BSEE and Texas A&M Engineering Experiment Station Announce Agreement

The Bureau of Safety and Environmental Enforcement (BSEE) announced on November 7, that the Mary Kay O’Connor Process Safety Center (MKOPSC) was selected to manage the Ocean Energy Safety Institute (Institute). The five-year agreement, with initial funding of $5 million from BSEE, will provide a forum for dialogue, shared learning and cooperative research among academia, government, industry and other non-government organizations in offshore-related technologies and activities that help ensure environmentally safe and responsible offshore operations. MKOPSC is partnering with Texas A&M University, University of Texas and University of Houston to manage the institute.

“I look forward to working closely with our partners at the Institute on finding ways to improve safety offshore,” said BSEE Director Brian Salerno. “The Institute will develop a program of research, technical assistance, and education that serves as a center of expertise in offshore oil and gas exploration, development, and production technology, including frontier areas, such as high temperature/high pressure reservoirs, deepwater, and Arctic exploration and development.”

Continued on page 3
On the morning of October 31, 2013, Dr. Trevor Kletz passed away peacefully and calmly. Our hearts are heavy and we are immensely saddened at the passing of Trevor Kletz; however, we must celebrate Trevor’s life and accomplishments. Trevor lived a very successful and productive life. He leaves behind a tremendous legacy that will for a long time impact growth and development in process safety in the chemical industry. Some have characterized Trevor as a scholar, some have called him an astute practitioner, and some hold him in high regard for his unique ability to transform complex issues into simple messages that he communicated in his unique way. Above all, Trevor was a visionary and a trailblazer, the likes of whom come in our midst only every few centuries. The Mary Kay O’Connor Process Safety Center has lost a great supporter and friend. I personally have lost a teacher, mentor and friend.

We extend our sincere and heartfelt condolences on this sad occasion to the family and friends of Trevor Kletz.

M. Sam Mannan
Fall 2013
“The three partner universities represent a unique combination of capabilities and resources needed to address the needs for the Institute,” said Dr. M. Sam Mannan, who is PI for the project. “We applaud BSEE for supporting this major undertaking of national importance that will impact ocean energy safety for the nation and world for years to come.”

During his visit to the Center, BSEE Director, Brian Salerno toured the facilities on the Texas A&M campus in College Station and spoke with university professors, TEES researchers, and officials from the University of Houston and University of Texas about how the Institute will be managed. The facilities visited by Director Salerno included the Offshore Technology Research Center, which is capable of large scale simulations of the effects of wind, waves, and currents on fixed, floating and moored floating structures.

The Institute stems from a recommendation from the Ocean Energy Safety Advisory Committee, a federal advisory group comprised of representatives from industry, federal government agencies, non-governmental organizations and the academic community. The Institute will be an important source of unbiased, independent information and will not have any regulatory authority over the offshore industry. It will be a collaborative venture that will also include involvement on science and technology issues from the Bureau of Ocean Energy Management.
2013 International Process Safety Symposium Continues with Record Attendance

The Mary Kay O'Connor Process Safety Center 16th annual international symposium “Beyond Regulatory Compliance, Making Safety Second Nature,” held on October 22-24 drew record attendance for its third consecutive year. More than 600 participants from industry, government and academia attended the symposium.


In addition to the highlighted keynote addresses, nearly 100 presentations were given on various safety-related topics, including safety culture/operational discipline, risk analysis, process management for safety, and inherent safety. Summaries of the papers are featured beginning on page 11. Exhibits from over two dozen companies that demonstrated products, technology and software related to process safety were displayed at the symposium.

On Wednesday evening, the Center sponsored a banquet for guests at the Traditions Golf Club. Entertainment for the evening was provided by the following Aggie Student organizations: Swaram A Cappella group, Akh Mastani, A.S.A. Dance Team, and the Aggieland Mariachi group.

A highlight of the symposium is the presentation of the Merit and Service awards. The annual Trevor Kletz Merit Award recognizes individuals who have made significant contributions to the advancement of education, research, or service activities related to process safety concepts and/or technologies. The contributions or accomplishments leading to the annual Merit Award need not be associated with the Center, but must fit within the central theme of the Center: Making Safety Second Nature. In establishing the Merit Award, the Steering Committee underscored the importance of promoting and recognizing significant contributions and accomplishments of practitioners and researchers worldwide. The 2013 Merit Award was presented to Pete Lodal. Lodal is a Technical Fellow and group leader of the Plant Protection Technical Services group at Eastman Chemical’s site in Kingsport, TN. He has been with Eastman in various positions for more than 32 years, 17 years in process engineering, and the past 15+ years in process safety and loss prevention. He is Eastman’s representative to the Center for Chemical Process Safety (CCPS) Technical Steering Committee, is the chair of the CCPS Planning committee, and is the past chair of
Pete chairs the Process Safety Subteam for the American Chemistry Council (ACC), and serves on the International Editorial Board for the Journal of Loss Prevention in the Process Industries. Pete is the author or co-author of over 20 papers and publications, a Fellow of the American Institute of Chemical Engineers (AIChE) and a Fellow of the Center for Chemical Process Safety (CCPS). He is a past Director of both his local AIChE section (East Tennessee), and is the 2010 Chair of AIChE’s Safety and Health division. Pete holds BS and MS degrees in Chemical Engineering from Purdue University, and is a registered Professional Engineer in the state of Tennessee.

The Harry H. West Service Award, on the other hand, was established by the Steering Committee to honor and recognize individuals who have contributed directly to the success of the Center and have played a significant role in advancing the mission of the Center. The Service Award was presented to Dennis Parker. Parker is a consultant in leadership, energy, project and operations management, commercial disputes, chemical process safety, nuclear safety culture assessment, environment and sustainability, and medical safety culture. In 2002, he retired from Conoco, Inc. where he was Vice President, Safety, Health, & Environment in charge of Global Functional Excellence, Corporate Safety, Health, & Environmental Auditing, Orphan Site Management, Sustainable Growth and Development, and SH&E litigation coordination. Prior to this position, he was a Refinery Manager with Conoco, Inc. in Ponca City, Oklahoma.

The Lamiya Zahin Memorial Safety Scholarship was presented to Pranav Kannan. In fond and living memory of Lamiya Zahin, the Artie McFerrin Department of Chemical Engineering and the Mary Kay O’Connor Process Safety Center have established the Lamiya Zahin Memorial Safety Scholarship. On July 31, 2004, an explosion and fire occurred in a university apartment on the Texas A&M University campus. Four members of the family of Saquib Ejaz, a chemical engineering graduate student -- were critically injured and hospitalized. Saquib’s mother and his four-year old daughter, Lamiya Zahin subsequently passed away a few days later in the intensive care burn unit at Galveston Hospital from injuries sustained in the fire. Graduate students in the department are encouraged to apply for the scholarship by writing a 1000-word essay on “Safety Innovations in Research Projects.” Honorable mention recipients were Preetha Thiruvenkataswamy and Monir Ahammad. Lamiya’s mother, Lufthansa Kanta handed out the awards to the successful recipients.
Recent Publications


Student News

Fall Graduates

Szu-Ying Huang, December 2013 graduate with a Ph.D. in Chemical Engineering has accepted a position with BASF in Michigan.

Wendy Lim, December 2013 graduate with a MS in Safety Engineering has accepted a position with Technip.

AIChE Fuels & Petrochemicals Best Presentation Awards

F&PD help a pilot program held a competition for the Best Presentation Award at the Spring 2013 AIChE Meeting. Byung Kim, recent Center graduate, received an award for his presentation "Key Findings of Experimental and Theoretical Studies On Forced Mitigation System for an LNG Spill Emergency." The objective of the award is to increase the participation and the quality of the papers presented at the conference. The session chairs evaluate the presentations based on guidelines prepared by the awards committee. The criteria used were – Organization, Topic Knowledge, Creativity, Visual Aids, Summary, Marketing/Sales Content (negative score), and Stage Presence.

Recent Publications—Continued


Bureau Veritas visited on October 7 for discussions on potential collaborative efforts. They also toured the MKOPSC labs and visited the Brayton Fire Training field. Bureau Veritas representatives were: Raul Vieira, Vice President; Everard Taylor, Julia Carval, and Gerardo Carmona, Risk and Safety Engineers; and Xinrui Li, Sr. Risk and Safety Engineer.

Hans Pasman made one of his two annual visits to the Center. During this visit, he met with all graduate students and Center research staff.

Roy Sanders visited the center. He gave a lecture in process safety and met with staff and students.

Simon Waldram spent a month at the Center in October. During this visit, he met with all graduate students and Center research staff.

Adam Markowski spent a week at the Center in October. He is from the Technical University in Lodz, Poland.

Maria Papadaki spent two weeks in October at the Center working on research with students. She is from the University of Western Greece.

Luc Vechot, Valeria Casson, and Tomasz Olewski, all from the MKOPSC-Doha and faculty at TAMUQ, spent a week at the Center in October.

Dr. Ian Cameron from the University of Queensland spent November 14 and 15 at the Center presenting a course on the BLHAZID software to Center graduate students and staff.

Adjunct faculty Dr. Scott Davis came to the Center on September 19 to visit with students about research projects.

Adjunct Faculty Dr. Chad Mashuga has been to the Center on multiple occasions. He gave a lecture in a process safety course, and visited with students about explosion research.

Mr. John Bresland has visited the Center to lecture in the process safety course and to visit with students.

Other visitors to the Center include Phillippie Viennot with Air Liquide and Rick Loofs and colleagues from ATMI.

Feng Wang with the Beijing University of Chemical Technology, arrived for his year long visit at the Center.
Upcoming Speaking Events

January 23
Hans Pasman
Process Safety: A Battle Against (Economic) Competition and Complexity
Dutch Contact Group on Health and Chemistry, and Dutch Association of Safety Experts
Amsterdam, The Netherlands

March 11-14
Sam Mannan
US NSF - China Workshop on Sustainable Manufacturing
Wuhan, China

March 15-19
Sam Mannan
Keynote Presentation
American Society of Safety Engineers-Middle East Chapter—11th Professional Development Conference and Exhibition
Kingdom of Bahrain

March 24-26
Sam Mannan
Qatar Process Safety Symposium
Doha, Qatar

March 30-April 3
Sam Mannan
AIChE Spring Meeting
New Orleans, Louisiana

Case History—Explosion at Williams Olefins plant in Geismar, LA
Presented by Sunder Janardanan at the October 21 Steering Committee Meeting

Catastrophe struck the Geismar, Louisiana olefins plant on June 13, 2013, when the release of hydrocarbon vapors (containing essentially propylene) caused a vapor cloud explosion. The release took place from a stand-by reboiler connected to the propylene fractionator. The release was caused by the rupture of the reboiler, which was heated after inadvertent addition of hydrocarbon. Investigations showed that the reboiler was disconnected from the pressure relief systems, which led to the over-pressurization of the system. OSHA and CSB are currently inspecting the matter to provide a detailed account of the incident. The issues, which need proper justification, are: 1) Was a leak in the control valve responsible for the accidental release? 2) Why was heat added to a standby reboiler? 3) Was the operator aware of the detachment of the reboiler from the pressure relief system?

The plant had several concerns regarding its gas emissions in the past. Until the day of the disaster, the plant management was engaged in negotiations with the Louisiana Department of Environmental Quality (DEQ). Apart from this, a propylene leak from a pipeline had led to a plant shutdown six months prior to the actual incident. The chemical propylene has been responsible for many explosions in the past. Some notable occurrences are the explosions at Dutch State Mines (Netherlands, 1975), Los Alfaques (Spain, 1978), Praxair (USA, 2005) and Formosa Plastics Corporation (USA, 2005). The role played by relief valves in enhancing process safety and the importance of fire protection systems and fireproofing as mitigation techniques were clearly established by these incidents. The integration of past knowledge and present situations could have averted the disaster.
Case History—Storage Tank Explosion
Presented by Ning Gan at the October 24 Technical Advisory Committee Meeting

On Aug 19, 2013, a 10,000 gallon fuel oil tank exploded in the Reynolds Industrial Park located in Greenville, Pennsylvania. In the early afternoon of that day, a welder was assigned to do hot work around the storage tank. Shortly before 5:27pm, the 911 emergency services received a call reporting fire and smoke in the area. A moment later, the blast occurred which caused the tank to be propelled across the street. The worker who was welding scaffolding onto the ladder of the tank at the time of the explosion was killed. Around 5:45pm, firefighters and crews from Brownie Oil Company arrived at the scene. They reported having the fire under control before 6pm.

The consequences of this accident included the death of the welder, spillage of 7,500 gallons of fuel oil, and damage to a nearby residential area. The possible causes of the accident are liquid spill through a hole in the tank, or ignition of fuel oil vapor inside the tank. Similar accidents have happened in the past, such as the ConAgra Foods explosion in Boardman, Oregon, in 2009, which involved one fatality. This explosion was also caused by the leakage of flammable materials at the bottom of the tank. Hot work is recognized as one of the most common causes of fire and explosion since it provides sufficient ignition energy and sufficient heat to vaporize liquids. Lessons should be learned from these incidents so that tragedies can be avoided in the future.

Case History—A Survey of Ammonia Incidents in Industry
Presented by Josh Richardson at the October 24 Technical Advisory Committee Meeting

Ammonia incidents have often occurred across industries, from the chemical industry which often uses it to create fertilizer, to the food processing industry which mainly uses anhydrous ammonia as a source of refrigeration. Though the hazards of ammonia are well known across all industries, the number of OSHA citations per inspection has stayed fairly constant, and the number of ammonia incidents in industry is only gradually falling.

Several cases were presented, the first being the Borden Ice Cream Plant Explosion in downtown Houston in 1983. This was caused by a leak of ammonia finding a source of ignition, thought to be a broken light bulb, causing the ammonia to explode. Before this incident, it was not well accepted that ammonia was able to cause such a massive explosion. The second case presented was the Millard Refrigerated Services ammonia leak in Theodore, Alabama, in 2010. This was a food industry incident where over 150 workers and numerous members of the public were exposed to ammonia from an ammonia release of over 30,000 lbs from an industrial refrigeration unit. Finally, two recent cases from August and September 2013 were briefly touched upon. Trends from OSHA citations were identified by taking a random survey of 28 citations identifying ammonia or an ammonia system as a component. It was found that 19 of these were from the food processing industries, as compared to only 5 for the chemical industries. It was also found that the food industry citations were far more likely to identify massive deficiencies in the company’s PSM program as a whole than the chemical industry citations, which were usually for just one or two components of a deficient PSM program.
Randy Freeman with S&PP Consulting presented, “Impact of LOPA Uncertainty on Safety Instrumented System Design.” Layer of Protection Analysis (LOPA) is a semi-quantitative risk evaluation tool. The methodology is widely used in setting Safety Integrity Level (SIL) targets for Safety Instrumented Systems (SIS). LOPA is often used to evaluate the adequacy of existing protective systems against corporate risk targets. The LOPA method is based on the use of conservative estimates of the initiating events and failure probability on demand of protective systems. Freeman explored the impact of the uncertainty in the LOPA estimated frequency of a scenario in setting target Risk Reduction Factors (RRFs) for SIS design.

Alex Sellers with Missouri University of Science and Technology presented, “Now What? After the LOPA Is Done.” The idea of “Safety Critical” equipment, devices, and procedures is a concept that is commonly used in the chemical process industries, although the concept is not specifically mentioned in OSHA’s Process Safety Management Standard. In many cases, classification as “Safety Critical” relies solely on engineering judgment. This approach is subject to a particular engineer’s experience, opinions, and prejudices, and can lead to an uneven distribution of “Safety Critical” functions across an organization and may lead to undue focus on high publicity hazards, rather than high risk hazards. This in turn can lead to a misallocation of finite safety resources, preventing some high risk hazards from receiving the attention they deserve.

Rinav Shah with Reliance Industries Limited presented, “Layer of Protection Analysis of Light Cycle Oil Hydrocracker at RIL Sez Refinery.” Rinav described a Layer of Protection Analysis (LOPA) recently conducted for Light Cycle Oil Hydrocracker (LCOHC) and associated facilities to identify the risk arising due to any malfunction affecting operating personnel and to carry out a more detailed study of existing safeguards after a baseline Process Hazard Analysis (PHA).

Megan Weichel with DNV presented, “Utilizing Field-based Risk Registers to Improve Process Safety Culture and Competence.” She discussed how the use of facility-based risk registers provides organizations of any size an opportunity to introduce the concepts of hazard identification, risk analysis, and risk control to personnel who otherwise might not participate in these types of activities. Weichel provided insight into how, if implemented correctly, these risk registers can provide a sense of ownership in the field regarding process safety, while still providing a method for improving personal safety and environmental protection.

Ron Chittim with API presented, “API Process Safety Site Assessment Program - Promoting a Culture of Process Safety.” A couple of years ago API and AFPM (formerly NPRA) joined together to address improving process safety performance with the goal of preventing process safety events at refineries and chemical plants. API, AFPM and the industry wanted this effort, known as Advancing Process Safety, to be focused on higher risk process safety activities; refining and petrochemical focused; voluntary; and provide opportunities to communicate and share experiences and knowledge. The intent of all the programs is to raise the level of process safety performance at the sites to prevent process safety events.

Clyde Young with John M. Campbell Co. presented, “Debrief: The experiential learning cycle, process safety Competency, Safe Work Practices, Identifying and Reporting of Near Miss/Incident Data.” A pillar of Risk Based Process Safety (RBPS) is Learn from Experience. The work we do and the processes we use to analyze our work provide significant learning opportunities to enhance process safety competency. This is a derivative of Kolb’s experiential learning cycle, but many times we fail to take advantage of the learning opportunities available to us unless there is an incident or a near miss. Young presented a simple method for debriefing the job tasks we perform to close the loop on this cycle and capture appropriate data to develop competency, work safety and capture near miss/incident data quickly and efficiently.

Luc Vechot with Texas A&M University at Qatar presented, “Integration of Process Safety in Chemical Process Design: Initiating a Different Way of Thinking.” Teaching process safety in Engineering curriculum in general and in Chemical Engineering curriculum in particular is becoming more crucial, giving the worldwide advancement and developments in process industries.
Courses on chemical process safety usually involve, but are not limited to, the application of different principles and fundamentals studied in engineering courses (from mathematics and statistics up to transport phenomena and process design) to process safety. Vechot discussed the experience gained from teaching chemical process safety courses to the senior students in chemical engineering department at Texas A&M University at Qatar (TAMU-Qatar).

Ben Poblete with Atkins presented, “Risk Management Decision Making (RMDM) Methodology.” The management of risks for any oil and gas organization is dependent on the consistent, measurable, repeatable and auditable method of making decisions. The difficulty of decision making across diverse asset portfolios (i.e. offshore platforms, onshore gas plants, pipelines, rail & road transport, chemical refineries) is that there are differences in life cycle activities and the focus on their assets, strengths, weaknesses, threats and opportunities. Poblete proposed a methodology that will aid in the decision making process by unitizing the risk, from the different business units or assets or organizations with a common unit of measurement or comparison.

Sonny Sachdeva with MKOPSC presented, “Development of an Effective Framework for Shift Handover.” Shift handover is the procedure by which an outgoing shift communicates critical process information to a new shift. By doing so, the new shift is made aware of any hazards or issues that need attention at the facility. By communicating recorded information (from log books, audio recordings, software logging systems, etc.), incoming workers know what they are dealing with and respond accordingly. Without this information, operators are left in the dark. Poor shift handover stems from problems with information. Whether information is inaccurate, ambiguous, inaccessible, or communicated poorly, low quality information can give workers a false picture of operations. Many catastrophic incidents in the chemical and petroleum industry have been caused by poor shift handover, e.g., the Piper Alpha Disaster and the BP Texas City Explosion.

Michelle Murphy with iMosaic Corporation presented, “The Role of Chemical Reactivity Data in Process Safety Management.” Chemical reactivity is addressed throughout the requirements of OSHA’s Process Safety Management (PSM) Standard. It is specifically required in the process safety information element. In addition, it is necessary input to process hazard analyses, operating procedure development, emergency relief system design, and mechanical integrity. As the understanding of the impact of chemical reactivity hazards on the operation of a chemical process continues to develop, it is important to have a method for developing this data. Equally important is a method for extracting meaningful reactivity information from the data and incorporating it into process safety. Murphy presented a process for evaluating chemical reactivity hazards using an Accelerating Rate Calorimeter (ARC®), and explained how to extract information from this data to help define process safety elements such as safe upper and lower limits, emergency relief system design, etc.

Nalluri Prabhakar with Reliance Industries Limited presented, “Building Safety Culture – RIL Experience.” Safety culture has been explained with different descriptions by various authors as a multifaceted subject. On rationalisation the safety culture of the organisation is determined by the human characteristics, technical knowledge and environment factors which lead to “Safety by Choice” rather than “Safety by Chance”. Prabhakar discussed the safety culture of Reliance Industries which has considerably changed the perception towards safety and improved its safety performance on daily, weekly, monthly and yearly basis, thus changing from a “production” oriented operation to a “safe production” mind set.

Angela E. Summers with SISTECH Solutions presented, “Safety controls, alarms, and interlocks as IPLs.” Layers of Protection Analysis (LOPA) evaluates the sequence of events that first initiate and then propagate to a hazardous event. This semi-quantitative risk assessment technique can expose the role that automation plays in causing initiating events and in responding to the resulting abnormal operation. Automation that is specifically designed to achieve or maintain a safe state of a process in response to a hazardous event is now referred to as safety controls, alarms, and interlocks (SCAI). Guidelines for Initiating Events and Independent Protection Layers addresses four basic types of SCAI: safety controls, safety alarms, safety interlocks, and safety instrumented systems (SIS). Summers discussed the design, operation, maintenance, and testing practices necessary for SCAI to be considered as independent protection layers (IPL) and
provided guidance on claiming multiple layers of protection in the basic process control system.

**Thomas N. Williams, Jr.** with Honeywell Process Solutions presented, “Procedural Automation.” Establishing effective procedures is a significant task for the process industries. Ensuring they are understood and used is a challenge. The Abnormal Situation Management Consortium® (ASM®) has studied procedures to determine how to make them effective, and has published a guideline based on considerable field research. The process industries have begun to automate procedures at various levels (or styles) to ensure procedure compliance, reduce operator workload, and to reduce incidents. Recently the ISA has established a committee, ISA-106, to develop a technical report and a standard to simplify and improve procedural automation. Williams presented an overview of some new developments, including ASM findings, a brief update on the ISA-106 Technical report, and simplified examples from our own work.

**Greg Hardin** presented, “Dealing with an Imperfect World.” Various standards, technical reports, and numerous books and articles provide a wealth of information about the Safety Lifecycle and requirements for its implementation. However, implementing the lifecycle in the real world can be challenging, especially when different phases of the lifecycle are implemented by different organizations. Acting as a consultant to an owner/operator of a chemical facility one must be careful not to overwhelm the staff of the facility with all the details at once (assuming they have only a minimal background in functional safety). If bringing an existing facility into compliance with the recent standards appears too daunting, the decision to take any action at all can be deferred.

**Jason E. Spearow,** with Smith & Burgess presented, “Before You Fix the Relief Valve Problem - Careful considerations When Mitigating Inadequate Relief Systems Designs.” In the oil and gas industry, changes are constantly made to existing equipment and processes. These changes often require modifications to the relief systems design. There are many options that could address the concern, but typically there is one option that is more economical than the others while still satisfying all safety requirements. Certain operational and economic considerations tend to be overlooked when these relief systems modifications are made, resulting in unnecessary capital costs, wasted engineering hours, or potentially unsafe design. Spearow reviewed some representative cases where existing relief systems were inadequate, and the more common mitigations raise additional concerns.

**Adam S. Markowski,** with the Industrial Safety Department, Faculty of Process and Environmental Engineering at the Technical University of Lodz presented “Paradigm of Process Safety.” Safety has always been a key element of all engineering disciplines, especially of chemical engineering. The background for process safety and the incidents that defined process safety go as far back as the Flixborough incident in 1974 in the UK and even earlier in USA. Through all these years, the regulations, knowledge and experiences have rapidly increased in many aspects of process safety design and operation. Markowski presented a set of practices of process safety indicating the most important principles for efficient safety assurance. The proposed paradigm, as universally recognized principles, can be employed for preparation of education and training programs within process safety as well as to provide model problems and potential solutions for the researchers.

**Brian D. Rains** with DuPont Process Safety/Operations Risk Management presented, “Establishing a Superior Bottom Line via Process Safety Management Excellence.” Companies are fundamentally in business to make money. With these profits, shareholders are compensated, projects to deliver future profits are funded and employees are rewarded. It is impossible to make money, however, if losses from unplanned events, even process safety incidents, are of such magnitude and/or frequency that profitable operations are not steadily achieved. The Fundamental Value Proposition for Process Safety Management (PSM) Excellence is for companies to achieve “triple bottom line” results; profitability plus safety and environment excellence. Rains described how to quantify the financial, functional and emotional factors that will help company leaders make sound “triple bottom line” investments in PSM Excellence.

**Roy E. Sanders** presented, “Keep a Sense of Vulnerability: For Safety’s Sake.” Excellent safety performance is our goal. But Safety is not bankable. Long periods of time without significant incidents may in some cases create an
unwarranted sense of complacency and relaxation of discipline. We must encourage a healthy respect for process industries chemicals, equipment, processes, procedures and all the things we do for process safety management. Continuous incident free operations may result in a slackening up of our well established practices and procedures. Sanders offered some suggestions on raising the awareness by sharing focused examples of past mistakes and some catastrophic blunders.

Joe Veasy with aeSolutions presented, “Control Systems, The Distinguishing Factors between Common Cause and Systematic Failures.” Quantification of common cause is an integral part of the safety integrity level (SIL) verification process for a safety instrumented function (SIF). There is a general recognition that its value can dominate the failure modes leading to it being the major contributor to overall probability of failure on demand (PFD) of a system. Many models have been developed in attempts to simplify and standardize this quantification. There is a perception that systematic failure has a somewhat limited impact on the overall integrity level. Veasy demonstrated that this term can easily dominate the system failure rate and overall PFD, and he discussed the two concepts as they relate to the entire ANSI/ISA 84.00.01 safety lifecycle and to each other.

Manuel Hernandez with Fluor Corporation presented, “Implementation of Safety System Programming Changes at an Operating Facility.” Hernandez discussed the development and implementation of safety system programming changes for a large refinery as part of a multi-unit upgrade project. Programmable Electronic Systems (PES) based safety systems can offer the option of making online programming changes so that operations can continue without having to shut a unit down. However, making changes to an operating safety system means that the entire unit covered by that system is placed at risk during and after the change is made. The resulting consequences can potentially be much more severe than shutting down the unit or plant. Therefore, meticulous panning in development and implementation is required to ensure that changes are made correctly and safety.

Ryszard Sauk with the Office of Technical Inspection, Poland presented, “Application of the Graph Theory and Matrix Calculus for Optimal HAZOP Nodes Order Determination.” Sauk discussed a method for determining the optimal order HAZOP nodes, as well as the issues related with a description of streams flow of information among the elements of process systems. Determination of the optimal HAZOP nodes sequence (a sequence of nodes being sources of information streams are analysed before the nodes receiving the streams) allows avoiding the necessity of assuming and afterward verifying an existence of possible deviation and their transmission from the upstream nodes to the one being the subject of the analysis. This procedure constitutes a difficult task for process installations with a complicated structure. The optimal order of HAZOP nodes can be determined by using the graph theory and the matrix calculus.

Renato Benintendi with Foster Wheeler presented, “Identification and Analysis of the Key Drivers for a Systemic and Process-Specific Reactive Hazard Assessment (RHA) Methodology.” The development and adoption of Quantitative Risk Assessment (QRA) techniques in process safety studies have shown a growing level of detail and completeness. A comparable accuracy and holistic degree has not been generally achieved in Reactive Hazard Assessment, as the incident case history and the methodological gaps demonstrate. Benintendi discussed a new systemic quantitative reactive hazard assessment methodology to be implemented within the QRA activity and Consequence Analysis.

Eric Chang with Shell International Exploration and Production presented, “Process Safety Management for Subsea Oil and Gas Production System in the Gulf of Mexico.” Subsea oil and gas production systems in the Gulf of Mexico (GoM) pose a unique challenge for process safety management. Subsea production systems are located on the seabed in deep water and not easily accessible for inspection and maintenance. Process safety is critical for deepwater operations. Process safety incidents in the subsea world have unacceptable human, environmental, and financial costs as evident in BP’s Macondo subsea blowout. Chang presented a systemic view of how process safety management is being implemented on subsea system in the Gulf of Mexico, design and safeguarding philosophy, assurance framework, and lifecycle integrity management function as key building blocks for process safety. He also discussed opportunities for improvement in current process safety management practices.

Melody Soderberg with ioMosaic Corporation presented, “Simplified Process Safety Management for Smaller Companies.” Small companies that don’t exceed the threshold quantity requirements to be covered...
by OSHA’s Process Safety Management (PSM) of Highly Hazardous Chemicals Standard are still handling hazardous materials that may pose risks to their employees and the public. However, many of these companies have limited resources and find the idea of implementing an entire PSM program daunting. These companies should start with a limited process safety program work towards establishing a culture that recognizes process safety to be equally important as personnel safety. Once this initial framework and culture are in place, companies can slowly build and adapt their PSM program to appropriately manage their risks. Soderberg presented a practical framework and provided steps on how to integrate a simplified PSM framework into your existing personnel safety program.

**Philip M. Myers** with Advantage Risk Solutions presented, “Overcoming PSM Challenges for Small Sites and Chemical Companies: Observations, Insights and Guidance from the Trenches.” Complete implementation of the OSHA Process Safety Management regulation can be a daunting task for small plant sites and chemical companies. Typically, small companies and sites are much more resource limited in terms of finance and manpower. There may be no process safety professionals on staff, leaving the company without the associated current process safety expert knowledge, skills, abilities and attendant tools. Myers presented observations and insights from years of experience working “in the trenches” with small companies - regarding common pitfalls and limitations at small sites and guidance for successful methods to move forward and overcome obstacles encountered.

**Liu Yang-yang** with Tianjin University presented, “Management of Life Extension for Topside Process System of Offshore Production Platforms in Chinese Bohai Bay.” Issues arising from life extension (LE), present key challenges for offshore production platforms in China. Technological advances in exploration and production mean that production platforms in Chinese Bohai Bay have many developments that are now operating beyond their original design life. As equipment ages, there are increased challenges to maintaining their integrity. Yang-yang provided an overview of issues related to LE management in UK and Norway. Further, combining the LE management system in Norway with the current situation in Chinese Bohai Bay, an LE management system model was designed.

**Michael Bearrow** with Optimized Systems and Solutions presented, “Best Practice Management of Change & PSSR Process.” Management of Change (MOC) and Pre Start-up Safety Review (PSSR) are still the most challenging elements of OSHA’s Process Safety Management (PSM) standard, the EPA’s Risk Management Program (RMP) rule, and now, the US Department of Interior’s Bureau of Safety and Environmental Enforcement’s Safety and Environmental Management Systems (SEMS). Even though the PSM standard has been around since 1992 and the industry has been managing change for several decades, we still can get it wrong, sometimes with disastrous results. The mindful or diligent efforts of many working in concert are necessary to ensure that change is identified, analyzed and executed in a quality way. Just when we get it right on paper and get the workforce up-to-speed, we have employee turnover, neglect and sometimes regulatory change. New actors and a constantly changing script make it hard to manage change efficiently and effectively. Bearrow discussed how the chemical process industry has defined the MOC and PSSR best management practices and how they should be automated.

**Mohammad Alkazimi** with Missouri University of Science and Technology presented, “Investigating Risk Reduction and Mitigation in the Petroleum Industry.” The oil and gas industry uses different risk assessment tools to mitigate failures. However, accidents on different scales could not be prevented as the industry has been negatively impacted by various major accidents. Alkazimi discussed Risk in Early Design (RED) as a risk assessment tool in identifying potential failures in oil and gas industry. Twenty-six major accidents in the industry underwent RED evaluation to identify potential causes of failures that could interrupt operations. Corresponding accident reports were used to validate RED results. The results of RED analysis confirm the failure modes of the accidents, in addition to potential failures, that can suspend process operations.

**Mark Minter** with PinnacleAIS presented, “Performing Assessments of Mechanical Integrity Management Systems.” Numerous catastrophic events have occurred in the petro-chemical manufacturing industry. The lack of adequate management systems, both in the form of written programs and the implementation of those programs, has been a major causal element in almost
every one of these events. OSHA federal regulation 29 CFR 1910.119 Process Safety Management, in effect since 1992, clearly spells out the requirement to have adequate written programs. This document states the requirement that each employer has to certify that they have evaluated compliance at least once every three years to ensure that the required procedures and practices are adequate and are being followed. Minter addressed two key items by providing an overview of how to approach the compliance verification process for mechanical integrity management systems and discussed the key elements required for such a process and the personnel required to support its effectiveness.

**Hans Pasman** with MKOPSC presented, “The Bumpy Road to Better Risk Control, A Tour d’Horizon of New Concepts and Ideas.” Perfect thoroughness, certainly in complex situations, requires an amount of time with which efficiency will be in conflict. For improved situational awareness, sufficient resilience, and adequate risk control, we must adopt a top-down system approach. Hazard scenarios possible in the system, with all its entangled interactions of hardware, procedures, and humans shall be identified bottom-up and causal relations made clear. Fortunately, in recent years two potentially helpful tools have become available: Blended Hazid, a vastly improved, heavily computerized combination of HazOp and FMEA, and Bayesian networks, a tool to model cause-effect structures allowing inclusion of uncertainty information. Pasman explained the directions these developments are advancing and the openings they provide for process safety research and risk assessment, resulting in improved risk control.

**C.S. Kabir** with Hess Corporation presented, “Wellbore Safety and Integrity during Hydrocarbon Production.” Wellbore safety and integrity pertaining to production of oil and gas are critical for sustained production within the regulatory guidelines. Potential integrity issues originate from various sources. The purpose of this talk is to identify some of these sources and outline the state-of-the-art approach to modeling en route to mitigating these hazards. Kabir discussed annular-pressure buildup (APB), sustained-casing pressure (SCP), and leaks in gas-lift valves triggering unwanted backflow during well shut-in.

**Maureen Orr** with Agency for Toxic Substances and Disease Registry, presented, “Public Health Consequences of Acute Ammonia Releases.” Ammonia is an ingredient in many cleaning supplies, fertilizers, refrigerants and is also used in illicit methamphetamine (meth) production. Because of ammonia’s volatility, exposure can occur quickly and result in a large number of injuries and costly public health actions. The analysis of trends and public health consequences of these events is critical to identify areas to target for prevention.

**Henk W.M. Witlox** with DNV Software presented, “Modelling of Time-Varying Dispersion for Elevated Pressurised Releases without Rainout.” Many commonly used atmospheric dispersion models are limited to continuous or instantaneous releases only, and cannot accurately simulate time-varying releases. Witlox discussed a new enhanced dispersion formulation accounting for time-varying effects resulting from a pressure drop in a vessel or pipe, and presuming no rainout. This new formulation is implemented in the Unified Dispersion Model (UDM), and is planned to be included in a future version of Phast.

**Tony Rocha-Valadez** with MKOPSC presented, “Evaluating the Consequence of Sustained Casing Pressure during Well Integrity Testing.” Sustained casing pressure (SCP), exhibited in many onshore and offshore wells, is defined as any measurable casing pressure that rebuilds after being bled down, attributable to causes other than artificially applied pressures or temperature fluctuations in the well. Gas leakage, leading to SCP, may occur through the poor cement bond between the casing and the formation, packer, and/or the casing itself. Bad cement bond can be attributed to mechanical or thermal stresses, during the life of the cement, or to a poor cement job. Most regulations require the monitoring, testing and, eventually, the elimination of SCP. However, test data analysis is mostly qualitative and limited to arbitrary criteria, therefore lacking consensus. Rocha discussed a theoretical framework and model for quantitative analysis of SCP test data.

**Graeme Ellis** with ABB Consulting presented, “Evergreen HAZOP as an essential part of your PSM system.” PHA Revalidation studies including HAZID and HAZOP are essential elements of an effective PSM system for existing facilities, helping to identify and eliminate significant risks and thereby maintain continuous improvement in process safety performance. The need for PHA Revalidation for an operating asset, typically carried out every 5 years to meet company or regulatory
requirements, has been recognized as good practice in the global process industry. Ellis discussed current approaches for PHA Revalidation on existing plants, based on the authors’ extensive experience in the Oil & Gas, Petrochemicals and Chemicals sectors.

Yuan Lu with Occidental Oil and Gas Corporation presented, “Development of Risk Screening Tool for Enhanced Oil Recovery Operation Using CO2.” Occidental Oil and Gas Corporation (Oxy) is the largest Enhanced Oil Recovery (EOR) operator using carbon dioxide (CO2) in the United States. An accidental release of CO2 could potentially impact public receptors and pose a risk of asphyxiation at a high concentration in the breathing zone. Lu presented Oxy’s development of a risk screening tool for CO2 EOR operations to assist decision-makers in identifying risks and applying appropriate safeguards.

Cynthia Spitzenberger with DNV presented, “A New Approach to Offshore Risk Modeling.” The cost and license to operate issues associated with major accidents offshore have increased the focus on major accident risk reduction. Part of the solution will come from safety and environmental management systems (SEMS) and more specific prescriptive requirements, but some will involve detailed risk analysis to assess design layout alternatives, fire and blast protection, and escape and evacuation measures. The numerical and hazard models available to date have been adequate, by answering key questions about risk indicators and major hazard contributors. However with increasing need for finer details and advanced comparison evaluation, a step change in the risk assessment abilities and evaluation is required. To demonstrate the new approach, she discussed a study that was performed based on a typical platform analyzed with a traditional method and with the new offshore risk assessment tool.

Irfan Shaikh with MMI Engineering presented, “Enhancing Facility Siting Studies with Process Hazard Analyses.” When evaluating facilities for safety, facility siting studies are demonstrated to be very important in the oil and gas industry. The benefits of facility sitings are realized through fewer incident reports, specifically those resulting in high consequences such as multiple fatalities. The OSHA 29 CFR 1910.119 PSM regulation requires Process Hazard Analysis (PHA) studies be performed to evaluate facility sites by producing a checklist to identify concerns. A PHA is not intended to be a substitute for a detailed facility siting study but rather a screening tool to identify critical hazards. There are a few factors that assist in determining whether a detailed facility siting study is necessary and those factors are: location of the building(s), process material flammability and/or vaporization, dispersion characteristics and release scenario. Shaikh discussed incorporating these factors into a facility specific checklist for PHAs and facility siting site visits.

Sloane Whiteley with AVEVA Asia Pacific presented, “Leveraging Multi-User Virtual Plant Environments and 3D Interactive Visualization to Optimize Plant Safety: An ISO 55000 Aligned Solution Framework for Optimizing Safety Performance and Achieving Operational Excellence.” The products and equipment handled throughout the operational lifecycle impose significant safety risks; compounding this are the numerous systems, processes and regulatory requirements resulting in vast quantities of information in varying formats. Inability to access, understand and use operations and maintenance (O&M) information are cited as leading causes of safety incidents and unplanned shutdowns. The forthcoming ISO 55000 Standard Series specifies the definition, requirements and implementation guidelines for an ‘Integrated Asset Management’ solution. Whiteley discussed how it is possible to not only mitigate operational safety risks, but also enable a zero-safety incident environment via implementation of a solution framework, aligned to the ISO 55000 requirements.

John Bresland, with the Mary Kay O’Connor Process Safety Center gave the presentation entitled, “Lessons Learned from my Time in Industry and the Chemical Safety Board.” He discussed incident and investigations which occurred during his time as Chair of the Chemical Safety Board.

Alberto J. Benavides-Serrano with MKOPSC presented, “A Quantitative Assessment on the Placement Practices of Gas Detectors in the Process Industries.” Gas detection is an important safety system with interfaces to several other safety safeguards. However, the generality of the regulations, standards and recommended practices in conjunction with the inherent challenges of the gas
Summary of Symposium Presentations—Continued

detector placement problem, has resulted in a widespread use of prescriptive and qualitative detector placement strategies. In order to address this issue, a stochastic programming formulation (SP-UV) was previously proposed, developed and validated by the authors in order to take advantage of the quantitative information provided by dispersion simulations. Benavides discussed four existing approaches for gas detector placement that were implemented and compared with the previously proposed quantitative optimization-based approach using three different performance metrics in accordance to the objectives of gas detection systems.

Kris Smith with Risktec Solutions presented, “Bridging the HSE Risk Management Competence Gap.” The demands on health, safety and environment (HSE) risk management professionals have never been so high. Regulators are requiring more formal demonstration that HSE risks are being properly controlled. Companies are operating in progressively more harsh and hazardous environments in the pursuit of future resources. The ‘bar’ is frequently raised on HSE standards to meet the expectations of the many stakeholders and regulators. Smith discussed an approach to HSE risk management learning which delivers a competent professional by combining the positive aspects of training, with practical experience of applying risk management techniques in the real-world; formal assessment of competence and qualification; and, understanding of industry-specific issues.

Stephen Johnson with Fluor Canada Ltd. presented, “The Other Sensitivity Training - The Use of Sensitivity Analysis in Design HSE Modeling.” Design HSE reviews – especially the more quantitative one such as consequence models, fault trees, etc. are predicated on a variety of assumptions, as there is almost never complete data available, and realities of time & budget preclude delaying report release until all significant uncertainties are resolved. It is important, however, once preliminary results are obtained to highlight those assumptions which are either particularly sensitive or highly uncertain. Depending on the circumstances, these can either be followed up for better definition or appropriate caveats can be appended. Johnson discussed guidelines for the working Design HSE Engineer to enable timely and transparent identification of key uncertainties and sensitivities.

Greg Alvarado with The Equity Engineering Group presented, “Understanding, Measuring and Managing Uncertainty - The Role of RBI.” One of the basic building blocks for success of any risk management program is a solid understanding of the uncertainties associated with the analysis. Some of the primary reasons why Risk Management Programs, especially Risk Based Inspection (RBI), fall short in realization of benefits are lack of this understanding and how risk modeling and selected risk targets or thresholds dictate the level of acceptable uncertainty. People (expertise = knowledge + experience), work processes and technology are all important aspects of a credible and effective program. Consistency and adherence to a set of inspection effectiveness confidence level rules, examples or guidelines are important in the RBI process for managing uncertainty, as are other options to manage risk drivers, especially those associated with probability of failure.

Laurence Cusco with Health and Safety Laboratory presented, “Flammable Vapor Cloud Generation from Overfilling Tanks: Learning the Lessons from Buncefield.” The Buncefield Incident in 2005 led to a significant change in our understanding of how flammable vapor clouds could be generated from overfilling bulk storage tanks with volatile liquids. Cusco presented the findings of the Buncefield Incident investigation team and further research that has been carried out on tank overfilling releases over the last seven years at the Health and Safety Laboratory (HSL). The work has involved a combination of unique spill experiments and Computational Fluid Dynamics (CFD) modeling, and has resulted in a simple methodology for predicting the rate of flammable vapor production from overfilling tanks. He presented for the first time a unified narrative, starting with the key findings of the incident investigation and culminating with the description of a workbook method for predicting which substances and storage tanks could create significant vapor clouds.

Kees van Wingerden presented, “Piper Alpha Revisited.” 25 years ago the Piper Alpha platform accident occurred. An explosion and following oil and gas fires destroyed the platform on 6 July 1988, killing 167 people. There were only 61 survivors. As part of the Cullen enquiry, the course of the accident was reconstructed using both wind tunnel experiments with models of the module C in which the initial explosion occurred and simulations of the explosion using the FLACS CFD simulation code. Now 25 years after the accident the accident was reconstructed again using the FLACS simulation code including the ventilation pattern in Module C (for this purpose the full platform was
represented in the simulation), the dispersion phase (trying to reconstruct the release rate, release direction on the basis of the gas detector readings) and the explosion phase (investigating various ignition locations and moments of ignition). The explosion loading is analyzed in the light of the initial damage on the platform due to the explosion. To be able to reconstruct the accident the platform and especially module C were rebuilt as detailed as possible.

Timothy L. Cullina with Fauske & Associates presented, “Case Study: A Risk-Based Approach for Combustible Dust Hazard Mitigation.” The National Fire Protection Association (NFPA) issues codes to provide guidance for fire and explosion protection. Guidelines for combustible dust in wood pellet manufacturing facilities are covered by NFPA 664, Standard for the Prevention of Fires and Explosions in Wood Processing and Woodworking Facilities. In this case study, the first step was to review the process and determine which materials in the process posed a combustible dust hazard. The next step was to evaluate the existing equipment according to the prescriptive requirements of NFPA 664. In some cases, the prescriptive requirements of NFPA 664 would lead to significant and expensive changes to the process. By performing a PHA on the wood pellet manufacturing process at this facility, a risk-based approach was applied to achieve an acceptable level of risk by implementing protective systems and safeguards.

Parag Gupte with ExxonMobil Upstream Research Company presented, “CFD Dispersion Modeling Supporting the Design of a Potential Oil Shale Field Test.” He described the modeling of gas dispersion for an in situ oil shale conversion test using electric heating of fractures. This test was to be conducted by ExxonMobil at the Colony mine site in Colorado, but has now been indefinitely postponed for a variety of reasons. The pyrolysis gas released during the test was expected to contain up to 4 mole % H2S and to have a lower flammability limit of 8.9 mole %. The scope of the study was to identify any potential hazardous conditions outside on the mine bench and inside the mine tunnels.

Johannes Lottermann with REMBE, Inc. presented, “From Belts and Suspenders! Or, How You Shouldn’t Leave Yourself Exposed Despite Explosion Protection Investments.” According to NFPA 654:2013 the employer must determine and assess the explosion risk by the help of process hazard analyses as part of his obligations to ensure life safety as per chapter 4.6.1 and implement the “necessary and appropriate” safety measures. In light of the considerably lower likelihood of occurrence of explosions in comparison with fires, the question of the meaningfulness of what are often more cost-intensive investments in appropriate explosion protection measures is understandable. However, more interesting in this context is the question of what in fact is to be understood by “appropriate” explosion protection measures? Lottermann addressed this question on the basis of practical examples from the field of dust handling facilities.

Agnieszka Gajek with Central Institute for Labour Protection - National Research Institute in Poland presented, “Substances that can be Formed During Major Accidents—Legal Requirements and Procedures.” The threat of a major industrial accident is especially high in the vicinity of industrial facilities. The release of large amounts of substances can, and often will, cause extremely severe harm to humans, the environment and the infrastructure. Gajek discussed a theoretical method that can be used to predict the behavior of the substances that may be generated under loss of control conditions. Selected substances were divided into groups according to previously adopted assumptions. Then, within each group, the promoters and the probable reaction mechanisms were estimated as well as their final products were determined.

Guibing Zhao with Chilworth Technology presented, “An Easy and Accurate Method to Design Gas/Vapor Relief.” Tank discharge gas/vapor flow problems are frequently encountered in both practice and design. To find the discharge rate from a reservoir requires a trial-and-error solution of an equation for adiabatic flow with friction from a reservoir through a pipe. To perform this type of calculation, the first step is to identify whether the flow is choked or not. Zhao presented an easy and quick method to identify the choking of gas flow for an emergency relief system consisting of a rupture disk and vent piping.

Josh Richardson with MKOPSC presented, “Effect of Confinement due to Parallel Vapor Barriers on Vapor Cloud Overpressures.” Two of the main components that affect the overpressure produced from a vapor cloud explosion (VCE) are congestion and confinement - congestion being created by smaller obstacles (e.g., piping) that create turbulence and flame acceleration, and confinement being due to larger
obstacles (e.g., walls) which limit venting of gases and combustion products. Within the context of LNG facility siting applications, concerns have been recently raised regarding the potential for overpressures being produced if a flammable vapor cloud is confined between parallel rows of vapor barriers and ignited. Richardson discussed a parametric study that was conducted to predict whether the overpressures from the confined scenarios could pose higher threat to the public than the overpressures from identical, unconfined clouds.

Quentin Baker with Baker Engineering and Risk Consultants presented, “Blast Wave Clearing Behavior for Positive and Negative Phases.” Blast waves from explosion sources like a vapor cloud explosion (VCE), pressure vessel burst or high explosive exhibit both positive and negative phases, and the relative magnitude of the positive and negative phases varies among explosion sources and the specific circumstances of each source. Baker discussed the differences between positive and negative phase blast clearing behavior for a typical blast wave and the implications of including negative phase clearing in building blast damage analysis.

Majdi Rajab with CBM presented, “Condition Based Monitoring Redefined.” He discussed how Acoustic Emission (AE) together with pressure and vibration plus performance data gives a more complete diagnostic analysis that helps to more accurately determine anomalies related to reciprocating pumps, compressors and engines. This innovative patented solution allows for deeper remote analysis by providing source data to machine specialists wherever they are located. This significantly increases availability and access to information and links the experts with the knowledge needed to resolve critical machinery condition issues as quickly as possible.

Charles Soczek with DuPont Sustainable Solutions presented, “Building Resilience-A Risk Based Approach to Disaster Response and Business Continuity Planning.” Building and integrating resilience into business planning requires processes to measure, understand, develop recommendations, and prioritize risk, as well as develop and implement plans to control, mitigate, and recover should a disaster occur. Facilities operating under OSHA 1910.119 are required to develop and implement Emergency Plans and Response Capabilities based on risks, which are then used for business continuity planning. Soczek discussed the requirements and relationships for Emergency Panning and Response, Crisis Management Planning, Incident Management, Disaster Recovery, Incident Investigation, and Business Continuity Planning with an emphasis on Risk Assessment and Risk Rationalization.

Sheila Van Geffen with The Dow Chemical Company presented, “Are Today's Engineering Designs Preventing Tomorrow's Process Safety Incidents?” here is opportunity for engineering design disciplines to understand the process safety impact and future performance of the project designs. Whether the projects are completed by an in house engineering department or an Engineering/Procurement/Construction firm, the resulting chemical manufacturing process inherits both the safety systems engineered into the design and the gaps that may one day result in a Process Safety Incident. By raising the knowledge and awareness within the design disciplines of what is Process Safety and how each discipline can impact performance, projects can be delivered that prevent future incidents.

Simon Waldram with MKOPSC presented, “Future Energy Technology – Thermal Hazards of Li-ion batteries.” At the time of writing (May 2013) 50 Boeing 787 Dreamliners have been grounded by the Federal Aviation Administration (FAA) since 16th January 2013 (i.e. 15 weeks ago) because of problems with overheating of on-board lithium ion batteries: Boeing say that the root causes of this overheating have not yet been fully established. Waldram discussed the adaptation of a well-known Adiabatic Reaction Calorimeter (ARC*), to test the thermal safety of complete batteries and their components over a wide range of conditions. The resulting device, BTC, conforms to the basic design principles of the ARC* but focuses particularly on flexibility of operation, allowing a wide range of tests to be performed easily and safely.

Partha P. Mukherjee with Texas A&M University, Department of Mechanical Engineering, presented, “Lithium-Ion Battery Safety – A Computational Perspective.” Critical issues in energy storage research are centered on the performance, safety, and life of rechargeable lithium-ion batteries (LIBs). Energy storage devices such
as LIBs are commonly the limiting element in an electric-powered device, such as an electric vehicle, as typical end-user performance metrics are based on the characteristics of the battery. While LIBs in particular demonstrate a comparatively large specific energy and power, they also suffer from safety concerns caused by external short circuit, thermal imbalance, and thermo-mechanical effects, which may contribute to thermal runaway and catastrophic failure of LIB cells. Mukherjee discussed a hierarchical computational model to study the thermo-mechano-electrochemical behavior of LIB electrodes and concomitant implications on safety and thermal management.

René Murata with Risk Integrity Safety Knowledge, Inc. presented, “A Methodology for Identifying and Addressing Dead-Legs and Corrosion Issues In a Process Hazard Analysis (PHA).” Identifying dead-legs and related corrosion issues continues to be a challenge in the process industry. Pipeline corrosion has been a factor in several recent incidents involving releases and fires. Murata describes a methodology for identifying and addressing dead-legs and related corrosion issues in a PHA that can be used to update corporate PHA procedures to be more robust in preventing corrosion related incidents.

Varsha Pedhireddy with Scandpower Risk Management Inc. presented, “Risk Assessments for Brownfield Modifications to Promote Inherently Safe Processes.” Brownfield projects are undertaken when there is a need identified to improve process safety, production, efficiency and lifespan of the existing facilities, to address regulatory compliance issues, and sometimes to update technology. Brownfield means modifications, extensions, repair, upgrade, replacement, addition etc on existing live offshore production facilities and equipment. Challenge lies in identification of current status of the platform and assessment of developed changes into the existing conditions. Pedhireddy described the contribution of risk assessment for brownfield modifications and future operations to prioritize "Inherently safe design", with some examples from concrete cases.

Shi Xuan with CNOOC Safety Technology Service Ltd. presented, “Research on the Correlation of the Info Activities with the Behavior on the Offshore Oil Platform.” Xuan discussed research using Data Canonical Correlation to analyze Info Activities on the offshore platform, and find the relationship between the info activities and behaviors on the Offshore Oil Platform.

Olav R. Hansen with DNV GL Group presented, “Improved Far-Field Blast Predictions from Fast Deflagrations, DDTs and Detonations of Vapor Clouds Using FLACS CFD.” He described a current study that will present a way to obtain more accurate far-field blast predictions by modified parameter settings in FLACS for strong deflagrations. Using modified settings, it is also possible, with good precision, to predict flame speeds, pressures and far-field blast from DDT-scenarios and directly initiated gas detonations, physics which are beyond the accepted capabilities of FLACS. Selected full-scale experiments from the DNV GL test site at Spadeadam will be used to compare with the simulations. Convincing evidence for DDT in large scale natural gas experiments (91% methane) was found in simulations of one of these tests.

Clementina Ramírez-Marengo with Instituto Tecnológico de Celaya presented, “A Stochastic Approach for Risk Analysis in Vapor Cloud Explosion.” Process equipment failures can lead to accidental releases of liquid or gaseous flammable or toxic substances. The consequences of these releases include toxic gas clouds, fires and explosions. Destructive explosions that cause large losses in the chemical industry are vapor cloud explosions. Examples of these accidents are Buncefield, UK and Flixborough, UK. Ramirez discussed a stochastic approach for evaluating the risk of vapor cloud explosions. The proposed methodology aims to incorporate the effect of uncertainty into the risk analysis to produce a better overall view for the risk.

A.W. Armstrong with Kestrel Management Services presented, “Using Human Factor Data to Evaluate Risk Controls and Identify Areas for Improvement.” It is generally accepted that employee and contractor behavior is a significant source of risk in industrial operations and contributes to the majority of incidents and accidents. To reduce these risks, companies strive to manage employee and contractor behavior through a variety of controls. Armstrong discussed how companies can employ a human factor analysis of incidents and accidents to evaluate their current layers of risk controls and identify areas needing improvement and/or creation.
Kelly Thomas with BakerRisk presented, “Impact of Vapor Cloud Detonation Propagation from a Congested Area on Building Blast Loads.” The potential for a deflagration to detonation transition to occur in an unconfined vapor cloud explosion with high reactivity flammable gases like ethylene and hydrogen under conditions relevant to chemical processing and petroleum refining plants has been demonstrated in multiple test programs. Tests have also shown that a vapor cloud detonation will readily propagate from a congested volume into an open uncongested area. Thomas discussed the impact of the vapor cloud detonation propagation into an uncongested area on the resulting blast load to buildings in the surrounding area and reviewed test data relevant to high reactivity DDTs and detonation wave propagation.

Susan Murray with Missouri University of Science & Technology presented, “Countermeasures to Improve Workers’ Performance and Reduce Errors Due to Inadequate Sleep and Fatigue.” Workers in the process industries are often required to work long hours performing monotonous tasks, various times of the night and day. Their work performance can suffer from inadequate sleep caused by a variety of factors including sleep disorders such as sleep apnea that affects the quality of sleep, sleep deprivation resulting in limited hours of sleep, or other sleep related issues associated with working varying shifts which can influence the ability to sleep. Research has shown that inadequate sleep can be detrimental to vigilance, information integration, and cognitive abilities. Murray discussed recommendations to address the potential impact of inadequate sleep on individual’s work performance. This includes countermeasures to be considered when designing operational procedures, work schedules, facilities, and operator interfaces.

James Henry with ProSys, Inc. presented, “The Cost of Operator Errors and What You Can Do to Minimize.” Based on data published by J.H. Marsh & McLennan, operator errors cause the highest average dollar loss per major incident at something over $80 million and second place is not even close. In addition, according to an ARC study, it is reported that “operator error accounts for 42 percent of unscheduled plant shutdowns accounting for the highest dollar losses per incident in the process industries.” These statements confirm the facts many plants are discovering the hard way through higher cost of goods, poor product quality, loss of production and possibly equipment damage or environmental events. Henry discussed practical solutions including examples and supporting data to significantly reduce operator loading and as a result lower risk and the chance for errors.

Thomas Ferris from the Human Factors and Cognitive Systems Laboratory, Texas A&M University presented, “Development of a Novel Communication System to Facilitate Navigational Guidance for Operators in Emergency Situations.” Operators facing the reduced sensory input and stress of unfamiliar emergency situations – such as when a structure fire or chemical spill occurs – can suffer from disorientation and cognitive tunneling effects, hindering their abilities to solve problems and navigate to safety. To aid operators in these situations, a communication system is currently being developed to facilitate the relay of navigation instructions quickly, reliably, and in a manner that requires minimal cognitive effort for both the sender and receiver of the instructions. Ferris discussed an experiment that analyzed the effects of both instruction encoding methods and display modality on a simple navigation task for cooperating dyads.

Stewart Behie with Occidental Oil and Gas Corporation presented, “HES/Asset Integrity Training and Development Program.” In response to a growing need for HES and Asset Integrity specialists and expertise in the Business Units, Occidental Oil and Gas Corporation embarked on a new program to provide targeted new graduates with the requisite skills and competencies to join a BU upon completion of the program and support their HES / AI programs. Behie discussed the details of the 12 month training and development program implemented by OOG to fulfill this need and reviewed aspects of the HES / Asset Integrity Training & Development Program.

Vishal Lagad with Lloyd's Register Energy Americas presented, “Utilizing Integrity Operating Windows (IOWs) for Enhanced Plant Reliability & Safety.” Several industry codes, standards and recommended practices have been developed and utilized to maintain pressure equipment integrity and improve reliability. These industry standards focus heavily on inspections (time or risk based) and guidelines for operating equipment at conditions that enable a tolerable deterioration rate. RBI (risk based inspection), in effect,
utilizes process conditions at a snapshot in time to recommend inspection strategies which can cover the span of the equipment’s remaining life. Lagad discussed the development of an IOW program and the benefits of combining it with a viable RBI program.

Donnie Dippel with Texas Ag Industries Association gave the presentation entitled “Overview on the Use of Ammonium Nitrate in the Texas Agricultural Business.”

Charles Soczek with DuPont Sustainable Solutions presented, “Quantitative Risk Analysis of a Complex Chemical Process and Utilizing the Results for Risk Reduction Decisions.” In the chemical, petrochemical, petroleum, and related industries, a broad range of qualitative and quantitative methodologies are employed to understand the impact of release of hazardous materials and the probability or frequency of these releases. These evaluations provide an understanding of risk. Soczek discussed a case study that integrates on site and supply chain risk analyses, resulting in a more resilient system. As a result of careful supply chain management, the facility continued operations without interruptions following the 2011 tsunami that resulted in extensive coastal damage, and the Fukushima disaster.

Scott Davis with GexCon US presented, “Hazards of Gasoline Contamination – Case Study of a Tanker Truck Explosion Resulting from Switch Loading.” He described a recent incident involving an explosion during the filling of a tank of a transport truck with diesel fuel. This particular tank was previously filled with gasoline and was not completely emptied of the gasoline prior to the switch loading. After only filling one-quarter of the programmed load, an electrostatic spark ignited the flammable mixture within the head space and caused significant damage to the truck and neighboring tanks. Davis discussed issues and lessons learned regarding spark promotion with the tank, reduction of static generation by the fluid being filled into the tank, and elimination of the flammable mixture within the tank prior to switch loading.

Larry Kistler with ExxonMobil gave the presentation entitled, “Safety Summaries, Numbers, Charts, Graphs, YTD vs YTD, Projected TRIR…….SO WHAT?”

Prasad Goteti with Honeywell Process Solution presented, “Use of KPI’s for Process Safety.” In recent years, the concept of Key Performance Indicators (KPI) and their application to Process Safety has taken prominence following incidents like the ones at BP Texas City Refinery in the USA and Buncefield Oil terminal in the UK. KPIs could be leading or lagging indicators and their proper usage could help prevent incidents involving hazardous materials and manage Process Risk. Goteti described the concepts of KPIs and Leading and Lagging indicators and explained the Four Tiers for Process Safety Events (PSE) as identified in API RP 754.

Karen Pauk with Phillips 66 Company presented, “An Industry’s Journey to Use Metrics to Improve Process Safety Performance.” She explained how the refining and petrochemical industries are collectively implementing ANSI/API RP-754 - Process Safety Performance Indicators for the Refining and Petrochemical Industries1. Published in April 2010, the RP-754 document established the first-ever consensus standard for developing a comprehensive leading and lagging indicators program for process safety. She discussed some of the industry’s early-years implementation successes and challenges.

Brian D. Rains with DuPont Sustainable Solutions presented, “Operational Discipline: Panacea for Performance?” He explained that over the last few years, many companies have had an increased focus on implementing or upgrading programs to improve Operational Discipline (OD) in pursuit of excellent PSM performance, leading to reduced process-related injury and incident rates. OD describes human behavior in following required systems, procedures, and practices to achieve reliable, high quality, and safe operations. Rains discussed the elements and precursors of a strong OD program, how leadership can help ensure successful improvement programs, and, ultimately, how a focus on OD and PSM performance must be integrated with operations and business processes throughout the life cycle of the facility.

Conductive Heat Flux from the Experiments and Analysis of the Vaporization Rate by Small Scale

FLNG facility with respect to DALs. (CFD) modeling can be used to optimize the layout of an method based on computational fluid dynamics discussed how a probabilistic explosion hazard analysis development from the very earliest design phase. Davis For these reasons, the analysis of explosion hazards on the high congestion levels of FLNGs, explosion design is a critical step that should accompany the facility designed to be very compact, due to the high costs of “floating real estate”. Given the high congestion levels of FLNGs, explosion design accidental loads (DALs) can become very large and are very sensitive to the layout of piping and equipment, the size of safety gaps, specifics of the liquefaction process, etc. For these reasons, the analysis of explosion hazards on FLNGs is a critical step that should accompany the facility development from the very earliest design phase. Davis discussed how a probabilistic explosion hazard analysis methodology based on computational fluid dynamics (CFD) modeling can be used to optimize the layout of an FLNG facility with respect to DALs.

Nirupama Gopalaswami with MKOPSC presented, “Assessment of LNG Pool Spreading Behavior in Brayton Fire Training Field Tests.” Consequence modeling for LNG safety deals with three distinct stages in estimating the potential consequences of major hazard accidents. The first stage is to determine the release mode and release rate of the hazardous material. The second stage is to determine the behavior of the material after its release and the third is to consider the effects of the material on people (Woodward & Pitblado, 2012). She discussed the first stage in quantifying the accident scenario which involves postulation of parameters of the accidental breach which often deals with spreading of LNG.

Scott Davis with GexCon US presented, “CFD-Based Probabilistic Explosion Hazard Analysis as an Early Tool to Improve FLNG Design.” Process areas on floating LNG facilities are typically designed to be very compact, due to the high costs of “floating real estate”. Given the high congestion levels of FLNGs, explosion design accidental loads (DALs) can become very large and are very sensitive to the layout of piping and equipment, the size of safety gaps, specifics of the liquefaction process, etc. For these reasons, the analysis of explosion hazards on FLNGs is a critical step that should accompany the facility development from the very earliest design phase. Davis discussed how a probabilistic explosion hazard analysis methodology based on computational fluid dynamics (CFD) modeling can be used to optimize the layout of an FLNG facility with respect to DALs.

Tomasz Olewski with Texas A&M University at Qatar presented, “Validation of Liquid Nitrogen Vaporization Rate by Small Scale Experiments and Analysis of the Conductive Heat Flux from the Concrete.” The vaporization of a liquid nitrogen pool spilled on concrete ground was investigated in small scale field experiments. The pool vaporization rate and the heat transfer from the concrete ground were measured using a balance and as set of embedded heat flux sensors and thermocouples. The ability to predict the concrete’s thermal properties based on these measurements was investigated. Olewski discussed how a simple theoretical model, assuming heat conduction through a semi-infinite ground with ideal contact between the cryogenic liquid and the ground, commonly used to describe the heat transfer from a ground to the LNG, does not predict the observed vaporization rate well.

Russell Mills with Risk Management Group presented, “Measuring & Managing Process and Occupational Risks Side by Side in a Gas Fired Power Station.” Fatality risks arising from process hazards are traditionally assessed by different means to those from occupational hazards. In the case of process hazards, measurement is done by quantitative risk assessment to determine Location Specific Individual Risk levels and derive Individual Risk Per Annum values for identified work groups. Measurement of the fatality risk arising from exposure to occupational hazards is often obtained from statistically based compilations of industry-specific data on occupational injury and fatalities. Mills discussed the results of a risk assessment of the process and occupational hazards in a gas fired power station in Australia.

F. Russ Davis with Mistras Group presented “Selecting Effective Inspection & Testing Methodology for Fixed Equipment.” Process equipment must be inspected and effective testing methodology must be accomplished in order to lower the risk of operation to an acceptable level. The current regulatory environment and public opinion will no longer tolerate accidents that were preventable had effective inspections and testing been performed in a proactive instead of a reactive mode. Davis discussed potential damage mechanisms that degrade process equipment and evaluate the effectiveness of non-destructive examinations (NDE) and inspection methods.

Zhe Han with MKOPSC presented, “Ammonium Nitrate Thermal Decomposition with Additives.” She described the main objective of the research is to study the root causes associated with ammonium nitrate (AN)
explosions during storage, specifically the effects of additives, while maintaining its agricultural benefit. Reactive Systems Screening Tool (RSST) has been used for reactivity evaluation and to better understand the mechanisms that result in explosion hazards.

**Alba Pineda** with MKOPSC presented, “Study of the N-Oxidation of 3-Picoline Using a 2K Factorial Design of Experiments.” Alkylpyridines and their N-oxides are widely used in the pharmaceutical industry in the fabrication of analgesics and antiulcer drugs such as omeprazole. N-oxides can be produced by oxidizing the nitrogen atom in the pyridine ring, using an aqueous solution of hydrogen peroxide as the oxidant and phosphotungstic acid as a catalyst. The main objective of this investigation is to obtain a clear understanding of the effect of each parameter of interest for the N-oxidation of alkylpyridines and determine which ones are the most significant. The information obtained from this work is key in the design of inherently safer and more efficient N-oxidation of alkylpyridines, as the results from this study can be extended to other members in the alkylpyridine family.

**X.H. Pan** with Nanjing University of Technology presented, “Thermal Hazard Assessment about Reaction of Ozone Oxidation 2-Butene-1, 4-dioildiacetate by RC1.” Oxidation is widely used in chemical production, large organic intermediates and polymer monomer can be produced through the oxidation reaction. Meanwhile, most of the oxidation reaction belongs to strong exothermic reaction and has a very high thermal hazard since a large amount of heat can be released in reaction process. Pan describe a study where the exothermic reaction of ozone oxidation 2-butene-1, 4-dioildiacetate was analyzed by RC1 in semi-batch operation. Heat releasing rate and heat conversion rate were studied with different operating conditions, such as setting temperature, ventilation rate, and so on.

**Phillip Mulligan** with Missouri University of Science and Technology presented, “Explosively Generate Pipe Collapse.” The recent BP incident in the Gulf of Mexico is an example of how technicians might apply underwater explosive lensing. The need for a fast response method to seal an oil pipe and stop the release of oil is important to prevent future oil leaks from turning into ecological and financial disasters. Underwater explosive lensing may be such a response method. Mulligan described research in determining the plausibility of using underwater explosive lensing as a means of sealing a leaking oil pipe, to mitigate the environmental damage of an event similar to the Deepwater Horizon incident.

**Jihui Geng** with Baker Engineering and Risk Consultants presented, “Blast Loads from Elevated Pressure Vessel Burst.” Pressure vessel burst (PVB) is a class of accidental explosions commonly considered in explosion hazard evaluations performed for refineries and chemical processing facilities. The standard blast curves developed for PVB blast sources are based on spherical vessels. However, many pressure vessels of interest are cylindrical, and the application of blast curves developed for spherical vessels to cylindrical vessels introduces some uncertainty. Geng discussed an effort to account for elevated vessels. Both elevated spherical and cylindrical PVBs are examined to provide additional correlations for the blast overpressure and impulse for a range of vessel geometries and burst conditions.

**Valeria Casson** with Texas A&M University at Qatar presented, “Modeling of the Venting of an Untempered System Under Runaway Conditions.” Runaway reactions are statistically one of the major concerns for the chemical industry. Historically, they have been the cause for many severe incidents, as in the well-known cases of Seveso (Italy, 1976), Bhopal (India, 1984) and more recently the T2 Laboratories (USA, 2007). The prediction of the consequences of a runaway reaction in term of temperature and pressure evolution in a reactor vessel requires the knowledge of the reaction kinetics, thermodynamics and fluid dynamics inside the vessel during venting. She discussed a dynamic model developed to simulate the behavior of an untempered reacting mixture during venting. The model provides the temperature, pressure and inventory profiles before and during venting.
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**KEYNOTE PRESENTERS**

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<tr>
<th>Amr El-Bakry</th>
<th>Richard Meserole</th>
<th>Greg Morales</th>
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<tbody>
<tr>
<td>Mr. El-Bakry is the Digital Technology in Asset Management Optimization Lead for ExxonMobil Production Co. He has 15 years of industrial experience in research and development of optimization systems for the Oil and Gas upstream sector.</td>
<td>Richard Meserole currently serves as the Vice President of Construction for Fluor, Energy &amp; Chemicals. Professionally, Mr. Meserole has over 20 years of Fluor experience involving positions as General Manager in Office Management, Project Management, and Construction on both domestic and international projects.</td>
<td>Greg Morales is the Site Reliability Director for Dow Texas Operations, the largest integrated petrochemical complex in the world. Before joining Dow, Mr. Morales worked in the Nylon Intermediates &amp; Specialties Business for DuPont as a maintenance engineer, production specialist and global supply chain manager.</td>
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Valerie Green, Associate Director
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Calendar of Events

Short Courses

2052 – Process Hazard Analysis Leadership Training
Instructor: Mr. Bill Anderson
Date: March 11 – 12, 2014
Time: 8:30am – 4:30pm
Credit: 1.4 CEUs/14 PDHs
Location: SIS–TECH Solutions, Houston, TX

3012 – Pressure Relief Systems – Best Practices
Instructor: Dr. Abdul Aldeeb
Date: March 18-19, 2014
Time: 8:30am – 4:30pm
Credit: 1.4 CEUs/14 PDHs
Location:Siemens Facility, Houston, TX

NEW!!
3151 – Disposal Systems Analysis – Best Practices
Instructor: Dr. Abdul Aldeeb
Date: March 20, 2014
Time: 8:30am – 4:30pm
Credit: 0.7 CEUs/7 PDHs
Location:Siemens Facility, Houston, TX

2073 – SIS Implementation
Instructor: Mr. Bill Hearn
Date: March 25 – 27, 2014
Time: 8:30am – 4:30pm
Credit: 2.1 CEUs/21 PDHs
Location: SIS–TECH Solutions, Houston, TX

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