Detection and Prediction Studies."
33. A.S.M. Obidullah, December 2006. Thesis title: Use of Incident Databases for Cause and Consequence Analysis and National Estimates."
34. Young-gil Park, August 2015. Thesis title: "Risk Analysis Including Organizational Change Aspects in Process Industries."
35. Vijay Raghunathan, December 2004. Thesis title: "Consequence Analysis of Aqueous Ammonia Spills Using an Improved Liquid Pool Evaporation Model."
36. Roberto Ruiz-Vasquez, August 2012. Thesis title: "Study of the Effects of Obstacles in Liquefied Natural-Gas (LNG) Vapor Dispersion Using CFD Modeling."
37. Irfan Shaikh, December 1999. Thesis title: "Role of Viscosity in the Accurate Prediction of Source Terms for High Molecular Weight Substances."
38. Gaurav Sharma, August 2002. Thesis title: "A Decision Support System for Chemical Incident Information."
39. Anecia Shelton-Davis, December 2007. Thesis title: "Transportation Risk Assessment for Pipeline Transport of Ethanol,"
40. Travis Sikes*, December 2014. Thesis title: "Laminar Flame Speeds of Nano-Aluminum/Methane Hybrid Mixtures."
41. Christina Sposato, December 2000. Thesis title: "The Effects of Obstacle Geometry on Jet Mixing in Releases of Silane."
42. Jaffee A. Suardin, August 2005. Thesis title: "The Integration of Dow's Fire and Explosion Index into Process Design and Optimization to Achieve Inherently Safer Design."
43. Passaporn Sukmarg, August 2000. Thesis title: "Effects of Operating Conditions on a Heat Transfer Fluid Aerosol."
44. Derrick S. Thomas, May 2011. Thesis title: "Critical Analysis and Review of Flash Points of High Molecular Weight C, H, N, O Poly-Functional Compounds."
45. Karla Ruiz Vazquez, August 2008. Thesis title: "Effect of Availability on Multi-Period Planning of Oil and Gas Production Systems."
46. Lisa M. Veltman, August 2008. Thesis title: "Incident Data Analysis Using Data Mining Techniques."
47. Andrew Vissotski*, August 2012. Thesis title: "Development of an Experimental Facility for Flame Speed Measurements in Powdered Aerosols." (co-advised with E. Petersen).
48. Mengtian Wang, August 2012. Thesis title: "Normalization of Process Safety Metrics."
49. Mengxi Yu, December 2015. Thesis title: "Development of a Safety Management System for Drilling and Servicing Operations Within OSHA Jurisdiction Area for Texas."
50. Geun-Woong Yun, December 2007. Thesis title: "Bayesian-LOPA Methodology for Risk

Assessment of an LNG Importation Terminal."
51. Ming Zeng, December 2015. Thesis title: "Integration of Human Factors in Offshore Blowout Risk Assessment." (co-advised with C.V. Mashuga).
52. Chuanji Zhang, May 2006. Thesis title: "Thermal Decomposition Study of Hydroxylamine Nitrate During Storage and Handling."
53. Fuman Zhao, May 2008. Thesis title: "Experimental Measurements and Modeling Prediction of Flammability Limits of Binary Hydrocarbon Mixtures."
54. Gerald A. Zuniga, December 2008. Thesis title: "Layer of Protection Analysis Applied to Ammonia Refrigeration Systems."

PEER-REVIEWED JOURNAL PUBLICATIONS

*indicates coauthor is past or present student

1. Starling, K.E. and M. Mannan, "AGA Compressibility-Factor Correlation Describes Rich Pipeline-Quality Natural Gas", Oil & Gas Journal, November 16, 1987, pp. 49-52.

2. Mannan, M. and K. E. Starling, "Equation-of-State Vapor-Liquid Equilibrium Prediction Methodology for Systems Containing Undefined Fractions", FUEL v. 67, no. 6, pp. 815-821, 1988.

3. Mannan, M., J.L. Savidge and K.E. Starling, "Equation Predicts Supercompressibility for Wet, Sour Gases", Oil & Gas Journal, January 2, 1989, p. 31-39.

4. Mannan, M., M.A. Khan, L.L. Lee and K.E. Starling, "Mixture Equations of State: Composition Dependence", International Journal of Physics, vol. 11, no. 2, pp. 373-380, 1990.

5. Mannan, M., D.B. Pfenning and C.D. Zinn, "Risk Analysis Procedures Ensure System Safety", Oil & Gas Journal, June 3, 1991, p. 83-87, June 10, 1991, p. 34-35.

6. Mannan, M., D.B. Pfenning and H.H. West, "Gas Pipeline Failure: Causes and Mitigation," Pipeline Industry, vol. 75, no. 7, pp. 37-39, July 1992.

7. Mannan, M., "Boiler Incident Directly Attributable to PSM Issues," Process Safety Progress, vol. 15, no. 4, pp. 258-261, Winter 1996.

8. Mannan, M., and M. Dreux, "EPA's Risk Management Program: An Overview," Occupational Hazards, March 1997, pp. 65-77.

9. West, H.H., M.S. Mannan, R. Danna and E.M. Stafford, "Make Plants Safer with a Proper Management of Change Program," Chemical Engineering Progress, June 1998, pp. 25-36.

10. Mannan, M.S., "Perspectives on Risk Communication and Dialogue for the Process Industries," Global Chemical Processing & Engineering Industry, published by the World Market Research Centre, London, United Kingdom, February 1999, pp. 84-89.

11. Mannan, M.S., T.M. O'Connor, and H.H. West, "Accident History Database: An Opportunity," Environmental Progress, vol. 18, no.1, Spring 1999, pp. 1-6.

12. Iglesias-Silva, G.A., M.S. Mannan, F.Y. Shaikh, and K.R. Hall, "Excess Virial Coefficients with Application in Data Analysis," Journal of Fluid Phase Equilibria, vol. 161, 1999, pp. 33-43.

13. Mannan, M.S., A. Akgerman, R.G. Anthony, R. Darby, P.T. Eubank, and K.R. Hall, "New Challenges in Chemical Engineering: Integrating Process Safety into Chemical Engineering Education and Research," Chemical Engineering Education, vol. 33, no. 3, Summer 1999, pp. 198-209.

14. Rosenthal, I. and M.S. Mannan, "Chemical Process Safety: National Goal Setting," Chemical Engineering Progress, March 2000, pp. 55-62.

15. Mannan, M.S. and J.T. Baldwin, "Inherently Safer is Inherently Cleaner: A Comprehensive Design Approach," Chemical Process Safety Report, March 2000, Tab. 100, pp. 125-132.

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2. "Study of Phase Equilibria of Nitrogen with Reservoir Fluids", project final report prepared for and submitted to INTEVEP June 1984 (with S. Watanasiri, K.H. Kumar and K.E. Starling).

3. "Thermophysical Properties Correlations and Pseudocomponent Characterization Parameter Estimation for Fossil Fluids", project final report prepared for and submitted to the Department of Energy, Pittsburgh Energy Technology Center, August, 1986 (with K.E. Starling et al).

4. "Development of an Equation of State for Computation of Supercompressibility Factors, Critical Flow Factors, and Other Properties for Wet, Sour Natural Gases, Synthetic Gases and Admixtures, project final report prepared for and submitted to the Gas Research

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7. "Year 2000 Issues: Technology Problems and Industrial Chemical Safety," Report to the US Senate Special Committee on the Year 2000 Technology Problem, prepared under contract with the US Chemical Safety and Hazard Investigation Board, March 1999.

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9. "Challenges in Implementing Inherent Safety Principles in New and Existing Chemical Processes," White Paper, Mary Kay O'Connor Process Safety Center, College Station, Texas, August 2002.

10. "Challenges of Regulating or Implementing a Reactive Chemicals Hazard Management Program," Comments provided to the United States Chemical Safety and Hazard Investigation Board, Reactive Chemicals Public Hearing, Houston, Texas, September 17, 2002.

11. "Prevention and Suppression of Metal Packing Fires," Mary Kay O'Connor Process Safety Center, College Station, August 2003.

12. "LNG Pool Fire Modeling," White Paper, Mary Kay O'Connor Process Safety Center, College Station, Texas, September 2008.

13. Developing a Roadmap of the Future of National Hazardous Substances Incident Surveillance," Whitepaper, Mary Kay O'Connor Process Safety Center, May 2009.

14. "Process Safety Research Agenda for the 21st Century," Mary Kay O'Connor Process Safety Center, College Station, TX, June 2012.

TECHNICAL MEETING PRESENTATIONS

1. "Characterization Methods for Systems Containing Many Components for Use in Phase Equilibrium and Thermophysical Properties Calculations", presented at the American Institute of Chemical Engineers 1984 Winter National Meeting at Atlanta, Georgia, March 11-14, 1984 (with S. Watanasiri, K.H. Kumar, and K.E. Starling).

2. "Development of an Uncertainty Statement for Each Datapoint in the Calculated Database", presented at the API/GPA/NBS Orifice Metering Seminar at the National Bureau of Standards, Gaithersburg, Maryland, September 23, 1986 (with K.E. Starling).

3. "Evaluation of A.G.A. Report No. 8 for Rich Gas Compressibility Factor Calculations", proceedings of the Sixty-Sixth Annual GPA Convention, Denver, Colorado, March 16-18, 1987 (with K.E. Starling and J.L. Savidge).

4. "New Strides Toward More Accurate Volumetric Measurement", presented at the Institute of Gas Technology Symposium on Natural Gas Energy Measurement, Chicago, Illinois, June 27, 1988 (with K.E. Starling).

5. "Evaluation of a High Accuracy Equation-of-State for Gas Phase Mixture Compressibility Factors", presented at the Fourth Pacific Area Chemical Engineering Congress in Acapulco, Mexico, October 19-23, 1988 (with K.E. Starling).

6. "Improvement in Compressibility Factor Predictions for Orifice Meter Calculations", presented at the 1989 Gas Gathering and Processing Workshop sponsored by the University of Oklahoma Energy Center and the Gas Research Institute, Norman, Oklahoma, May 9-10, 1989.

7. "Fundamentals of Gas Measurement - IV", with K.E. Starling, presented at the 64th International School of Hydrocarbon Measurement, Norman, Oklahoma, May 16-18, 1989.

8. "Energy Analysis of Integrated Energy Systems: Natural Gas-Fired Combined Cycle Power Plant", presented at the 9th Miami International Congress on Energy and Environment, December 11-13, 1989, Miami Beach, Florida.

9. "Thermodynamic Properties for Natural Gas Flow Measurement", International Symposium on Fluid Flow Measurement, AGA, Arlington, VA, May 1990 (with K.E. Starling, M.A. Khan and J.L. Savidge).

10. "Safety Engineering for Sour Gas Pipelines", paper presented at the PETRO-SAFE 1991 Conference, Houston, Texas, February 6-8, 1991 (with D.B. Pfenning and C.D. Zinn).

11. "Overview of OSHA's Process Safety Management Rule and its Effect on the High Technology Industry," paper presented at the Semiconductor Safety Association Hill Country Conference, Austin, Texas, February 11-12, 1993.

12. "Impact of OSHA's Process Safety Management and Confined Space Regulations on Aboveground Storage Tank Facilities," paper presented at the 4th Annual Aboveground Tank Conference, Houston, Texas, June 8-9, 1993 (with V.J. Bily).

13. "Management of Change: Process Safety Management Practice," paper presented at the 1994 AIChE Spring National Meeting, Atlanta, GA, April 18-20, 1994 (with R. Danna and H. West).

14. “Synergistic Development of PHA's for Compliance With EPA's Risk Management Program and OSHA's PSM Rules,” paper presented at the 1994 TCC/ACIT Safety Seminar, Galveston, Texas, June 6-9, 1994.

15. "Impact of EPA's Proposed Risk Management Program Rule On the Ammonia/Fertilizer Industry," paper presented at the 1995 Gulf Coast Ammonia Producers Conference, Baton Rouge, Louisiana, April 10-12, 1995.

16. "Revalidation of PHA's," paper presented at the 1995 TCC/ACIT Safety Seminar, Galveston, Texas, June 5-8, 1995.

17. "EPA's Risk Management Program Regulation and It's Impact on Industry in the Midwestern United States," paper presented at the Environment 96 Conference sponsored by the Federation of Environmental Technologists, Milwaukee, Wisconsin, March 5-6, 1996.

18. "Process Risk Management," paper presented at the 1996 Environmental Audit Roundtable, Memphis, Tennessee, May 7, 1996.

19. "Impact of EPA's Risk Management Program Rule and OSHA's PSM Program Rule on Foundries," paper prepared for presentation at the 1997 American Foundrymen's Society Training Course, Des Plaines, Illinois, March 25-27, 1997 (with J. Radia).

20. "PSM, RMP, SEMP, and API RP 75," Keynote speaker, Occupational Safety Congress and Exhibition, Acadiana Safety Association, National Safety Council, Lafayette, Louisiana, October 1-2, 1997.

21. "Research Programs at the Mary Kay O'Connor Process Safety Center," presentation to the Chemical Manufacturers Association, Washington, DC, October 28, 1997.

22. "Collaborative Efforts Between the Mary Kay O'Connor Process Safety Center and the USEPA," presentation to the US Environmental Protection Agency, Washington, DC, January 6, 1998.

23. "Collaborative Efforts Between the Mary Kay O'Connor Process Safety Center and the Dow Chemical Company," presentation to the Dow Chemical Company, Freeport, TX, January 14, 1998.

24. "The Role of the Chemical Safety & Hazard Investigation Board," Keynote Speaker, PSM/RMP Open Forum, Albany, Georgia, January 15, 1998.

25. "New Challenges in Chemical Engineering: Integrating Process Safety into Chemical Engineering Education and Research," 1998 Annual Symposium of the Mary Kay O'Connor Process Safety Center, March 30-31, 1998, College Station, Texas.

26. "Accident History Database: An Opportunity," 1998 Annual Symposium of the Mary Kay O'Connor Process Safety Center, March 30-31, 1998, College Station, Texas.

27. "Data Required for Predicting Reactive Chemical Pathways," 1998 Annual Symposium of the Mary Kay O'Connor Process Safety Center, March 30-31, 1998, College Station, Texas.

28. "Stakeholders Must Work Together to Accomplish the Objectives of the Risk Management Program," The Fourteenth International Hazardous Materials Spills Conference, April 5-9, 1998, Chicago, Illinois.

29. "Risk Communication and the Role of the Chemical Safety & Hazard Investigation Board," Keynote Speaker, PSM/RMP Open Forum, Cleveland, Ohio, April 21, 1998.

30. "Risk Communication and Community Relations," paper presented at the 1998 TCC/ACIT Safety Seminar, The Woodlands, Texas, June 8-11, 1998.

31. "Basic Research Needs in Process Safety," paper presented at the 1998 Process Plant Safety Symposium, Sheraton Astrodome Hotel, Houston, October 26-27, 1998.

32. "Dense Gas Modeling for Aqueous Releases," paper presented at the 1998 Process Plant Safety Symposium, Sheraton Astrodome Hotel, Houston, October 26-27, 1998 (presented by A. Lara, graduate student).

33. "Source Term Modeling for High Pressure, High Temperature Releases of High Viscosity Fluids," paper presented at the 1998 Process Plant Safety Symposium, Sheraton Astrodome Hotel, Houston, October 26-27, 1998 (presented by I. Shaikh, graduate student).

34. "Experiences with Management of Change Systems," paper presented at the 1998 Process Plant Safety Symposium, Sheraton Astrodome Hotel, Houston, October 26-27, 1998.

35. "If you Model It, Will They Come?" paper presented at the 1998 Process Plant Safety Symposium, Sheraton Astrodome Hotel, Houston, October 26-27, 1998.

36. "The Use of Risk Management Plan Information by Local Emergency Response Organizations," paper presented at the OECD Workshop on *New Developments in Chemical Emergency Preparedness and Response*, Lappeenranta, Finland, November 3-6, 1998.

37. “Pollution Prevention in Design,” paper presented at the Second Pollution Prevention Conference, American Institute of Chemical Engineers, March 18-19, 1999, Houston, Texas.

38. "The Y2K Problem and Its Impact on the Trucking Industry," paper presented at the Annual Meeting of the Texas Tank Truck Carriers Association, Sheraton Astrodome Hotel, Houston, Texas, April 29, 1999.

39. "Federal Guidelines and Safety Education," Keynote Address at the 1999 SACHE FACULTY WORKSHOP ON PROCESS SAFETY, May 18, 1999, Freeport, Texas.

41. "Process Safety Engineering Tools for Design Engineers," paper presented at the 1999 Kellogg Brown and Root HSE Conference, Hyatt Regency Hotel, Houston, Texas, September 8, 1999.

42. "Y2K, Chemical Safety, and Emergency Planning," paper presented at the OES Contingency Planning Conference, Sacramento, CA, September 9, 1999.

43. "National Chemical Safety Goals For a New Millenium," paper presented at the PPP2000 Conference - *When Natural and Industrial Disasters Collide*, Washington, DC – October 13, 1999.

44. "Impact of Chemical Safety Advances on the Process Control and Instrumentation Industry," Keynote Address at the 1999 Triconex Users Group Meeting, November 2, 1999, Galveston, Texas.

46. "Quantitative Risk Assessment Study of a Liquefied Oxygen Reactor Feed System," paper presented at the 2000 AIChE Spring National Meeting, Atlanta, GA, March 5-9, 2000.

47. "Chemical Safety Trend Analyses," paper presented at the 2001 AIChE Spring National Meeting, Houston, TX, April 23-25, 2001.

48. "LNG Safety Practice & Regulations: From the 1944 East Ohio Tragedy to Today's Excellent Safety Record," paper presented at the 2001 AIChE Spring National Meeting, Houston, TX, April 23-25, 2001.

49. "SEGURIDAD INTRÍNSECA: un enfoque opuesto a la seguridad tradicional," paper presented at the 2001 IMIQ National Convention, October 3-5, 2001, Puebla, Mexico (presented by M. Gentile, graduate student).

50. "Development of an Inherent Safety Index Based on Fuzzy Logic," paper presented at the 2001 AIChE Annual Meeting, November 5-9, 2001, Reno, Nevada (presented by M. Gentile, graduate student).

51. "Thermal Decomposition Studies of Hydoxylamine Compounds," paper presented at the 2001 AIChE Annual Meeting, November 5-9, 2001, Reno, Nevada (presented by L.O. Cisneros, graduate student).

52. "Density Functional Investigation of Hydroxylamine Decomposition," paper presented at the 2001 AIChE Annual Meeting, November 5-9, 2001, Reno, Nevada (presented by S. Saraf, graduate student).

53. "Computational Chemistry and Molecular Simulation for Engineers: A Cooperative

Effort across College Boundaries," paper presented at the 2001 AIChE Annual Meeting, November 5-9, 2001, Reno, Nevada (presented by D.M. Ford).

54. "Understanding the Role of Process Chemistry in Fires and Explosions," paper presented at the 36th Annual Loss Prevention Symposium, AIChE Meeting, March 10-14, 2002, New Orleans, Louisiana (presented by A.A. Aldeeb, graduate student).

55. "Calorimetric Studies of Hydroxylamine and Related Compounds," paper presented at the 1st International Congress on the Process Industries, AchemAmerica 2002, March 18-20, 2002, Mexico City, Mexico (presented by L.O. Cisneros, graduate student).

56. "Calorimetric Data Correlations Using Molecular Descriptors," paper presented at the 2002 AIChE Annual Meeting, November 4-8, 2002, Indianapolis, Indiana (presented by S.R. Saraf, graduate student).

57. "Analyzing Reaction Pathways for Evaluation of Reactive Hazards," paper presented at the 2002 AIChE Annual Meeting, November 4-8, 2002, Indianapolis, Indiana (presented by A.A. Aldeeb, graduate student).

58. "Learning from RMP Accident History," paper presented at the Risk Center Roundtable, Wharton Risk Management & Decision Processes Center, University of Pennsylvania, March 4, 2003, Philadelphia, Pennsylvania.

59. "Lessons Learned from a Catastrophic Control Valve Failure," paper presented at the ISA Safety Division Symposium, March 20, 2003, Houston, Texas.

60. "Refrigerant System Control Valve Failure," paper presented at the AIChE Spring National Meeting, 3rd Topical Conference on Natural Gas Utilization, April 2, 2003, New Orleans, Louisiana.

61. "Chemical Incident Data Mining and Application to Chemical Safety Analysis," paper presented at the Centers for Disease Control, Hazardous Substances Emergency Events Surveillance Meeting, May 8, 2003, Atlanta, Georgia.

62. "Challenges of Regulating or Implementing a Reactive Chemicals Hazard Management Program," paper presented at the 2003 American Industrial Hygiene Conference & Exposition, May 10-15, 2003, Dallas Convention Center, Dallas, TX.

63. "Research on Reactive Chemical Hazards at the Mary Kay O'Connor Process Safety Center," paper presented at the Texas Chemical Council 2003 Safety Seminar, June 2-5, 2003, Galveston, Texas.

64. "Options with Regard to Reactive Chemical Hazard Management Systems," paper presented at the *Reactive Chemical Hazard Management Roundtable* sponsored by the U.S. Chemical Safety and Hazard Investigation Board, June 10, 2003, Washington, DC.

65. "MOC's Impact on Engineering Information Management," paper presented at the *Engineering Information Management Conference*, June 27, 2003, Houston, Texas.

66. "Predicting Properties of Energetic Materials via Molecular Modeling," paper presented at the AIChE 2003 Annual Meeting, November 16-21, 2003, San Francisco, California (presented by S.R. Saraf, graduate student).

67. "Dynamic Process Monitoring Based On Classification Tree and Discriminant Analysis," paper presented at the AIChE 2003 Annual Meeting, November 16-21, 2003, San Francisco, California (presented by Y. Zhou, graduate student).

68. "Thermal Stability of Inhibited 1,3-Butadiene in the Presence and Absence of Oxygen," paper presented at the AIChE 2003 Annual Meeting, November 16-21, 2003, San Francisco, California (presented by A.A. Aldeeb, graduate student).

69. "Adiabatic Calorimetric Analysis of Runaway Polymerization Reactions," paper presented at the AIChE 2003 Annual Meeting, November 16-21, 2003, San Francisco, California (presented by A.A. Aldeeb, graduate student).

70. "Process Safety Challenges for the Chlorine Industry," Keynote Presentation at the Chlorine Institute's 80th Annual Meeting, March 9, 2004, Houston, Texas.

71. "The Unique Role of the University-Based Centers in Meeting Process Safety Challenges," paper presented at the Texas Chemical Council, March 26, 2004, Houston, Texas.

72. "Designing and Auditing Management Systems for Safety, Health and Environmental Risks Related to Chemical Processing," paper presented at the Risk Center Roundtable, Wharton Risk Management & Decision Processes Center, University of Pennsylvania, April 22, 2004, Philadelphia, Pennsylvania.

73. "Implementation Issues With Regard to Reactive Chemicals," paper presented at Rohm and Haas Training Center, April 23, 2004, Bristol, Pennsylvania.

74. "A Systematic Approach to Reactive Chemicals Analysis," paper presented at the 3rd Annual NaTex Meeting, *Frontiers in Materials Research: Applications of Thermal Analysis and Rheology*, April 29-30, 2004, Dallas, Texas.

75. "PSM Programs in the United States: Present Status and Future Directions – A Moving Target," paper presented at the *International Seminar on Preventive Safety Management in Gas Industry*, June 24, 2004, Seoul, South Korea.

76. "Application of Accidental Release Information for the Development of Prevention, Mitigation, and Response Measures for Counterterrorism," paper presented at the 2nd Toxic Industrial Chemical (TIC) and Toxic Industrial Material (TIM) Symposium, Virginia Commonwealth University, July 20-22, 2004, Richmond, Virginia.

77. "Use of Incident Data Collection from Various Sources For Industrial Safety Performance Assessments," paper presented at the OECD Workshop on *Lessons Learned from Chemical Accidents and Incidents*, Karlskoga, Sweden, September 21-23, 2004.

78. "Hydroxylamine decomposition pathways in the presence of acid or base," paper presented at the AIChE 2004 Annual Meeting, November 7-12, 2004, Austin, Texas (presented by C. Wei, graduate student).

79. "Computational Tools to Predict Heats of Reaction and Activation Energy for Reactivity Hazards Evaluation," paper presented at the AIChE 2004 Annual Meeting, November 7-12, 2004, Austin, Texas (presented by M. Vidal, graduate student).

80. "Flash point of mixtures: Can computational chemistry help you decide?" paper presented at the AIChE 2004 Annual Meeting, November 7-12, 2004, Austin, Texas (presented by M. Vidal, graduate student).

81. "Routing Methodology Design for Hazardous Materials Transportation: Evaluating Uncertainty by Fuzzy Logic," paper presented at the AIChE 2004 Annual Meeting, November 7-12, 2004, Austin, Texas (presented by Y. Qiao, graduate student).

82. "Experimental and Computational Methods for Process Safety Research," paper presented at the 11th National Engineering Congress, Maracaibo, Venezuela, November 8-12, 2004.

83. "Sustainability: Lip Service to Measurable Advances," paper presented at *Science and Engineering for Sustainable Development: 2005 Annual Sigma Xi Symposium*, Texas A&M University, College Station, Texas, March 31, 2005.

84. "Equipment Reliability and the Overall Safety of Process Plants," paper presented at the 2005 Meridium Conference, Houston, Texas, April 12, 2005.

85. "LNG Fire Fighting at Texas A&M: Training and Research," paper presented at the AIChE Spring National Meeting, Topical Conference on Natural Gas Utilization, Atlanta, Georgia, April 2005.

86. "Experience with FEM3A," paper presented at the AIChE 2006 Spring National Meeting, April 23-27, 2006, Orlando, Florida (presented by B. Cormier, graduate student).

87. "Learnings With Regard to Safety Culture from the Columbia Disaster," Invited Lecture, May 11, 2006, Technical University of Lódz, Poland.

88. "Engineering Ethics," Invited Seminar at BP, May 30, 2006, BP Corporate Office, Houston, Texas.

89. 'Fundamentals of Safety and Loss Prevention," Invited Seminar at Eastman Chemical, May

30–June 1, 2006, Batesville, Arkansas.

90. "Improving Safety and Small- and Mid-Sized Facilities," Invited Seminar at Texas Chemical Council EHS Conference, June 8, 2006, Galveston, Texas.

91. "Safety Challenges for Alternative Energy Sources," Invited presentation at the National Research Laboratory, Seoul, South Korea, June 22, 2006.

92. "Incident Investigation," Invited presentation at the 8th Annual Gas Safety Promotion and Rally, Korea Gas Safety Corporation, Seoul, South Korea, June 23, 2006.

93. "Safety and Engineering for Refinery Upgrade," Invited presentation at BP America, Inc., Houston, Texas, July 26, 2006.

94. "Hazards and Risks for Ethylene Production Processes," Invited presentation at Aker Kvaerner, Houston, Texas, July 27, 2006.

95. "Data Leads the Way," CDC NCEH/ATSDR 7th National Environmental Health Conference, Hilton Atlanta Hotel, Atlanta, Georgia, December 4-6, 2006.

96. "Reactive Chemicals and Process Plant Incidents," Invited presentation at the East China University of Science and Technology, Shanghai, China, December 15, 2006.

97. "Lessons Learned From Recent Incidents," Invited presentation at Zhejiang University, Zhejiang, China, December 18, 2006.

98. "Polymerization and Chemical Process Safety," Invited presentation at Tsinghua University, Beijing, China, December 20, 2006.

99. "Challenges for the Process Industry," Invited presentation at the Beijing University of Chemical Technology, Beijing, China, December 21, 2006.

100. "Learning From the Past: Three Incidents Provide a Wealth of Learnings," Invited presentation at the ExxonMobil Annual Engineering Conference, Marriott Intercontinental Hotel, Houston, Texas, January 23, 2007.

101. "The Use of Indicators and Metrics for Measuring Abnormal Situations and Improving Safety Performance," Invited presentation at the Abnormal Situation Management Consortium Quarterly Meeting, Atlanta, Georgia, January 24-25, 2007.

102. "Emergency Planning and Response to Process Plant Incidents," Invited presentation at the Local Emergency Planning Committee Meeting, College Station, Texas, February 15, 2007.

103. "Fire and Explosion Assessment on Oil and Gas Floating Production Storage Offloading (FPSO) : an Effective Screening and Comparison Tool," paper presented at

the AIChE 2007 Spring Meeting, April 22-26, 2007, Houston, Texas (presented by J.A. Suardin, graduate student).

104. "Use of Adiabatic Calorimetry and Aging Test for Safe Storage Study of Hydroxylamine Nitrate," paper presented at the AIChE 2007 Spring Meeting, April 22-26, 2007, Houston, Texas (presented by L. Liu, graduate student).

105. "Resilient Engineered Systems: the Development and Demonstration of an Inherent System Property," paper presented at the AIChE 2007 Spring Meeting, April 22-26, 2007, Houston, Texas (presented by S.M. Mitchell, graduate student).

106. "Development of a Miniature Calorimeter for Identification and Detection of Explosives and Other Energetic Compounds," paper presented at the AIChE 2007 Spring Meeting, April 22-26, 2007, Houston, Texas (presented by Y.-S. Liu, Assistant Professor, University of Louisiana at Lafayette).

107. "Optimum Route Selection for Hazardous Materials Transportation Incorporating Security and Cost-Effectiveness Considerations," paper presented at the AIChE 2007 Spring Meeting, April 22-26, 2007, Houston, Texas (presented by Y. Qiao, DNV Inc.).

108. "High Expansion Foam Application for Controlling LNG Pool Fire -- Experiment Results and Analysis," paper presented at the AIChE 2007 Spring Meeting, April 22-26, 2007, Houston, Texas (presented by J.A. Suardin, graduate student).

109. "Bulk Temperature Profile of LNG Spill on Unconfined Water – Experiment Results and Analysis," paper presented at the AIChE 2007 Spring Meeting, April 22-26, 2007, Houston, Texas (presented by B. Cormier, graduate student).

110. "Bulk Temperature Profile of LNG Spill on Unconfined Water – Experiment Results and Analysis," paper presented at the AIChE 2007 Spring Meeting, April 22-26, 2007, Houston, Texas (presented by B. Cormier, graduate student).

111. "Chemical Safety – Update and Challenges," Keynote Speech at National Petrochemical and Refiners Association National Safety Conference, May 2, 2007, The Woodlands, Texas.

112. "Are We Safer Today," Keynote Speech at the 2007 Coking Safety Seminar, May 8, 2007, League City, Texas.

113. "Chemical Safety – The Aftermath of BP Texas City Incident," Keynote Speech at the 2007 Global Refining Strategies Summit, September 10-11, 2007, Houston, Texas.

114. "Bio-Diesel Safety Issues," Conference on Process Safety Challenges in the Biorenewables Era, Iowa State University, Ames, Iowa, March 13, 2008

115. "Globalization and its Challenges in Industrial Process Safety," Wendell Miller

Distinguished Lecture, Iowa State University, Ames, Iowa, March 14, 2008

116. "A Framework for Creating a Best-in-Class Safety Culture," 2008 Oil and Gas Software Users Group Meeting, March 26, 2008, Houston, Texas.

117. "The Risk Assessment of Bayesian-LOPA Methodology for an LNG Importation Terminal," paper presented at the 2008 AIChE Spring National Meeting, 8th Topical Conference on Natural Gas Utilization, New Orleans, Louisiana, April 6-10, 2008. (presented by G. Yun, graduate student).

118. "Comparison of LNG Computational Fluid Dynamics Consequence Modeling with Brayton Field Fire School Test Data – Preliminary Assessment," paper presented at the 2008 AIChE Spring National Meeting, 8th Topical Conference on Natural Gas Utilization, New Orleans, Louisiana, April 6-10, 2008 (presented by B.R. Cormier, graduate student).

119. "Detection and Measurement of Fugitive Methane Gas Emission Using Infrared Imaging Camera," paper presented at the 2008 AIChE Spring National Meeting, 8th Topical Conference on Natural Gas Utilization, New Orleans, Louisiana, April 6-10, 2008 (presented by A. Safitri, graduate student).

120. "Expansion Foam 3-D Temperature Profile during Application on LNG Experimental Results," paper presented at the 2008 AIChE Spring National Meeting, 8th Topical Conference on Natural Gas Utilization, New Orleans, Louisiana, April 6-10, 2008 (presented by J.A. Suardin, graduate student).

121. "Alternative Fuels and Engineering for Sustainable Development," paper presented at the 2008 AIChE Spring National Meeting, New Orleans, Louisiana, April 6-10, 2008 (presented by Y. Guo, research scientist).

122. "Effect of Availability on Multi-Period Planning of Oil and Gas Production Systems," paper presented at the 2008 AIChE Spring National Meeting, New Orleans, Louisiana, April 6-10, 2008 (presented by K.R. Vazquez, graduate student).

123. "A Novel Approach for Predicting and Quantifying Tangible and Intangible Risks for Catastrophic Incidences in the Chemical Process Industry," paper presented at the 2008 AIChE Spring National Meeting, New Orleans, Louisiana, April 6-10, 2008 (presented by K. Prem, graduate student).

124. Markowski, A.S. and M.S. Mannan, "*f*Risk Assessment in Chemical Industry," 18th International Congress of Chemical and Process Engineering, August 24-28, 2008, Prague, Czech Republic.

125. Medina, A.F., M.S. Mannan, H.H. West, W.J. Rogers, R.J. Solano and C. Aiello, "Initiation and Mechanism of Carbon Filter Fires," 18th International Congress of Chemical and Process Engineering, August 24-28, 2008, Prague, Czech Republic.

126. Mannan, M.S., S.A. Ashfaque and Y. Guo, "Engineering for Sustainable Development and its Application to Fuel Cell Systems," 18th International Congress of Chemical and Process Engineering, August 24-28, 2008, Prague, Czech Republic.

127. Mannan, M.S., "A Technical Analysis of the Buncefield Explosion and Fire," Invited Keynote Presentation, International Process Safety Symposium, Technical University of Lodz, Poland, December 12, 2008.

128. Mannan, M.S., "Sustainability in Chemical Engineering," Invited Keynote Speech, 2009 Auditing Roundtable National Meeting, April 21-23, 2009, San Antonio, Texas.

129. Mannan, M.S., "Recent Advances in LNG Field Experiments and Modeling of LNG Release and Mitigation Scenarios," Invited Keynote Speech, 9th Topical Conference on Natural Gas Utilization, AIChE Spring 2009 National Meeting, April 29, 2009, Tampa, Florida.

130. Rana, M.A. and M. S. Mannan, "Water Curtain Application for Forced Dispersion of LNG Vapor," 9th Topical Conference on Natural Gas Utilization, 2009 AIChE Spring National Meeting, Tampa, Florida, April 26-30, 2009 (presented by M. Rana, graduate student).

131. Yun, G., Y. Guo and M. S. Mannan, "Study on the Heat Transfer of Expansion Foam on LNG Pool," 9th Topical Conference on Natural Gas Utilization, 2009 AIChE Spring National Meeting, Tampa, Florida, April 26-30, 2009 (presented by G. Yun, graduate student).

132. Qi, R., D. Ng, W.J. Rogers and M. S. Mannan, "LNG Vapor Dispersion Modeling with ANSYS CFX," 9th Topical Conference on Natural Gas Utilization, 2009 AIChE Spring National Meeting, Tampa, Florida, April 26-30, 2009.

133. Wang, Q., D. Ng and M.S. Mannan, "Will a Molecular Simulation Approach Help You Predict Thermodynamic Properties?" 2009 AIChE Spring National Meeting, Tampa, Florida, April 26-30, 2009.

134. Mannan, M.S., "Making the Right Decision: What We Learn From our History," 38th Annual Iowa Governor's Safety and Health Conference, Cedar Rapids Marriott, Cedar Rapids, Iowa, November 4-5, 2009.

135. Mannan, M.S., "Lessons Learned from Past Incidents Shed Light on Present Day Needs and Challenges in Process Safety," Distinguished Lecture Series, Texas A&M University at Qatar, Doha, Qatar, January 26, 2010.

136. Mannan, M.S., "Development of the Effective Metrics for Measuring Improvements in Safety Performance," Plenary Keynote Lecture, The 3rd Doha

Engineering and Technology Forum at Texas A&M University at Qatar and the 1st Texas A&M at Qatar Safety Symposium, Doha, Qatar, March 15-16, 2010.

137. Yun, G., D. Ng and M. S. Mannan, "A medium-scale field test on expansion foam application – key findings of LNG pool fire suppression on land," 10th Topical Conference on Natural Gas Utilization, 2010 AIChE Spring National Meeting, San Antonio, Texas, March 21-25, 2010 (presented by G. Yun, graduate student).

138. Qi, R., D. Ng, S.P. Waldram and M. S. Mannan, "Uncertainties in Modeling LNG Vapor Dispersion with CFD Codes," Professor Cedomir M. Sliepcevich Memorial Session, 10th Topical Conference on Natural Gas Utilization, 2010 AIChE Spring National Meeting, San Antonio, Texas, March 21-25, 2010 (presented by R. Qi, graduate student).

139. Patel, S., D. Ng and M. S. Mannan, "Integrating Safety Issues in Solvent Selection and Process Design," 2010 AIChE Spring National Meeting, San Antonio, Texas, March 21-25, 2010 (presented by S. Patel, graduate student).

140. Jung, S., D. Ng, C. Laird and M. S. Mannan, "A New Approach to Optimizing Facility Layout by Mapping Risk On Grids," 2010 AIChE Spring National Meeting, San Antonio, Texas, March 21-25, 2010 (presented by S. Jung, graduate student).

141. Wang, Q., B.F. Bennighof, J.A. Suardin, N.R. Popat, J. McPhate and M. S. Mannan, "RIV and SSIV Installations On Deepwater Platforms: A Decision Making Screening Tool," 2010 AIChE Spring National Meeting, San Antonio, Texas, March 21-25, 2010 (presented by Q. Wang, graduate student).

142. Yang, X., C.D. Laird and M. S. Mannan, "Pareto Optimization On Component Inspection Interval for Level Control in An Oil/ Gas Separation System," 2010 AIChE Spring National Meeting, San Antonio, Texas, March 21-25, 2010 (presented by X. Yang, graduate student).

143. Mannan, M.S., "How Can Academia and the Safety Industry Support Each Other," American Society of Safety Engineers Annual Conference, Baltimore, Maryland, June 13-16, 2010.

144. Mannan, M.S., "Globalization and its Challenges in Industrial Process Safety," Invited Keynote Speech, The 3rd World Conference on Safety of Oil and Gas Industry, WCOGI 2010, September 27-28, 2010, Beijing, China.

145. Mannan, M.S., "Adapting Downstream Guidelines and Methodologies to Upstream Facilities," Invited Keynote Speech, 2010 Siemens Users Forum, October 14, 2010, Houston, Texas.

146. Mannan, M.S., "Consequence Analysis & Inherently Safer Design," Invited two-day presentation, The Society of Loss prevention in the Process Industries, December 6-7,

2010, Singapore.

147. Mannan, M.S., "The Relationship of Safety and Risk Management to Engineering for Sustainable Development," Invited Keynote Speech, Bangladesh University of Engineering and Technology (BUET), December 9, 2010, Dhaka, Bangladesh.

148. Mannan, M.S. and H.J. Pasman, "Fundamentals of Process Safety and Risk Management," Invited two-day presentation, Bangladesh University of Engineering and Technology (BUET), December 9-10, 2010, Dhaka, Bangladesh.

149. Mannan, M.S., and H. Pasman, "Layer of Protection Analysis," Invited two-day presentation, Cholamandalam MS Risk Services, December 14-15, 2010, Chennai, India.

150. Mannan, M.S., "Global Concerns About Energy Security and Safety" Invited two-day presentation, Rajiv Gandhi Institute of Petroleum Technology, December 16-17, 2010, Mumbai, India.

151. Pineda-Solano, A., L. Saenz-Noval, M. Papadaki, V.H. Carreto-Vazquez, S.P. Waldram, S. Nayak, J. Gao, W.J. Rogers, and M.S. Mannan, "Inherently Safer Reactor Design for Complex Reactions Based on Calorimetry Studies," 7th Global Congress on Process Safety, Loss Prevention Symposium, 2011 AIChE Spring National Meeting, Chicago, Illinois, March 13-16, 2011 (presented by A. Pineda-Solano, graduate student).

152. Gao, X., and M.S. Mannan, "Sustainability and Safety Study for Biodiesel Production," 2011 AIChE Spring National Meeting, Chicago, Illinois, March 13-16, 2011.

153. Mannan, M.S., "Opportunities in the Horizon: Process Safety Research at the Mary Kay O'Connor Process Safety Center," Invited Lecture, Ljubljana University, Ljubljana, Slovenia, March 30, 2011.

154. Mannan, M.S., "Advantages and Pitfalls of Mechanical Integrity and Management of Change Programs," Keynote speech at the 2011 Meridium Conference, Roanoke, West Virginia, May 4, 2011.

155. Mannan, M.S., "Society's Choices Have Consequences," Keynote speech at the 2011 Energy Summit, Houston Club, Houston, Texas, May 12, 2011.

156. Mannan, M.S., "The Relationship of Safety and Risk Management to Engineering for Sustainable Development," Keynote speech at the 2011 EHS&S and Sustainability National Conference Hosted by ChemStewards®, Society of Chemical Manufacturers & Affiliates, Houston, Texas, May 18, 2011.

157. Mannan, M.S., "Risk Discussions with the General Public," Keynote speech, 2011 Society of Chemical Manufacturers & Affiliates, Safety and Security Subcommittee, Baltimore, Maryland, July 5, 2011.

158. Mannan, M.S., "The Need for Constructive and Rational Dialogue on Risk," 2011 AIChE Regional Process Technology Conference, Moody Gardens Hotel, Galveston, Texas, October 6-7, 2011.

159. Mannan, M.S., "The Relevance of Consequence and Risk in Chemical Plant Operations," Chemical Engineering Seminar Series, Oklahoma State University, Stillwater, Oklahoma, November 3, 2011.

160. Mannan, M.S., "Process Safety for Building a Sustainable Energy Future: Case Study of LNG," Boots and Coots Distinguished Seminar Series, Conoco-Phillips Alumni Center, Oklahoma State University, Stillwater, Oklahoma, November 3, 2011.

161. Mannan, M.S., "Process Safety Competency Development," Invited Lecture, Reliance Industries, Mumbai, India, December 22, 2011.

162. Mannan, M.S., "Risk Perception and Societal Choices," Plenary Lecture, 3rd International Conference on Chemical Engineering, Bangladesh University of Engineering and Technology, Dhaka, Bangladesh, December 29-30, 2011.

163. Mannan, M.S., "The Need for a National Hazardous Substances Incident Surveillance System – Public Health and Chemical Accident Prevention," NCEH/ATSDR Director's Science Seminar, Atlanta, Georgia, February 1, 2012.

164. Mannan, M.S, "Increasing Public Trust by Increasing Safety," Invited Lecture, Chiba Institute of Science, Tokyo, Japan, February 15, 2012.

165. Mannan, M.S, "Risk Management for the 21st Century," Invited Lecture, Japan Chemical Industry Association/Japan Petrochemical Industry Association, Tokyo, Japan, February 16, 2012.

166. Mannan, M.S., "Society's Choices and Relationship to Risk," Invited Lecture, Nanjing University of Technology, Nanjing, China, March 5, 2012.

167. Mannan, M.S., "Normalization of Deviation and the Columbia Disaster," Invited Lecture, Nanjing University of Technology, Nanjing, China, March 6, 2012.

168. Mannan, M.S., "The Role of Education and Research in Developing Future Leaders Committed to Safety," Keynote Lecture, Qatar Process Safety Symposium, Texas A&M University at Qatar, Doha, Qatar, March 13-14, 2012.

169. Mannan, M.S., "Speaking of Engineering … Have you ever wondered … about safety measures in process engineering?" Invited Lecture, Bruneau Centre for Research and Innovation, Memorial University, St John's Campus, Canada, March 26, 2012.

170. Optimal Layout of Gas Detector Networks: A Comparison Study," paper presented at the AIChE 2012 Spring Meeting, April 1-4, 2012, Houston, Texas (presented by Alberto Benavides-Serrano, graduate student).

171. "Phase Behavior of Poly-Substituted Mono-Nitrated Aromatic Compounds," paper presented at the AIChE 2012 Spring Meeting, April 1-4, 2012, Houston, Texas (presented by William Pittman, graduate student).

172. "Theoretical Study of Expansion Foam Application on LNG Pool Using Computational Fluid Dynamics," paper presented at the AIChE 2012 Spring Meeting, April 1-4, 2012, Houston, Texas (presented by Bin Zhang, graduate student).

173. "Normalization of Process Safety Metrics," paper presented at the AIChE 2012 Spring Meeting, April 1-4, 2012, Houston, Texas (presented by Mengtian Wang, graduate student).

174. Liu, Y., X. Gao, D. Li, M.S. Mannan, "A Novel Resilient Process Design of Propylene Hydrogenation Purification by Catalytic Distillation," paper presented at the AIChE 2012 Spring Meeting, April 1-4, 2012, Houston, Texas (presented by Yi Liu, postdoctoral research associate).

175. "Effect of LNG Chemical Composition on Consequence Assessment," paper presented at the AIChE 2012 Spring Meeting, April 1-4, 2012, Houston, Texas (presented by Xiaodan Gao, postdoctoral research associate).

176. "Source Term Modeling of Vapor Cloud Formation During a Cryogenic Liquid Spill Based on a Boiling Model by CFD Method," paper presented at the AIChE 2012 Spring Meeting, April 1-4, 2012, Houston, Texas (presented by Yi Liu, postdoctoral research associate).

177. Mannan, M.S., "Developing Effective Safety Programs for Academia and Industry," Chemical Engineering Seminar Series, Texas Tech University, April 20, 2012.

178. Mannan, M.S., "Columbia Space Shuttle Disaster and Lesson Learned," Invited Lecture, RasGas Corporation, Doha, Qatar, April 30, 2012.

179. Mannan, M.S., "Dashboard Data for Managers for Monitoring and Measuring Process Safety Performance," Invited Lecture, RasGas Corporation, Doha, Qatar, April 30, 2012.

180. Mannan, M.S., "Aftermath of the Macondo Disaster and Regulatory Response in the United States," Invited Lecture, RasGas Corporation, Ras Laffan, Qatar, May 1, 2012.

181. Mannan, M.S., "Implementation Issues With Regard to Process Safety Management Programs," Invited Lecture, RasGas Corporation, Ras Laffan, Qatar, May 1, 2012.

182. Mannan, M.S., "Process Safety Research Agenda for the 21st Century," Keynote Lecture, 4th World Congress on Safety of Oil and Gas Industry, WCOGI2012, Seoul, Korea, June 27-30, 2012.

183. Mannan, M.S., "Engineers-in-Partnership for Technology Transfer to Developing Countries," Keynote Speech, BUET Engineers Night, Houston, Texas, August 11, 2012.

184. Mannan, M.S., "What Role does the Academic Community have in Chemical Security?" Chemical Security Sector Summit, Department of Homeland Security, Baltimore, MD, July 31 - August 2, 2012.

185. Mannan, M.S., "The Pros and Cons of Performance-Based Regulatory Models" Expert Forum on the Use of Performance-Based Regulatory Models in the U.S. Oil and Gas Industry, Offshore and Onshore, College of the Mainland in Texas City, September 20-21, 2012.

186. Harding, B., T. Rocha-Valadez, X. Gao and M. Sam Mannan, "Application of Inherently Safer Technology Rules in New Jersey and Contra Costa," AIChE Regional Conference, Southshore Convention Center, League City, Texas, October 4-5, 2012.

187. Mannan, M.S., "Framework for Creating the Best-in-Class Safety Culture," Keynote Speech, International Conference on Safety-ICS 2012 - Promoting a Culture of Safety, IIT, Gandhinagar, India, October 12-13, 2012.

188. Mannan, M.S., "Lessons From Process Chemical Incidents and Accidents," International Meeting on Chemical Safety and Security, Organisation for the Prohibition of Chemical Weapons, Tarnów, Poland, November 8-9, 2012.

189. Mannan, M.S., "Gasket Safety, For Want of a Nail a Kingdom was Lost," National Sealants Meeting, San Antonio, Texas, March 18-21, 2013.

190. "Forced Dispersion Analysis of LNG Vapor Mitigation Using Fire Dynamic Simulator," paper presented at the AIChE 2013 Spring Meeting, April 28-May 2, 2013, San Antonio, Texas (presented by W.Y. Molina-Torres, undergraduate research intern).

191. "Summary of Expert Forum On the Use of Performance-Based Regulatory Models in the U.S. Oil and Gas Industry, Offshore and Onshore," paper presented at the AIChE 2013 Spring Meeting, April 28-May 2, 2013, San Antonio, Texas (presented by X. Gao, Research Scientist).

192. "Key Findings of Experimental and Theoretical Studies On Forced Mitigation System for an LNG Spill Emergency," paper presented at the AIChE 2013 Spring Meeting, April 28-May 2, 2013, San Antonio, Texas (presented by B. Kim, Graduate Research Assistant).

193. "Can Fire Suppressants Inhibit Ignition? A Study Of HFC-125 and HFC-227,"

paper presented at the AIChE 2013 Spring Meeting, April 28-May 2, 2013, San Antonio, Texas (presented by C. Osorio, Graduate Research Assistant).

194. "Sustained Casing Pressure Modeling and Well Integrity," paper presented at the AIChE 2013 Spring Meeting, April 28-May 2, 2013, San Antonio, Texas (presented by T. Rocho-Valadez, Graduate Research Assistant).

195. "Scale up of Stirred Batch and Semi-Batch Reactors - Gaps and Limitations of the Current Methodologies," paper presented at the AIChE 2013 Spring Meeting, April 28-May 2, 2013, San Antonio, Texas (presented by O. Reyes, Graduate Research Assistant).

196. "Explosion Characteristics of Carbon Nano-Fibers," paper presented at the AIChE 2013 Spring Meeting, April 28-May 2, 2013, San Antonio, Texas (presented by J. Zhang, Graduate Research Assistant).

197. "The Use of CFD to Evaluate the Interactions Between Multiple-Leak Sources and to Assess Effectiveness of Integral Modeling Techniques in a Multiple-Leak Scenario," paper presented at the AIChE 2013 Spring Meeting, April 28-May 2, 2013, San Antonio, Texas (presented by J. Richardson, Graduate Research Assistant).

198. "Minimum Ignition Energy Study of Flowing Heat Transfer Fluid Aerosols: Experimental and Theoretical Approach," paper presented at the AIChE 2013 Spring Meeting, April 28-May 2, 2013, San Antonio, Texas (presented by S. Huang, Graduate Research Assistant).

199. "Current Issues in Process Safety," Keynote speaker, 2013 National Chemical Safety Symposium, Society of Chemical Manufacturers and Affiliates, Houston, Texas, May 22, 2013.

200. "Dust Explosion Research Development for Coal Mining Safety Issues," 1st CCPS Asia-Pacific Conference on Process Safety, Hotel Kempinski, Qing Dao, China, September 4-5, 2013.

201. "Risk Management in Business Expansion," Keynote speaker, 2013 Process Safety Technical Exchange Meeting, Saudi Aramco, Le Meridien Hotel, Al Khobar, Saudi Arabia, November 13-14, 2013.

202. "Gas Detectors Layout Optimization Considering False Positive and False Negatives: A Stochastic Programming Approach and a Quantitative Assessment of the Process Industries," paper presented at the AIChE 2013 Annual Meeting, November 3-8, 2013, San Francisco, California (presented by A.J. Benavides-Serrano, Graduate Research Assistant).

203. "Process Safety and Engineering for a Sustainable Development," paper presented at the China NSFC-US NSF Workshop on Sustainable Manufacturing, Wuhan, China, March 13-15, 2014.

204. Mannan, M.S., "Inherently Safer Design and Its Role in Process Safety," Keynote Speech at the 11th Professional Development Conference & Exhibition – "Innovative Approaches Toward Emerging SHE Challenges," American Society of Safety Engineers, Middle East Chapter, Kingdom of Bahrain, March 16-20, 2014.

205. "Optimal Placement of Imperfect Detectors in the Design of Mitigation Systems: A Non-Uniform Unavailability P-Median Formulation," paper presented at the 2014 AIChE Spring Meeting, March 30-April 3, 2014, New Orleans, Louisiana (presented by A.J. Benavides-Serrano, Graduate Research Assistant).

206. "Numerical Simulation of Cryogenic Boiling Using Volume of Fluid (VOF) Method," paper presented at the 2014 AIChE Spring Meeting, March 30-April 3, 2014, New Orleans, Louisiana (presented by M. Ahammad, Graduate Research Assistant).

207. "Development of Low-Charring Nanocomposites to Aid in Fundamental Understanding of Nanocomposite Flame Retardancy," paper presented at the 2014 AIChE Spring Meeting-48th Annual Loss Prevention Symposium, March 30-April 3, 2014, New Orleans, Louisiana (presented by L. Hatanaka, Graduate Research Assistant).

208. "A Correlation for the Lower Flammability Limit of Hybrid Mixtures," paper presented at the 2014 AIChE Spring Meeting-48th Annual Loss Prevention Symposium, March 30-April 3, 2014, New Orleans, Louisiana (presented by J. Jiang, Graduate Research Assistant).

209. "Flame Propagation Speed of Hydrocarbon Aerosols Generated by Electrospray," paper presented at the 2014 AIChE Spring Meeting-48th Annual Loss Prevention Symposium, March 30-April 3, 2014, New Orleans, Louisiana (presented by Y. Lin, Graduate Research Assistant).

210. "For Want of a Nail, the Kingdom Was Lost: Process Safety Management of Gaskets and Flanged Connections," paper presented at the 2014 AIChE Spring Meeting-29th CCPS International Conference, March 30-April 3, 2014, New Orleans, Louisiana (presented by J. Nelson, Graduate Research Assistant).

211. "Effects of Expansion Foam on Controlling LNG Vaporization Rate," paper presented at the 2014 AIChE Spring Meeting-14th Topical Conference on Gas Utilization, March 30-April 3, 2014, New Orleans, Louisiana (presented by B. Zhang, Graduate Research Assistant).

212. "West Explosion: Causation, Regulatory Analysis and Lessons Learned," paper presented at the Qatar Process Safety Symposium, Doha, Qatar, April 8-9, 2014.

213. "West Explosion and Its Aftermath," paper presented at the 2014 TCC/ACIT Safety Seminar, Galveston, Texas, June 2-5, 2014.

214. "Ocean Energy: Safety Issues and Opportunities in the Horizon," invited presentation to SPE International, Gulf Coast Section, Petroleum Club, Houston, Texas, July 1, 2014.

215. "Role of Education and Research in Developing Future Leaders Committed to Safety," keynote speech at XXIV ENEIQ – Encuentro Nacional de Estudiantes de Ingeneria Quimica de Procesos, Universidad de San Buenaventura, Cartagena, Colombia, July 15, 2014.

216. "Process Safety at the Crossroads of Systems Engineering, Complex Systems, and Engineering for Sustainable Development," invited speech at FOCAPD 2014 – 8th International Conference on Foundations of Computer-Aided Process Design, Suncadia Resort, Cle Elum, Washington, July 17, 2014.

217. "Process Safety at the Crossroads of Systems Engineering, Complex Systems, and Engineering for Sustainable Development," Invited Lecture, 2014 China Process Systems Engineering Conference, Northeast Hotel, Shenyang, China, August 21-23, 2014.

218. "Lessons Learned from Recent Pipeline Incidents and the Path Forward," Keynote Address, 2nd CCPS China Conference on Process Safety, Howard Johnson, Qing Dao, China, August 28-29, 2014.

219. "The Future of Process Safety Management From an Industry, Government and Academic Perspective," Keynote Address, 2014 Huntsman Americas EHS Manufacturing Excellence Conference, Houston, Texas, September 16-18, 2014.

220. "The Evolution of Process Safety and the Need for New Competencies," Keynote Address, 2015 ChemStewards Annual Meeting, Houston, Texas, February 13, 2015.

221. "Industrial Behavior and How PSM and Environmental Work Together," Lunch Keynote Address, 4C Environmental Conference, Austin, Texas, February 16-19, 2015.

222. "Small Dysfunctions in a Complex System Can Cause a Catastrophic Outcome," Keynote Speaker, Workshop Safety and Control Valves, von Karman Institute for Fluid Dynamics, Brussels, Belgium, April 8-9, 2015.

223. "Mitigation Effect of High-Expansion Foam on LNG Vapor Hazard," paper presented at the 2015 AIChE Spring Meeting-49th Annual Loss Prevention Symposium, April 26-30, 2015, Austin, Texas (presented by B. Zhang, Graduate Research Assistant).

224. "Experimental Study on Propane Jet Fire Hazards: Thermal Radiation," paper presented at the 2015 AIChE Spring Meeting-49th Annual Loss Prevention Symposium, April 26-30, 2015, Austin, Texas (presented by B. Zhang, Graduate Research Assistant).

225. "An Optimization Formulation for Risk Reduction of the Layout of Offshore Platforms," paper presented at the 2015 AIChE Spring Meeting-49th Annual Loss

Prevention Symposium, April 26-30, 2015, Austin, Texas (presented by J.C. Richardson, Graduate Research Assistant).

226. "Combustion and Explosion-Related Properties of Carbon Nanofibers," paper presented at the 2015 AIChE Spring Meeting-49th Annual Loss Prevention Symposium, April 26-30, 2015, Austin, Texas (presented by J. Zhang, Graduate Research Assistant).

227. "Quantification of Turbulence in Cryogenic Liquid Pool Using High-Speed Flow Visualization," paper presented at the 2015 AIChE Spring Meeting-49th Annual Loss Prevention Symposium, April 26-30, 2015, Austin, Texas (presented by N. Gopalaswami, Graduate Research Assistant).

228. "Experimental Study and CFD Simulation of Bund Overtopping in Case of a Catastrophic Failure of Tanks Containing Water/Liquid Nitrogen/LNG," paper presented at the 2015 AIChE Spring Meeting-49th Annual Loss Prevention Symposium, April 26-30, 2015, Austin, Texas (presented by Y. Liu, Research Scientist).

229. "Mary Kay O'Connor Process Safety Center: A Catalyst for Enhanced Process Safety Competency and Knowledge," paper presented at the 2015 AIChE Spring Meeting-30th CCPS International Conference, April 26-30, 2015, Austin, Texas.

230. "Hazards Recognition and Evaluation: Implementing the Teachings of Trevor Kletz," Inaugural Trevor Kletz Memorial Lecture, HAZARDS 25, May 13-15, 2015, Edinburgh, United Kingdom.

231. "Hazards Recognition and Evaluation: Implementing the Teachings of Trevor Kletz," Inaugural Trevor Kletz Memorial Lecture, HAZARDS Australasia, May 26-27, 2015, Brisbane, Australia.

232. "Role of Effective Valve Selection and Operation for Improved Safety Performance," Plenary Lecture at Valve World Americas Expo & Conference 2015, George R. Brown Convention Center, Houston, Texas, July 15-16, 2015.

233. "Why Do Catastrophic Incidents Keep on Happening?" Invited Lecture at the Nanjing Tech University, Nanjing, China, September 14, 2015.

234. "Cultivation Model of American Safety Professionals, Employment Needs, and Development Trend," Invited Lecture at the Nanjing University of Science and Technology, Nanjing, China, September 15, 2015.

235. "Energetic Chemical Substances," 2015 Nanjing Safety Forum - The 7th International Workshop on Safety Technology for Pharmaceutical & Chemical Processes, Nanjing, China, September 16-18, 2015.

236. "Inherent Safety of Chemical Processes and the Application of Layer of Protection Analysis," Invited Lecture at the Sichuan Province Academy of Safety Science and

Technology, Chengdu, China, September 21, 2015.

237. "Role of Safety Programs for the Continued Development of Industry - A Chinese Perspective," Invited Keynote Speech at the 2nd China International Chemical PSM Symposium & the 3rd CCPS China Conference on Process Safety, Ningbo, China, September 23-24, 2015.

238. "LOPA and its Application Practices," Invited Lecture, Beijing Safety Institute, Beijing, China, September 24, 2015.

239. "Synergism Between Fire Protection Engineering and Process Safety Engineering," Invited Lecture, AIChE Southwest Process Technology Conference, Moody Gardens Hotel, Galveston, Texas, October 1-2, 2015.

240. "Accountability and Competence for Improved Process Safety Performance," Keynote speaker, 2015 National Chemical Safety Symposium, Society of Chemical Manufacturers and Affiliates, Houston, Texas, October 21, 2015.

BIOGRAPHICAL INFORMATION

Dr. M. Sam Mannan is Regents Professor in the Chemical Engineering Department at Texas A&M University and Director of the Mary Kay O'Connor Process Safety Center at the Texas Engineering Experiment Station. The mission of the Center is to improve safety in the chemical process industry by conducting programs and research activities that promote safety as second nature for all plant personnel in their day-to-day activities. Before joining Texas A&M University, Dr. Mannan was Vice President at RMT, Inc., a nationwide engineering services company.

Dr. Mannan is a registered professional engineer in the states of Texas and Louisiana, a Certified Safety Professional, and a Professional Process Safety Engineer. His experience is wide ranging, covering process design of chemical plants and refineries, computer simulation of engineering problems, mathematical modeling, process safety, risk assessment, inherently safer design, critical infrastructure vulnerability assessment, aerosol modeling, and reactive and energetic materials assessments.

Dr. Mannan is involved very closely with projects that include hazard assessment and risk analysis, process hazard identification, HAZOP (hazard and operability) studies, vulnerability assessment, process safety management, and risk management. His research interests include development of inherently safer processes, application of computational fluid dynamics to study the explosive characteristics of flammable gases, development of quantitative methods to determine incompatibility among various chemicals, application of calorimetric methods for the assessment of reactive hazards, and the application of consequence analyses to assess the impact of process plant incidents. He co-authored the ***Guidelines for Safe Process Operations and Maintenance*** published by the Center for Chemical Process Safety, American Institute of Chemical Engineers.

He is the editor of the 3rd and 4th edition of the 3-volume authoritative reference for process safety and loss prevention, **Lees' Loss Prevention in the Process Industries**. Dr. Mannan has published 250 peer-reviewed journal publications, 5 books, 8 book chapters, 212 proceedings papers, 14 major reports, and 240 technical meeting presentations.

Dr. Mannan is the recipient of numerous awards and recognitions including the American Institute of Chemical Engineers ***Service to Society Award***, the Texas A&M University Association of Former Students' ***Distinguished Achievement Award for Teaching***, the Texas Engineering Experiment Station ***Research Fellow***, the Texas A&M University Dwight Look College of Engineering ***George Armistead, Jr. '23 Fellow***. In 2003, Dr. Mannan served as a ***consultant to Columbia Accident Investigation Board***. In 2006, he was named the inaugural holder of the T. Michael O'Connor Chair I. In 2007, he was elected Fellow of the American Institute of Chemical Engineers. In December 2008, the Board of Regents of Texas A&M University System recognized Dr. Mannan's exemplary contributions to the university, agency, and to the people of Texas in teaching, research and service by naming him Regents Professor of Chemical Engineering. Dr. Mannan is a Guest Professor at the Nanjing University of Technology and the China University of Petroleum in Qing Dao. In September 2011, the Technical University of Łódź, Poland, conferred the ***Doctoris Honoris Causa*** on Dr. Mannan. In 2012, Dr. Mannan was awarded the Bush Excellence Award for Faculty in Public Service. In March 2013, Dr. Mannan was named a Distinguished Honorary Professor at the Rajiv Gandhi Institute of Petroleum Technology. In 2015, Dr. Mannan was elected Fellow of the Institution of Chemical Engineers, UK.

Dr. Mannan received his B.S. in chemical engineering from Bangladesh University of Engineering and Technology (BUET) in Dhaka, Bangladesh in 1978, and obtained his M.S. in 1983 and Ph.D. in 1986 in chemical engineering from the University of Oklahoma.

KEY PROJECTS

Confidential - Consequence Analysis for Litigation Support (Canada). March, 1991 to March, 1993.
Project Manager: The consequence analysis was performed for a major refinery fire. A refinery fire had resulted in extensive damages to the refinery. The objective of the consequence analysis was to determine if the extent of damage would have been any different if the design of the plant had been different. Using computer models of hazard assessment (e.g., vapor generation and dispersion, fires, and explosion), the base case for the refinery fire was established. Perturbations were then made to the design configuration and plant layout and the hazard assessment model was rerun to determine the extent of the damages. The consequence analysis project provided critical evidence with regard to settlement of litigation claims.

OXY USA, Inc. - Disaster Review Modeling - (Myrtle Springs, Texas). July, 1990 to May, 1991.
Project Manager: The gas company was planning the installation of a compressor to transfer sour natural gas from its gathering fields to its processing facility. The disaster

review modeling (required by TACB/TNRCC regulations) was performed to determine the worst-case accident and release scenario. This information was then used to determine off-property ground-level concentrations and the impacted areas.

Coastal Eagle Point Oil Company - Dispersion Modeling for Off-Site Impact Assessment - (Westville, New Jersey). October, 1993 to December 1993.
Project Manager: State regulations required the refinery to conduct a worst-case release analysis for power failure. The refinery had multiple relief valves on different units in the plant. The fluid streams inside the units had varying concentrations of hydrogen sulfide. The state regulatory agency required the refinery to submit a report showing off-property concentrations of hydrogen sulfide resulting from simultaneous releases from all the relief valves because of a total power failure. We used our dense gas hazard assessment model to simulate the postulated worst-case scenario and develop impact contours for downwind dispersion distances.

Calcasieu Refining Company - Emergency Response Plan (Lake Charles, Louisiana). January, 1993 to June, 1993.
Project Manager: The emergency response plan (ERP) was developed for a crude oil topping plant in Louisiana. The ERP was prepared in accordance with 29 CFR 1910.119(n) and 29 CFR 1910.38(a) and covers such issues as plant emergency coordination, risk evaluation, notification procedures, communication systems, emergency equipment, training and procedures to return to normal operations. The plan defines responses to emergency releases and/or explosions, both small and large. The worst-case scenario and risk analysis was used as the basis of the ERP.

American Institute of Chemical Engineers - Guidelines for Safe Process Operations and Maintenance (New York, New York). March, 1992 to March 1995.
Lead Author: The Center for Chemical Process Safety (CCPS) was established in 1985 by the American Institute of Chemical Engineers to develop and disseminate technical information for use in the prevention of major chemical accidents. The "Guidelines for Safe Process Operations and Maintenance" is part of a series of guideline documents published by the CCPS to reduce the risk of catastrophic incidents in the process industries. The Guidelines is intended for plant personnel who must execute site safety programs, policies, and procedures during the life cycle of a plant. The primary target audience includes all operations and maintenance personnel who have first-and second-line supervision in maintaining the process and equipment integrity of the plant throughout the life cycle of the plant. The cycle starts from initial design, and continues through construction, pre-startup and commissioning, startup, operation, maintenance, shutdown, and decommissioning/demolition.

OXY USA, Inc. - Hazard Assessment - (East Texas). May, 1990 to August, 1991.
Engineer: The gas processing company was planning various modifications and expansions in a gas plant. In addition, the company was also planning to decommission various equipment and facilities at another plant. The objective of the hazard assessment was to identify possible hazards, which may result from the proposed changes. As a result of the assessment, recommendations were made to enhance safety in the operation and

maintenance activities of the plants.

City of Austin - Hazardous Materials Water Contamination Risk Study (Austin, Texas). July, 1993 to April, 1994.
Project Manager: The objective of the risk study performed for the City of Austin was to assess the risk of accidental water contamination from catastrophic releases of toxic and hazardous materials to the different water bodies within the city and the extraterritorial jurisdiction (ETJ) of Austin. Potential sources of releases included approximately 1,800 different companies which reported storage of over 7,000 containers of hazardous or toxic materials. Hazard scenarios were identified by establishing exposure pathways for known surrounding features (man-made or natural) between the released liquid and the water body of concern. The results from the risk assessment included an assessment of the relative risk which the sites pose for accidental water contamination from catastrophic releases of hazardous and toxic materials and identification of measures that the City can take to reduce the risks of accidental contamination. In addition, transportation routes were analyzed for sensitivity to potential water contamination from spills of toxic and hazardous materials.

LaRoche Chemicals, Hazop Study for Ammonia Storage System, (Baton Rouge, Louisiana). January, 1993 to March 1993.
Project Manager: This project was performed for a fertilizer company's ammonia storage system at the Baton Rouge facility to comply with the OSHA Process Safety Management regulations (29 CFR 1910.119). A team of appropriately qualified personnel was constituted for conducting this process hazards analysis. The Hazard and Operability (HAZOP) study methodology was selected to perform the analysis on the ammonia storage tank, repulper tanks and the associated piping and equipment. As a result of this study, a total of twenty-two recommendations were suggested by the team to either reduce the likelihood of occurrence or lower the consequence resulting from an identified scenario.

Confidential Client, Health and Safety Audit, (Freeport, Texas). June, 1991 to December 1991.
Project Manager: This project was performed for a mid-size chemical plant to determine compliance with Occupational Safety and Health Administration regulations affecting the health and safety of employees in the plant. The project was performed under attorney/client privilege. The objective of the project was to determine compliance with OSHA health and safety regulations. The project resulted in a health and safety audit report and a health and safety manual. The health and safety manual was developed for use in conjunction with safety standards, policies, and procedures within the company. During the project, all applicable regulatory standards and recommended industry practices were analyzed with regard to impact on operations of the plant. The resulting manual was later used for training of field personnel and first-line supervisors.

Calcasieu Refining Company, Operating Procedures, (Lake Charles, Louisiana). March, 1993 to May, 1993.
Project Manager: A standard operating procedures manual was prepared for the refinery in Lake Charles, Louisiana. The development and implementation of written operating procedures are required under the OSHA Process Safety management regulations (29 CFR

1910.119). The objective of the operating procedures is to provide clear operating instructions for safely conducting processing activities in the crude oil topping plant. The resulting manual is also used for training of the plant personnel. It covers steps for each operating phase; operating limits; and safety systems and their functions.

Calcasieu Refining Company, PSM Compliance Assessment, (Lake Charles, Louisiana). June, 1992 to August, 1992.
Project Manager: This project was performed for the refinery to determine compliance with the OSHA Process Safety Management regulations (29 CFR 1910.119). The compliance assessment was designed to identify documentation and procedures in place and determined whether this fulfilled the requirements of the OSHA PSM regulations. More importantly, the assessment also identified any additional procedures or documentation needed to fully comply with the regulation. From the assessment, a plan and schedule was developed that included a work plan addressing the manpower needed for compliance. The plan was used as an effective management tool with regard to budget allocation and decisions for manpower scheduling.

OXY USA, Inc., Risk Assessment, (East Texas). June, 1990 to November, 1991.
Engineer: The company was planning the construction of a sour gas gathering line for transferring sour gas from its producing fields to its processing facilities. The objective of the risk analysis before construction of the pipeline was aimed at (1) determining problem areas regarding design, construction, operation and maintenance of sour gas pipelines which may contribute to pipeline failure; (2) suggesting measures and techniques for detecting pipeline failures and reducing the impact of such failures; (3) assuring compliance with governmental regulations; and (4) suggesting methods to build redundancies into the system to facilitate safe operation and maintenance. The work from this project was used as the basis of an article published in the Oil and Gas Journal.

Champlin Refining and Chemicals, Inc., Safety Engineering for High Pressure LPG Storage, (Corpus Christi, TX). January, 1991 to December, 1991.
Engineer: The refinery was planning the construction of two large spherical storage vessels for storing liquefied petroleum gas (LPG). The objective of the safety engineering study was to (1) provide our recommendation on the selection of a site between two available sites; (2) determine potential hazard scenarios from the operation and maintenance of the storage vessels at the selected site; (3) determine consequences of potential hazard scenarios and the impact of these consequences on the surrounding area and the public; (4) provide recommendations for changes in design and construction to improve safety of the storage vessels, and (5) provide recommendations to improve safety during operation and maintenance of the storage vessels.

Vista Chemical Company, PSM Audit Program, (Houston, Texas). November, 1993 to date.
Project Manager: The objective of this project was the development and implementation of a corporate program for Process Safety management (PSM) Compliance Auditing and an associated Training Program for training Vista personnel for auditing Vista's facilities for compliance with the OSHA PSM rule as described in 29 CFR 1910.119. The project effort

was focused towards providing the staff of Vista the tools and training with which: 1) they can efficiently perform audits of the PSM programs being implemented at each of the company's five facilities; and 2) Vista management can gauge the overall effectiveness of the implementation efforts now is progress at the facilities to meet the requirements of the OSHA PSM rule.

Vista Chemical Company, Baltimore Plant Revamping, (Baltimore, Maryland). March, 1994 to February 1995.
Project Manager: A major revamping project for the Baltimore plant was necessitated by business reasons. The revamping is needed because of a change in technology precipitated by market demands. The revamped plant will continue to produce detergent alkylate. However, instead of the earlier process, Vista has decided to use the UOP process to make olefins and then make detergent alkylate. The objective of the project was to provide Vista with PSM support services during the design, construction, and installation of the revamping project. The intent was to: ensure that the design, construction, and installation of equipment follow the requirements of the PSM rule; ensure the development of the data, process information, and procedures that will be needed for compliance with the PSM rule; and provide for a smooth transition of the PSM program from the design, construction, and installation phases to operation.

J.R. Simplot Company, PSM Tracking Database (Pocatello, Idaho). May 1994 - April 1995.
Project Manager: The PSM rule requires covered facilities to develop, implement and practice a 14-element program. The implementation and practice of many of these elements, including process hazard analysis, management of change, incident investigation and compliance audits, results in hazard management and risk reduction recommendations. This project was undertaken in response to a client request to develop a computerized system for the fertilizer manufacturer to do tracking, recordkeeping and documentation. The objectives are to compile the recommendations from various PSM activities, to update and maintain any related information, and to produce specific reports for documentation as needed. This customized program was developed using Microsoft's FoxPro software to meet specific tracking expectations and employee access requirements.

J.R. Simplot Company, Mechanical Integrity program (Pocatello, Idaho). January 1994 - March 1996.
Project Manager: Engineering, fabrication, inspection and test, and maintenance of applicable chemical processes and equipment are now regulated plant activities by OSHA's 29 CFR 1910.119 and EPA's 40 CFR 68. The regulations require equipment to be designed, operated, and maintained in accordance with good engineering practice, manufacturers recommendations, and plant history. The regulatory requirements are performance-based, or results-oriented, requiring the plant to develop its specific equipment design basis and mechanical integrity programs. This project involved the formidable task of developing and implementing mechanical integrity programs for plant equipment with little or no existing design basis documentation. Key programs that were implemented include identification of critical equipment, inspection and test planning, good engineering practice, corrective action policies, training, and procedure development.

Ameripol Synpol Corporation, Relief Valve Design and Design Basis Study (Beaumont, Texas). May 1995 – June 1997
Project Manager: This project was performed for a synthetic rubber production plant including the storage facilities to comply with the OSHA Process Safety Management regulations (*29 CFR 1910.119*). As part of the Process Safety Information requirements of the regulation, relief device design and design basis must be maintained and updated. A study was conducted to ensure and compile the proper relief valve design data needed to comply with the regulation. As a result of this study, relief valve design calculations were done and recommendations for modifications and operating procedures for the relief device system were made. The study resulted in a report which included: a) the standards and design basis used for sizing the relief valves for the PSM-covered process, b) the recommendations that resulted from the study, c) a list of relief valves that were undersized for the intended applications, and d) a calculation and sizing sheet for each of the relief valves. As needed, DIERS technology was applied for the relief valve sizing calculations.

Ashland Chemical Company, Corporate Risk Management Program Implementation (Columbus, Ohio). January 1996 – December 1999
Project Manager: EPA's risk management program rule requires regulated facilities to develop and implement appropriate risk management programs to minimize the frequency and severity of chemical plant accidents. The risk management program rule has three main components. They are hazard assessment, prevention program, and emergency response program. The rule also requires regulated facilities to develop a Risk Management Plan (RMP). The RMP includes a description of the hazard assessment, prevention program, and the emergency response program. The project involved the development of an implementation plan to bring all the Ashland facilities into compliance. This included development of guidance documents, training of appropriate personnel, completion of modeling, improvement and revision of prevention programs and emergency response programs, and development of format and content for risk communication, and public meetings for risk communication.

Brazoria County Petrochemical Council, Risk Management/Risk Communication program (Freeport, Texas). June 1996 - December 1998
Project Manager: The 13 petrochemical companies of Freeport, Texas joined together in an effort aimed at complying with EPA's Risk Management Program. The companies working together in this project are Air Liquide America, Amoco Chemicals, BASF Corporation, Dow Chemical Company, Gulf Chemical and Metallurgical Corporation, Nalco/Exxon Energy Chemicals, Phillips Petroleum Company, Rhone-Poulenc, Roche Company, Schenectady International, and Shintech. The objective of this project is to develop homogeneous programs for compliance with the various requirements of EPA's risk management program. After completion of the risk management plans, the companies expect to communicate the plans to the public in town hall meetings or other such suitable format.

Expert Panel on Quantitative Risk Assessment for the Anniston Chemical Agent Disposal Facility (ANCDF) and the Umatilla Chemical Agent Disposal Facility

(UMCDF). January 1998 – July 2001.
Expert Panel Member: To help manage the risk during the construction, operation, and maintenance of the ANCDF and the UMCDF, SAIC conducted detailed quantitative risk assessments. Expert panels were constituted to review and critique the risk assessment methodology and the resulting reports. As an expert panel member, we met periodically with the SAIC project team to review progress and provide input to the project team. We also visited the ANCDF and UMCDF sites to evaluate, a) site-specific conditions and the use of site-specific information, and b) the application of the quantitative risk assessment in the risk management process.

Parsons, Quantitative Risk Assessment for Chemical Demilitarization Process - Phase I and Phase II, 1/01/00-12/31/01
Principal Investigator: A quantitative risk analysis was conducted to evaluate the design of the VX neutralization subsystem and related support facility of the Newport Chemical Agent Disposal Facility. Three major accidents including agent release, personnel injury, and system loss were studied using fault tree analysis methodology. Each incident was assigned Risk Assessment Codes by the severity level and the occurrence probability of the accidents. Safety mitigations or design changes were recommended to bring the "undesired" risk level (typical agent release events) to be "acceptable with controls" or "acceptable".

Ashland, Inc., Reactive Chemicals Analysis of Hydroxylamine Compounds, 1/01/01-12/31/01
Principal Investigator: This project involved the measurement of calorimetric data for hydroxylamine and hydroxylamine compounds. Two calorimeters were used for studying thermal behavior of reactive systems. One is a Reactive Systems Screening Tool (RSST), which is designed for rapid measurement of thermal behavior of small samples (10 cm^3) for temperatures up to 400°C and pressures to 500 psia. The second apparatus is an Automatic Pressure Tracking Adiabatic Calorimeter (APTAC) for detailed analyses of thermal behavior of larger samples (up to ~ 130 cm^3) for temperatures up to 450°C and pressures up to 2,000 psia. In this calorimeter, closed-cell sample pressures are continuously matched by an external pressure of nitrogen so that sample cells of low mass and therefore low thermal inertia can be used for highly sensitive measurements of sample thermal behavior. Other advanced features of the APTAC include *in situ* additions to the sample cell of reactants or catalysts with a high-pressure syringe pump.

US Environmental Protection Agency, Chemical Safety Program Assessment Project, 7/01/01-6/30/03
Principal Investigator: The project on chemical safety program assessment includes four phases:

Phase I:	Describe the evolution of chemical safety
Phase II:	Describe stakeholders' goals and objectives for improving chemical safety
Phase III:	Develop indicators, measures, and metrics to measure progress towards goals and objectives

Phase IV: Develop report

The objective of the project was to develop a methodology for chemical safety program assessment and to apply the methodology in an analysis of the impact of various programs for prevention of accidental releases of reactive, flammable and toxic chemicals from stationary sources. The programs evaluated include those required by regulatory authorities (e.g., OSHA, EPA) and industry standards (e.g., API, CMA). The phased approach establishes different segments of the program, each of which allows an opportunity to stop and reflect on how and whether or not to proceed.

US Environmental Protection Agency, National Chemical Safety Data System, 7/01/01-6/30/03
Principal Investigator: This project involves the development of a national data system in the area of chemical safety and chemical accidents. This database is a critical beginning element in a national initiative to identify national chemical safety goals, implement activities to reach the goals, and establish a measurement system to measure progress towards the goals. Current data collected at the national level through different sources do not provide sufficient information to be useful in the establishment of baseline and measurement systems. Without this essential measurement tool, movement toward the accomplishment of national chemical safety goals will not be captured. The proposed data system will utilize, where appropriate, existing data sources, and collect and analyze data of near-misses and incidents which can be related to actual causes to aid in the establishment of chemical safety baselines. With the database in place, the nation can move towards the establishment of metrics and targeted reduction goals for chemical safety incidents.

Texas Higher Education Coordinating Board, Behavior of Heat Exchange Fluid Aerosols Leaking from Manufacturing Processes, 1/1/99-12/31/2002
Principal Investigator: Heat transfer fluids are widely used in industry, but conditions for safe fluid operations are not well understood and aerosols have caused costly explosions and fires. The primary goal of this research is to study the formation and dispersion of aerosols that form because of escape of heat transfer fluids through leak structures in industry. This research includes study of a variety of heat exchange fluids with a nonintrusive laser method based on the Malvern Instrument Diffraction Particle Analyzer to measure droplet sizes, spatial distributions, and concentrations forming from nozzles of various shapes to simulate leaks in pipes and vessels. The goal is to improve industrial process safety and economic practices through an understanding of how aerosols can form and strategies for safe handling of leaking fluids.

Propane Education and Research Council, Propane Industry Incident Data Collection - Propane Education and Research Council, 1/1/02 – 3/31/03
Principal Investigator: This project involves the implementation of a system to collect and report incidents involving propane consistent with the overall mission to promote the safe handling and use of odorized propane in the United States. The incident data will be applied in improvement of the following areas: research and development, safety and training, consumer education, and agricultural.

Expert Panel on Airborne Release Fractions – Department of Energy. June 2002 – December 2002.
Panel Member: Airborne release fractions (ARFs) are the coefficients used to estimate the amount of material suspended in air as aerosols following an accident (e.g., fire, spill, earthquake). These ARFs are used in both facility hazard categorization and detailed accident analysis to estimate accident dose consequences for DOE nuclear facilities. Existing DOE standards do not currently address several material forms of interest to the EM Program (e.g., containerized wastes, fixed matrix forms such as concrete, and contaminated soils). DOE-EM attempted to define five alternate ARFs for materials of interest in the 1995-1996 time frame. This technical effort was never finalized and published, although it was documented in multiple versions of a draft, DOE Standard (SAFT-0029). Some DOE-EM sites have been, and are currently, utilizing SAFT-0029's draft values in certain facility hazard categorization and accident analyses.

Consultant to Columbia Accident Investigation Board. April 2003 – December 2003.
Analyze NASA's safety management and programs, decision-making processes, and safety culture. In addition, also reviewed risk analysis and risk management in addition to accident investigation models, safety culture, metrics, indicators, and decision-making processes. The analysis led to several conclusions and recommendations: The safety requirements for space flight are quite demanding and require a multi-layered approach. In the first layer, one must build in the technology and procedures that provide an appropriate level of safety for manned spacecraft. The second layer consists of management systems that ensure that procedures are followed and proper standards are implemented at all times. Finally, the third layer consists of creating a healthy and strong safety culture. The increasingly higher levels are harder to define and implement but they are very important. In fact, safety culture is very elusive and varies according to the activity and the mission of the organization.

Peer Review Panel, Hazardous Substances Emergency Events Surveillance System, Agency for Toxic Substances and Disease Registry, Centers for Disease Control, Department of Health and Human Services. July 2004 – December 2004.
Panel Member: In 2004, 16 state health departments had cooperative agreements with ATSDR to participate in the Hazardous Substances Emergency Events Surveillance System (HSEES). The state health departments report an "event" if it meets the HSEES definition, which is "any release(s) or threatened release(s) of at least one hazardous substance." A substance is considered hazardous if it might reasonably be expected to cause adverse human health effects. Releases of petroleum products are excluded from this system. Data are entered by participating state health departments into a Web-based application that enables ATSDR to access the data instantly for analysis. The public does not have access to the data; ATSDR provides summary reports of the data. The peer review panel was asked to perform a review of the HSEES system to include reviewing program accomplishments, quality of science, impact and directions, and make recommendations on improvements and modifications.

National Academy of Science, Committee on Mustard Processing at Tooele Chemical Agent Disposal Facility, 2004-2005.
Committee Member: The National Academy of Science established an ad-hoc committee to assess the technical adequacy of the proposal by the systems contractor for the Tooele Chemical Agent Disposal Facility (TOCDF) to dispose of the mustard agent stockpile stored at the adjacent Deseret Chemical Depot (DCD). The objectives of the report:

- Examine the process designs used for metal emissions removal to ensure that the selected technologies are adequate to minimize and control metal emissions, and that emissions will be within all applicable environmental regulations and requirements.

- Examine non-incineration treatment process designs for mercury contaminated liquid and solid mustard agent and assess the adequacy of the process design to destroy the mustard agent

- Assess the adequacy of processes for mustard agent hydrolysate disposal

- Assess the robustness of the selected process designs for their adequacy to support continuous disposal operations over the requisite duration.

American Petroleum Institute, Develop Compendium of Technologies for the Petroleum Industry and Associated Petrochemical Operations, January 2005-January 2006
Principal Investigator- This project proposed to research Practical Risk Reduction (PRR) for the petroleum and related petrochemical industry. As defined by API, PRR involves evaluation of all phases of a process system to determine cost effective process improvements to reduce risk holistically within the system. In this project, the integration and interrelation of the PRR approach was analyzed with inherently safer design principles.

National Acute Hazardous Substances Release Surveillance, Centers for Disease Control & Prevention - 2007-2009
Principal Investigator- The purpose of this project is to obtain contractor assistance in some additional data analysis comparing HSEES data with other data sources including potentially poison control centers, Consumer Product Safety Commission, Department of Transportation Hazardous Materials Information System, National Response Center, and Environmental Protection Agency's Risk Management Plan accident history. Work groups were convened by phone to complete identified tasks at the November 2007 national meeting to: undertake review of incident definition and HSEES data fields; develop a plan to harmonize data fields among agencies; evaluate cost benefits of removing petroleum exclusion including establishing an appropriate threshold quantity; establish the statistical relationship of HSEES states, other states and the entire US; evaluate whether low quantity releases cause sufficient injuries to justify data collection. A white paper was developed and published as a result of this project.

BP LNG Spill Emergency Response, BP Energy Company -Experimental and Theoretical Studies on LNG dispersion, LNG Pool fire, and Mitigation Systems.- 2007-2009 –

Principal Investigator- The Center has been involved in LNG research since 2004. During this time the Center has performed theoretical and experimental studies in this field. As a short overview, the Center's research has focused on safety issues related to LNG including:

- Experimental and theoretical study of LNG vapor dispersion using CFD modeling,
- Experimental testing on the application of expansion foam and foamglass to control LNG vapor dispersion and suppress LNG pool fires,
- Theoretical and experimental studies of the key parameters affecting the effectiveness of water curtain systems to mitigate LNG vapor dispersion
- Experimental determination of mass burning rates and heat radiation from small scale LNG pool fires.

Confidential Client, Analytical and Technical Support for Process Safety and Risk Management for ADN (Nylon Polymer) Syntheses Safety, September 2008-December 2009

Principal Investigator- This project reviewed the incident investigation report of a scrubber unit and a root cause of the incident—the generation of charged droplets. To understand the intrinsic characteristics and to improve the safety of this process, software tools were used to study the performance and characteristics of the process units involved in the incident. The simulations, coupled with laboratory experimental work, uncovered the cause of the incidents in the scrubber and a simple solution was proposed and implemented.

Department of Homeland Security, Representative User and Distributor Facilities and Scenarios for Task 1 of the Chemical Infrastructure Risk Assessment, December 2008-July 2010

Principal Investigator- In order to help secure the U.S. chemical infrastructure and reduce potential consequences of terrorist attacks, the Chemical Security Analysis Center (CSAC) of the U.S. Department of Homeland Security (DHS) is supporting the efforts of the Office of Infrastructure Protection (OIP) has contracted research to conduct a project to study alternatives for high priority processes and the potential impact of the alternatives on the overall risk of process chemicals due to releases from terrorist events. The study focuses on facilities that make, use, store, or transport toxic compounds contained on the DHS Chemical Facility Anti-terrorism Appendix A list of compounds. As a foundation for the overall DHS project, CSAC contracted with the MKOPSC to perform a literature review of IST approaches and green chemistry initiatives project as a primary component of a Chemical Infrastructure Risk Assessment (CIRA) to assess risk in the chemical supply chain and to support implementation of the Chemical Facilities Anti-Terrorism (CFAT) standards.

Department of Homeland Security, Literature Review for Inherently Safer Technologies and Green Chemistry Initiatives, July 2008-March 2010

Principal Investigator- MKOPSC conducted a comprehensive literature search for IST

related articles and identified more than 200 articles within this scope. An on-line database was built, which is content searchable using key words, including author names, which have been entered for each document. This database is currently updated continuously if new articles are searched. As a second part of this IST project, MKOPSC proposed a conceptual inherent security index and flowchart to evaluate process options. This metrics tool was adopted by DHS.

Confidential Clients, Development and Implementation of a Corporate PSM Program

Principal Investigator- Several multi-national chemical companies have contracted with the MKOPSC to develop and implement a corporate PSM program. This entailed the review and evaluation of the current operational practices and based on this understanding MKOPSC made recommendations to help improve operations and safety practices company-wide. In addition, if incidents had occurred, the MKOPSC team would provide a root cause analysis to identify specific safety and PSM needs. Finally, PSM policies, procedures and guidelines were developed and implemented.

Abnormal Situation Management Consortium, Risk Criteria That Impact Operator Decision Making During Abnormal Situations, March 2011- December 2011

Principal Investigator- The purpose of this project is to establish and maintain safety of processes through automation and analysis methodologies. Because modern chemical plants are large and complex, early and accurate fault detection and diagnosis is imperative. Effective application of these methods can reduce product rejection rates, limit downtime, and help to attain stringent safety requirements. Abnormal Situation Management is a method of identifying and responding to unusual events in a process, which can include instrument failure and logistic problems. The central goal is to document all possible normal modes of a plant operation and detect and diagnose deviations from normal behavior. Although this goal is complete in itself, attaining it requires the methods of "Fault Detection and Diagnosis," which analyzes unmanageable events that occur frequently. The primary focus is on process upsets caused by events such as fouling, catalyst deactivation, instrument failures including sensors (thermocouple), and actuator (valve) failures. Therefore, monitoring key variables (*e.g.*, product concentration, temperature, and flow rates) is the primary task.

Confidential Client, Gas Leak Detection, June 2011- May 2012

Principal Investigator - The Center participated in an experimental test for assessing the effectiveness for gas detection from different size-sources of a number of different sensors types and manufacturers to determine their suitability for the service in chemical plants that handle flammable gases. The tests were conducted at the Brayton Fire Training Field in College Station, Texas.

NIOSH Physical Hazard Banding, July 2013-September 2014

Principal Investigator - NIOSH invited the Center to work in collaboration with DOT and ORAU to develop guidance for the rapid evaluation of the chemical and physical hazards that emergency responders may be exposed to while performing their job. As a result of this work, two manuscripts were developed. The first manuscript provided an

overview of different types of physical hazards and hazard classification systems both in the US (HAZCOM) and internationally (GHS). The second manuscript provided guidance on the resources to be used during the different stages of emergency response.

National Science Foundation, EAGER, Correlation of Explosibility and Dispersion Characteristics of Combustible Engineered Nanomaterials, August 2013-July 2015
Principal Investigator - In this study, commercially available metallic and non-metallic combustible engineered nanomaterials, together with their micro-scale counterparts were investigated. The conventional explosibility characteristics, essential in determining the likelihood and severity of a dust explosion, of these nanomaterials in terms of minimum explosive concentration (MEC), maximum pressure (P_{max}), maximum pressure increase rate ($[dP/dt]_{max}$), and minimum ignition temperature (MIT) were evaluated experimentally. Since nanomaterials have propensity to agglomerate; and because the degree of agglomeration has a significant effect on the explosion behavior, an attempt was made to obtain complete understanding of the dispersion and agglomeration behavior of nanomaterials and determine the relationship between the corresponding particle diameter and surface area and the ignition tendencies.

National Science Foundation: Collaborative Research: Study of Flammability, Mechanism and Heat/Mass Transfer Associated with Burning of Flame Retardant Polymer Nanocomposites, September 2013-September-2016
Principal Investigator – This project involves collaboration with Dr. Qinsheng Wang at Oklahoma State University to understand the mechanism and to quantify the synergistic fire retardant effect of the nanofillers that form a physical barrier and the nanofillers that cause catalytic charring of the burning polymer. The project involves the study of the kinetics and the mass and heat transfer processes involved in the pyrolysis of the polymer with and without the nanofillers. A cone-calorimeter at OSU, which simulates an effective medium-sized polymer fire (similar to real world fire), is being used to determine the mass loss rate, temperature profiles of the pyrolysis zone and the heat reradiated by the residue layer to quantify the individual and synergistic fire retardant effect of the nanofillers used. This is of importance because it would facilitate the accomplishment of the ultimate goal of fire retardancy, extensive charring of the polymer matrix, which means that the polymer can be used at the service temperature, whereas in case of fire, it would rapidly char limiting the production of combustible volatiles.

TetraKO, Testing Degradation Behavior of Fire-retardant Materials September 2013-March 2014
Principal Investigator – Testing and analysis of the burning mechanism of samples of fire suppression material using thermogravimetric analysis (TGA), differential scanning calorimetry (DSC) and cone-calorimetry studies. These tests are aimed to study the gases produced during degradation of the fire-suppressant gel as well as degradation behavior.

AVEVA, Development of an Effective Framework for Shift Handover: July 2012-April 2014
Principal Investigator – The scope of this work focused on Shift Handover in the industry. The goal was to identify the gaps and deficiencies in current shift handover

practices (from literature review and field survey) that lead to incidents, near-misses, or delays and propose solutions to address these issues. The study and recommendations were documented in a report and point-of-view paper.

U.S. Department of Transportation, Radio Frequency Identification (RFID) Smart Corrosion Coupon, January 2013-April, 2014

Principal Investigator – Our work on RFID smart corrosion coupons was able to discover a suitable application for the coupons, develop a new coupon design that would accommodate the needs of the environment and the industry, and perform accelerated corrosion tests on the coupons. Additionally, corrosion tests using industry standard corrosion coupons allowed the comparison of coupon corrosion to pipeline corrosion to develop a basic relationship between coupon and metal coupon corrosion rate that is necessary for real-world application. The two potential applications of this technology could be in buried pipelines and in corrosion under insulation. Experiments were conducted to mimic these scenarios, and the results show that the coupon is able to perform well in both cases. The innovative design of the coupon allows a modified on/off response, which should reduce the dependence on signal analysis, and should simply provide an indication of the state of the coupon without extra effort from the end user.

PEC OSHA, **Current Industry Practices on Keeping Up with Codes, PHA Conduction and PHA Revalidation, October 2014-March 2015**

Principal Investigator – This project involved studies and development of reports describing current industry practices related to some elements of process safety management (PSM), including how industry keeps up with the changes in codes and process safety practices, how industry conducts process hazard analysis (PHA) and revalidates PHA.

National Grid, Liquefied Natural Gas (LNG) in Trench filled with water

Principal Investigator – The overall objective of this project is to improve the understanding of pool spreading and vaporization of LNG releases. The study included both experimental and computational to simulate a scenario of rupture in loading arm, causing LNG to spill in the space between LNG carrier and onshore platform of waterfront LNG facility. The experimental study involved the determination of vaporization rate for a continuous release of LNG in trench. Along with the vaporization rate, the spreading rate and pool height were measured. The computational work involves the modeling of the pool spreading and vaporization in Computational Fluid Dynamics (CFD) for the defined scenario.

Crosstex, 200 MMSCFD and 50 MMSCFD Natural Gas Processing Facilities Blast Survey

Principal Investigator – The objective of this project was to perform explosion simulation for the 200 MMSCFD and 50 MMSCFD Crosstex Energy Services natural gas process plant using consequence modeling software PHAST®. The results provided were representative of a selection of realistic scenarios that had been identified by the project team as most hazardous to the plant in the case of an event. The results given

could be used as a reference in the facility layout of a new plant with similar properties to those studied.

OSHA RFI Response to Revise Process Safety Management Standard, February 2013-March 2013

Principal Investigator – In response to Executive Order 13650, OSHA had requested comments on potential revisions to its Process Safety Management (PSM) standard and its Explosives and Blasting Agents standard, potential updates to its Flammable Liquids standard and Spray Finishing standard, and potential changes to PSM enforcement policies. An item-by-item response of the17 proposed changes to OSHA's Request for Information (RFI) was provided with supporting information.

Genesis, Literature search for the Assessment and Management of Mercury Emissions and Threshold Limit Value, May 2013-June 2013

Principal Investigator – The objective of this study was to perform a literature search for the assessment and management of mercury emissions and set threshold limit value. The literature search focused on data collection to comprise current best practices in terms of hazard identification, toxicity classification, fugitive, planned and unplanned leak sources, modeling techniques, design mitigation, active detection and personnel protection and management of contaminated plant/ equipment. Possible causes of emission of gas with a mercury concentration were identified considering fugitive (*i.e.,* ever present), planned (*i.e.*, PSV release, maintenance, flaring) and unplanned (*i.e.*, flange breaks, damaged fittings) emissions in offshore/onshore facilities and lessons learned.

Hydrocarbon Jet Fire – Detector Testing, General Motors, September 2013-November 2013

Principal Investigator – A series of experiments were conducted to evaluate the performance of a multi-spectrum infrared (MSIR) flame detector (model FL4000H). The evaluation of this flame detector consisted of determining its ability to detect a hydrocarbon jet fire at different distances and angles from the source. This information was used to give insight about the susceptibility of the FL4000H to produce "false negatives" when located too close to the source of the jet fire. The tests were conducted at the Brayton Fire Training Field (BFTF), which is a part of the Texas A&M Engineering Extension Service (TEEX), located in College Station, Texas.

Chevron, Gas Leak Detection September, 2013-November 2013

Principal Investigator – The purpose of this study was to investigate the performance of gas cloud imaging systems. Examples of such instruments include the Bruker SIGIS 2 and the General Monitor's Second Sight TC. The actual cameras tested during the experiment were from different vendors who agreed to perform the testing.

Occidental Oil and Gas Corporation (OOG), Risk Screening on H2S Radius of Exposure, January 2014- July 2014

Principal Investigator – Risk analysis of the H2S radius of exposure (ROE) for several processes were performed. A number of simulations were conducted using PHAST 6.7 for a series of scenarios defined by OOG to improve the existing Risk Screening Tool

used by OOG.

Ascend Performance Materials, Deflagration/Detonation Hazard Analysis for ADN Synthesis Unit Based on Two-Phase Flow Pattern Recognition, 2014
Principal Investigator – Ascend had requested the Mary Kay O'Connor Process Safety Center to perform a flow pattern determination and a deflagration/detonation hazard analysis. This study was performed using the Lockhart–Martinelli correlations described in the Engineering Data book and the Multiphase flow handbook.