2011 Symposium Attendance Surpasses 500

The 2011 Mary Kay O’Connor Process Safety Center International Symposium, *Beyond Regulatory Compliance, Making Safety Second Nature* was held October 25-27, 2011 at the Hilton Conference Center in College Station, Texas. Over 530 people attended the symposium representing many countries, including the United States, United Arab Emirates, Canada, China, Columbia, France, Germany, Great Britain, Israel, India, Iran, Japan, Korea, Mexico, Netherlands, Norway, Poland, Qatar and Taiwan.

The Frank P. Lees Memorial Lecture entitled “Energy: An Overview” was presented on the first day of the symposium by the Honorable Lee H. Hamilton, retired congressman and director of The Center on Congress at Indiana University. Keynote speaker for day two was Professor Edward Calabrese with the University of Massachusetts, School of Public Health, Amherst who talked about “Hormesis: Its Significance for Risk Assessment and Regulatory Agencies.” Day three included two general sessions, “Process Safety in a Volatile & Ever Changing World,” by Mr. John Prows, with Huntsman Corporation and “Process Safety Evolution – An Air Products Case Study,” by Mr. Shakeel Kadri with Air Products

The center presented the annual Merit and Service awards on Wednesday morning. The Merit Award recognizes an individual who has 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, i.e., Making Safety Second Nature.

Two Merit Awards was presented. Receiving awards were Mr. Art Dowell and Mr. Jack McCavit. The 2011 Harry H. West Service Award was presented to Mr. Roy Sanders.

Over ninety papers were presented during the two and a half day symposium. Summaries of the papers are included in this newsletter.

The next Mary Kay O’Connor Process Safety Center International Symposium will be held on October 23-25, 2012 at the College Station Hilton.
Your Magnificence, Members of the High Senate, Distinguished Guests, Ladies and Gentlemen.

It is with great humility and happiness that I accept this honor you have kindly bestowed upon me today. It is by far one of the most significant and highest honors I have been conferred upon and I shall forever treasure it. I want to express my deepest sense of gratitude and sincere appreciation to everyone and all the academic bodies involved in the process of conferring this highly prestigious award of Doctor Honoris Causa upon me at this memorable ceremony.

I must clarify at the outset that I take this honor as a collective recognition of the efforts of my numerous mentors throughout my career as well as the hard work put in by my students, research associates and collaborators around the world. I have learned much from my professors and mentors as well as my students. It has indeed been an absolutely delightful journey of well over 33 years of teaching, advising as well as learning from and working with many of my bright, enthusiastic, diligent and conscientious students and associates. My students, research associates and research collaborators have generously provided assistance whenever it was needed. Moreover, for the record, I also want to emphasize the support and encouragement I received from my family members. I am grateful to my mother for her love and everything she has done and continues to do for me. The foundation for lifelong learning was instilled in me early on in my life by my father. He was a humble man who truly believed that, “If you stop learning, you must already be dead.” I would also like to thank my wife, Afroza, and our daughters, Joya and Rumki, for their love and support. Quite often the public accomplishments of an individual come at burdens borne by family and friends. I appreciate their understanding for all the things I have not been able to do with them because of my time away at work.

I would also like to take this opportunity to thank two individuals who have provided more than moral support and encouragement. They are Trevor Kletz and Mike O’Connor. First, I really appreciate Trevor’s support for our work at the Mary Kay O’Connor Process Safety Center. I also want to thank him for his pioneering leadership in many areas of process safety. Trevor is really a giant in this field, and as Roy Sanders likes to say, “Trevor does cast a long shadow in the field of process safety.” I am proud to have Trevor’s friendship and his support. I also want to take this opportunity to thank Mike O’Connor. He has converted his personal tragedy into an opportunity to integrate process safety into education, research, and service activities at universities. He has been a true friend and supporter of the mission and goals of the Center.
I have had many professors and mentors throughout my education and career whom I would like to also recognize today. During my formative years during my undergraduate education, Professor Iqbal Mahmud at Bangladesh University of Engineering and Technology left an indelible impression on me and propelled me forward in my life long quest. During my graduate studies in Oklahoma, I learned a lot from Professor Ken Starling and Professor Cheddy Sliepcevich. In fact, I learned much more from them than just pure chemical engineering. And, along this journey, many other collaborators and mentors shaped me into what I am today. I would be remiss if I did not mention my late friend and mentor, Dr. Harry West. I am sure he is watching this event from somewhere in heaven with that interesting smile on his face. Of course, I also want to mention my colleague right here in Lodz, Professor Adam Markowski. He has been a great friend and mentor from whom I have learned much. I am sure I have failed to mention everybody who has helped me with the many facets of my career. To them I apologize and want to assure them the oversight is not intended. To everyone, I owe a big debt of gratitude and I accept this honor on their collective behalf.

With your leave, I would like to take this opportunity to say a few words about general topics of my interest as well as my research and professional activity. I would like to talk about four things, namely the need for research, process safety and sustainable development, the need for a rational and constructive dialogue on risk, and globalization. Of course, you might think that we would need a massive book to cover these topics in detail and the depth they deserve and you would be right. I can also understand some of you cringing at the thought of having to listen to a dry and boring professor for hours. Thankfully for all of you, I have been given a time limit and I intend to honor that limit. Let me share a few of my thoughts about my favorite subject: teaching and mentoring the next generation in the quest for new knowledge and understanding of the world we live in. R&D organizations whose sole purpose is research and development of new ideas are very much needed and serve their unique purpose. However, one might ask what is the role of research in major universities? Some might argue that that the only role of universities should be teaching. But the question is what is meant by teaching and does that only involve summarizing the contents of a textbook and helping students learn to solve the problems at the end of each chapter. I would unequivocally state that teaching involves a lot more than that. Every moment of a student’s experience in the university should involve some kind of learning. So what should they learn and what should the professors teach. Naturally the professors should teach the material from the various textbooks and help the students complete the various courses required in their degree program. But an important part of teaching at a major university is to mentor/teach the student to seek new knowledge. This is often done by challenging students, both at the undergraduate level and the graduate level, with solving open-ended problems. At the graduate level, working on proposals (whether successful or unsuccessful) teaches students to push the frontiers of knowledge in a coherent and understandable manner. And once the project is funded, being able to give meaning and substance to those ideas are crowning achievements for a student that often shapes future accomplishments and successes. Other things that professors must teach are ethics, teamwork, leadership, diversity of all kinds, and resolution of conflicts. So, it would not be wrong to say that every moment of interaction between a professor and a student is dedicated to teaching, whether it is in the class room, or doing research, or for that matter working on other assignments.

So, if research is integral to teaching and universities have an important role in this, the question is how the research should be funded. Clearly, from the ancient times, countries and societies that have funded research have prospered. A recent example is the decision by Singapore to fund research at the level of 3% of GDP and a significant majority of this outlay is expected to come from industry and businesses. I am sure the example of a relatively small population and economy is not applicable to all countries, nevertheless it is a powerful endorsement by Singapore on the necessity of research and the value of research.

With regard to who should fund the research, the main problem arises in the type of research, fundamental or applied. There is a saying that universities are interested in the “R” that is the research part of R&D, and industry is primarily interested in the “D” that is the development part of
R&D. My opinion is that both universities and industry should try to move a bit closer to each other. There is a reason that R&D is always lumped together. If there is no progress in research, there is no development. Also, since the time scales of research in universities is typically longer, it results in more incompatibility. So, I believe that there should be an accommodation from both universities and the industry. Close industry-university interaction is essential to foster this new paradigm. Finally, government has also a significant role in boosting support for research, both fundamental and applied. As a bottom line, research must continue to be funded at a very significant level or we as a society will go the way of dinosaurs that is become extinct.

Now I would like to turn to my research area, i.e., process safety and its link to sustainable development. Our engineering education today lacks integration of knowledge needed for modern industry practice, and is inadequate in providing students with an understanding of societal impact and global role of engineering. My vision for engineering education brings together elements of manufacturing, design and sustainable engineering in an integrated form. And interwoven through this new paradigm is the consideration of risk in every aspect. An engineer must function as a member of the global community. This means not only competing in the global marketplace, but also acting as a professional who shares the global responsibilities. These responsibilities entail proper account of the finite world resources, sensitivity to the impact on the environment, ethical conduct, process safety, risk consideration and much more. Today’s engineering education largely neglects preparing our graduates to meet these challenges. This “extra”, but much needed aspect may be called “the sustainability dimension” to engineering education and practice, and can be summarized as, “The design of materials, processes, products and systems to sustain good and safe conditions for human health and environment.”

On December 3, 1984, events in Bhopal, India, forever changed the chemical industry and left a distinct legacy. It was a quiet night in Bhopal, India, until a cascading series of catastrophic circumstances, system failures, and management system deficiencies at the nearby Union Carbide India pesticide plant led to the release into the atmosphere of approximately 40 metric tons of acutely toxic methyl isocyanate. The dense cloud of deadly vapor spread over the sleeping community, and within a few days more than 3,000 people had died and at least 100,000 were injured. It is widely acknowledged to be the worst industrial accident in history, leaving as many as 50,000 people partially or totally disabled as of 1994, according to the International Medical Commission on Bhopal. The incident also left a miasma of civil and criminal litigation in its wake. The Bhopal incident is not an isolated incident. Over the last 30+ years, other catastrophic incidents have grabbed the attention of the public and the media. It is even more important now to design processes and equipment to precise standards based on a complete understanding of the underlying hazards, process chemistry, and the impact of operating conditions. Recently a lot of attention has been paid to human factors and its impact on chemical plant incidents. Process safety is a relatively young and evolving field whose driving force has been mainly based on tragic events. Unfortunately, it is also a thankless activity, whose importance becomes evident only after negative events occur. Even today, after so many industrial incidents, there is a school of thought that if nothing bad happens, it is because there are no hazards and hence no need to take preventive measures. However, time and again incidents like Flixborough, UK; Seveso, Italy; Mexico City, Mexico; Bhopal, India; Texas City, USA; Buncefield, UK and more recently the Macondo Deep Water Oil Spill in the United States have reinforced the need to develop and implement sound process safety programs. We need a framework where industry, government, academia and other stakeholders can work together to reduce the probability of occurrence and the consequences of such catastrophic incidents. Companies cannot be sustainable without successful safety and risk management programs. And thus by extension, it is impossible for society to reach the goals for “engineering for sustainable development” without successful safety and risk management programs. Our inability to adapt to the demands of a changing world and eco-system has the potential to take us down the same path as “dinosaurs.”

The driving forces for change and sustainable development in a society are growing population, rising standard of living, perception of risk, and society’s choices based on these driving forces. As the population is growing there is also at the same
time a rise in standard of living. These changes are imminent not only in the United States, but particularly when you travel abroad to countries like China and India. And when the standard of living increases, the perception of risk or how willing you are to tolerate risk also changes. When you don’t have a square meal to eat, risk means something quite different. But when you have three good meals, a nice house to live in, and a car to drive, your perception of risk is completely different. And then there comes the issue of society’s choices, and as people’s perspectives change, the choices made also change. And that’s where a constructive and rational public dialogue on risk is essential.

China currently has an annual growth rate of 11% while the Indian economy is growing at about 8%. On a per capita basis, the United States uses 25 times more energy than China and on a similar comparative bases, the United States uses 62 times more energy per capita than India. In addition, when one takes into account the population of the two countries combined (about 2 and a half billion), the math is very simple but scary. So, if the growth rates of the world economies keep on increasing at the rate they are, the question is where the resources are going to come to feed the growth.

Given the back drop of the facts above, we do have to think about what our options are on a day-to-day basis. Clearly, “not in my back yard,” is not an approach that will give us sustainable options. There are numerous examples of recent events that puts this dialogue on risk “front and center.” In one recent incident, a facility engaged in the production of pesticide, had an accident in 2008, it was inspected by OSHA after that, and citations were issued. It was also inspected and investigated by the EPA and a host of other agencies, including the Chemical Safety and Hazard Investigation Board (CSB). The facility used methyl isocyanate in the production of the pesticide, but the 2008 incident did not involve methyl isocyanate, neither was any part of the plant handling methyl isocyanate involved in the incident. Following the incident, however; the plant went through extensive redesign that included reduction of inventory of methyl isocyanate and major reconfiguration. However, prior to startup of the redesigned plant, a lawsuit was filed in federal court claiming that the plant posed an “unreasonable risk” to the neighbors. The ultimate outcome of the chain of events that followed gives us some interesting and thought provoking issues to think about.

Globalization of the economy has intensified over the recent years and, together with the development of the new information and telecommunications technology, it is bringing about radical changes in society, comparable to those produced during the industrial revolution. Occupational process safety cannot ignore those changes. And, in this context, the greatest challenge for the countries is the transformation of the difficulties involved in adapting to the new situation into opportunities for the future development of process safety. One of the most important impacts that economic integration and the liberalization of international trade have had on occupational safety and health is undoubtedly that of the harmonization of standards. In talking about process safety standards, we are in fact referring to two distinct types of standards. First, there are the standards concerning labor. They define the general conditions of occupational safety in the workplace. The objective in harmonizing this type of standard is to prevent the comparative advantages that are derived from lower production costs at the expense of inferior working conditions in the enterprise. Second are the standards concerning product safety. As tariffs are eliminated or reduced, as is currently occurring with the regional economic integration agreements and with the signing of multilateral trade agreements in the framework of the World Trade Organization (WTO), non-tariff technical barriers acquire more significance in international trade. Technical standards, particularly those related to product safety, could block international trade as effectively as high tariffs did in the past, and for that reason harmonization of product safety standards has become a prerequisite for economic integration. With the elimination of tariff barriers, less state intervention in economic matters and the globalization of the economy, markets are becoming more and more transparent and an enterprise that wants to stay in the market is forced to continuously improve its competitiveness. Three factors can be seen as determining the competitiveness of an enterprise: its capacity for innovation, the quality of its products, and its productivity. It is, therefore, not surprising that these three factors have become a true obsession for the modern enterprise that wants to remain competitive and thus, survive in the global economy.
That brings me to my long-standing and extremely fruitful and enlightening collaboration with Professor Adam Markowski and his associates. He has been a great friend and a continuous source of inspiration. I only wish I were as young and energetic as him. I must state with gratitude that a number of contributions I was able to make to the field of process safety benefited from outstanding support from Professor Markowski and his associates. I will also look positively forward to further collaboration with the Technical University of Lodz in the area of process safety for mutual benefits.

Poland is blessed with a large number of very highly reputable universities, some hundreds of years old and some relatively young like Technical University of Lodz. Despite the relatively short history, your university can be extremely proud of the global impact of your contributions to science and society. I am also happy to note that in the area of process safety, your university is one of the global leaders.

In closing, I want to again humbly state my gratitude for this exceptional honor your university has bestowed upon me today. I shall continue to strive hard to remain worthy of this award.

Thank you.

M. Sam Mannan
Fall, 2011

Recent Publications


News & Events

2012 Merit Awards

Mr. Jack McCavit receiving the 2012 Merit Award from Dr. Mannan.

Mr. Art Dowell receiving the 2012 Merit Award from Dr. Mannan.

Lamiya Zahin Memorial Safety Scholarship

Zhe Han received the 2012 Lamiya Zahin Memorial Scholarship from Dr. Mannan.

Harry H. West Memorial Service Award

Mr. Roy Sanders receiving the 2012 Harry West Memorial Service Award from Dr. Mannan.
Inaugural International Workshop Aims to Enhance Process Safety Research

The Mary Kay O'Connor Process Safety Center hosted the workshop on Process Safety Research Agenda for the 21st Century was held October 21-22, 2011 in the Emerging Technologies Building located on the Texas A&M University campus in College Station, Texas.

Key discussions generated from a first-of-its-kind international workshop on process safety research are helping to guide future research endeavors in the field. The “Process Safety Research Agenda for the 21st Century.” The workshop provided an opportunity for 40 authorities on process safety, from 17 countries, to exchange knowledge on critical issues facing the process safety field and engaged in a series of thought-provoking presentations and discussions, which positioned the group to outline key topics in various breakout groups.

“The two days [of the workshop] were highly successful and exceeded all expectations for broad agreement on key process safety research that should be pursued and funded on a global basis,” said M. Sam Mannan, director of the Mary Kay O’Connor Process Safety Center and Regents Professor in the Artie McFerrin Department of Chemical Engineering at Texas A&M.

Proceedings of the meeting are being prepared, a summary of which will appear in the Journal of Loss Prevention in the Process Industries (JLPPI).

Student News

December Graduate

MKOPSC graduate student, **Lina Saenz** will receive her PhD in Chemical Engineering in December. She has accepted a position with BP.

PhD Student Internship

Josh Richardson, PhD student at MKOPSC, is spending five months at GexCon AS in Norway. He will be conducting research on Dust Explosions.
The Instrumentation Symposium for the Process Industries is in its 67th year of educating professionals and students in the instrumentation industry. At the symposium, technical papers are presented to disseminate the latest instrumentation and control systems developments so that engineers and technicians can continually improve their knowledge in this highly specialized field. Over the years, the Symposium has grown in both stature and attendance, with nearly 300 attendees last year.

2012 Keynote Speakers:

F.G. (Sandy) Vasser  
Facilities I&E Manager  
ExxonMobil Development Company

Mark R. Briggs  
Area Director, Houston South Area Office,  
Occupational Safety and Health Administration

EXHIBITS
The Symposium also offers an Exhibit Area where companies can display products, technology, and software related to the instrumentation and control systems field.

For more information on exhibits, please see:
http://instrumentation-symposium.che.tamu.edu/exhibitors

Contact: donnas@tamu.edu -or- 979/845-5981  
http://instrumentation-symposium.che.tamu.edu/
## Tuesday, January 24, 2012

<table>
<thead>
<tr>
<th>Time</th>
<th>Session Chairs:</th>
<th>Workshop 1</th>
<th>Workshop 2</th>
<th>Workshop 3</th>
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<tr>
<td>10:00 - 10:25 AM</td>
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<td>Break and Exhibit Hall</td>
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<tr>
<th>Time</th>
<th>Session Chairs:</th>
<th>Keynote Address</th>
<th>Break and Exhibit Hall</th>
<th>&quot;Distributed SIS,&quot; Angela Summers, SIS-TECH Solutions, LP</th>
<th>&quot;Valve Torque Requirements for General Purpose and SIS Automated Block Valve Assemblies,&quot; Henk Hinssen and Kees Meliefste, iHandl Engineering</th>
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<tbody>
<tr>
<td>10:25 - 11:20 AM</td>
<td>Bob Brown, Chris Kulcak, Kerry McFee</td>
<td>“Successful Project Execution is Only One Acronym Away or Can We All Just Work Together?” F.G. (Sandy) Vasser, Facilities I&amp;E Manager, ExxonMobil Development Company</td>
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<td>&quot;Using Engineering Automation to Document Safety Instrumented Systems,&quot; John E. Dressel, Fluor Corporation</td>
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<td>11:20 AM - 12PM</td>
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<td>&quot;Competence counts! Defining, Validating and Documenting,&quot; John Campbell, ConocoPhillips</td>
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<tr>
<td>12:00 - 2:00 PM</td>
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<td>Lunch and Exhibit Hall</td>
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<tr>
<th>Time</th>
<th>Session Chairs:</th>
<th>Break and Exhibit Hall</th>
<th>&quot;A Primer on a Good Instrument Grounding System,&quot; William (Bill) L. Mostia, Jr., SIS-TECH Solutions, LP</th>
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<tr>
<td>2:00 - 2:40PM</td>
<td>Patrick Skweres, Tom Blanton, Tom Shephard</td>
<td>&quot;Valve Torque Requirements for General Purpose and SIS Automated Block Valve Assemblies,&quot; Henk Hinssen and Kees Meliefste, iHandl Engineering</td>
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<td>3:20 - 3:50PM</td>
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<td>3:50 - 4:30PM</td>
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<td>&quot;Shared Field Instruments in SIS: Incidents Caused by Poor Design and Recommendations for Improvement,&quot; Edward M. Marszal, Kenexis</td>
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<td>4:30 - 6:00PM</td>
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<td>Display of Exhibits &amp; Refreshments</td>
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## Wednesday, January 25, 2012

<table>
<thead>
<tr>
<th>Time</th>
<th>Morning Refreshments and Exhibit Hall</th>
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<td>7:30-8:00AM</td>
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<tr>
<th>Time</th>
<th>Session Chairs:</th>
<th>Keynote Address</th>
<th>&quot;How SAP Can Deliver Asset Performance Management Result,&quot; Gus McIntosh, Vesta Partners</th>
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<tr>
<td>8:00 - 9:00 AM</td>
<td>Kevin Klein, Chris Kulcak, Don Johnson</td>
<td>&quot;Industry/OSHA - A Future Focus,&quot; Mark R. Briggs, Area Director, Houston South Area Office, OSHA</td>
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<td>9:00 - 9:40 AM</td>
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<td>&quot;Using Engineering Automation to Document Safety Instrumented Systems,&quot; John E. Dressel, Fluor Corporation</td>
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<td>9:40 - 10:10 AM</td>
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<td>Break and Exhibit Hall</td>
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<td>10:50 - 11:30AM</td>
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<td>11:30AM - 12:10PM</td>
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<td>&quot;A Primer on a Good Instrument Grounding System,&quot; William (Bill) L. Mostia, Jr., SIS-TECH Solutions, LP</td>
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### 2012 Instrumentation Symposium
#### January 24-26, 2012

**Jan 25—Continued**

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<tr>
<th>Time</th>
<th>Session Chairs: Paul Gruhn, Tom Blanton, David Land, David Skinner</th>
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<tr>
<td><strong>12:10 - 2:00 PM</strong></td>
<td>Lunch and Exhibit Hall</td>
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<tr>
<td><strong>2:00 - 4:00 PM</strong></td>
<td><strong>Workshop 1</strong> &quot;Engineering Ethics,&quot; Harvey Willeby, Dow Chemical Company</td>
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<td><strong>Workshop 2</strong> &quot;Temperature Measurement - Can it handle the stress?,&quot; Kevin Klein, Celanese and Van Tran, Fluor</td>
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<td><strong>Workshop 3</strong> &quot;What 's an ISF?,&quot; Angela Summers, SIS-TECH Solutions, LP</td>
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<td><strong>Workshop 4</strong> &quot;The Many Uses of Adaptive Gain,&quot; Jude Golla</td>
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<tr>
<td><strong>6:00 —9:00 PM</strong></td>
<td>• BBQ Social (Brazos Center)</td>
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**Thursday, January 26, 2012**

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<tr>
<th>Time</th>
<th>Session Chairs: Kris Worfe, Paul Gruhn, David Land</th>
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<tr>
<td><strong>7:30-8:00AM</strong></td>
<td>Morning Refreshments</td>
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<tr>
<td><strong>8:00 - 8:40 AM</strong></td>
<td>&quot;AGA Report #11: Coriolis Meters for Natural Gas Measurement Overview,&quot; Angela Floyd, ConocoPhillips</td>
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<td><strong>8:40 - 9:20 AM</strong></td>
<td>&quot;Wireless Lessons Learned,&quot; Jim Smith, Kevin Klein, Alan Trochta, Nate Zbranek, and Michael Morano, Celanese</td>
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<td><strong>9:20 - 9:50 AM</strong></td>
<td>Coffee Break</td>
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<td><strong>9:50 - 10:30 AM</strong></td>
<td>&quot;Improve the Sizing &amp; Selection Process to Spot the Best Fit for Purpose Control Valve,&quot; Henk Hinssen, Holger Siemens, &amp; Andreas Vogt, iHandl Engineering</td>
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<td><strong>11:10 - 11:50 AM</strong></td>
<td>&quot;Utilizing RFID for Pipeline Preventative Maintenance System,&quot; Ben Zoghi, Texas A&amp;M, Sam Falsafi, Shipcom Wireless &amp; David Taylor, Motorola</td>
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<tr>
<td><strong>11:50 AM – 12 PM</strong></td>
<td>Announcements</td>
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<td><strong>11:50AM - 1:00 PM</strong></td>
<td>Lunch</td>
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<tr>
<td><strong>1:00 - 3:00 PM</strong></td>
<td><strong>Workshop 1</strong> &quot;Engineering Ethics,&quot;, Jerry Bradshaw, TAMU</td>
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<td><strong>Workshop 2</strong> &quot;Partial Stroke Testing of Valves: Benefit, Analysis, Techniques and Open Discussion,&quot; Paul Gruhn, ICS Triplex</td>
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<td><strong>Workshop 4</strong> &quot;The New Face of Threats to Industrial Control Systems,&quot; Bryan Singer, Kenexis</td>
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El-Halwagi Pens New Textbook on Process Design

Mahmoud El-Halwagi, professor in the Artie McFerrin Department of Chemical Engineering, is the author of a newly published textbook on process engineering, titled “Sustainable Design through Process Integration.”

The book covers the fundamental concepts and practical techniques on the use of process integration to maximize the efficiency and sustainability of industrial processes.

The book, El-Halwagi says, serves as a resource tool for systematically enhancing process performance and developing novel and sustainable process designs and is applicable to process engineers, industrial decision makers and researchers in the field. It’s also ideal for use as a text in an upper level undergraduate or an introductory graduate course on process design and sustainability, he adds.

Among its key features, the textbook details the development of rigorous targets that benchmark the performance of industrial processes and examines cost-effective implementations. It also contains state-of-the-art process integration approaches and applications including graphical, algebraic and mathematical techniques. The book also presents fundamentals and step-by-step procedures that can be applied to the design and optimization of new processes as well the retrofitting and operation of existing processes.

El-Halwagi Honored by Dwight Look College

Professor Mahmoud El-Halwagi has been named a Texas Engineering Experiment (TEES) Station Fellow. He was among a select faculty group honored for contributions to teaching, research and service by Texas A&M University's Dwight Look College of Engineering.

Holder of the McFerrin Professorship, El-Halwagi is internationally known for his pioneering contributions in the fields of sustainable design and process integration, and he has written three widely used texts on the subject. At Texas A&M, he conducts research and teaches senior-level undergraduate and graduate classes, covering the areas of sustainability, energy conversion, novel energy technologies, process design, simulation, economics, integration and optimization.

Visitors to the Center

Several of the center’s research associates visited in September, October and November.

Dr. Maria Molnarne, retired from BAM Germany, was here in October to work on research and work with our graduate students and researchers.

Dr. Richart Vazquez-Roman, professor from the Instituto Tecnológico de Celaya, in Mexico attended the symposium. He brought several of his students from his university.

Dr. Hans Pasman from the Netherlands was here in September and October to meet with center students and advise on their research.

Dr. Maria Papadaki from the University of Ioannina in Greece spent some time at the center in November.

Also here for the symposium were Dr. Adam Markowski with the University of Lodz in Poland and Dr. Simon Waldram, retired from Texas A&M University-Qatar.
International Workshop on Loss Prevention and Safety to be Held at The Institution of Engineers in Bangladesh

The International Workshop on Loss Prevention and Safety will be hosted by The Institution of Engineers in Bangladesh beginning on December 31, 2011. Engineers from all engineering disciplines will attend the two-day workshop, which will be presided over by Prof Dil Afroza Begum, Chairman of the Chemical Engineering Divisional Committee, IEB. Special guest will be the Ministry of Environment, GoB.

The workshop will consist of five sessions presented by Dr. Sam Mannan, director and several Center research associates.

The sessions will include Inherently Safer Design presented by Dr. Mannan and Professor Jai Gupta. Dr. Gupta is Professor and Director of Rajiv Gandhi Institute of Petroleum Technology, Rae Bareli.

Layers of Protection Analysis will be presented by Professor Hans Pasman and Dr. Mannan. Dr. Pasman is Emeritus Professor of Chemical Risk Management at Delft University of Technology in The Netherlands and Visiting Research Professor at the Center.

Short Courses and Presentations

During travel in December and January, Dr. Sam will be giving several presentations and workshops. To begin, he will present the 2-day workshop, “Recent Developments in Process Safety” at IOCL Refineries of the Indian Oil Corporation Ltd. in New Delhi.

Following the workshop, Mannan will travel to Mumbai to Reliance Industries where he will give the presentation “Process Safety Competency Development.”

Mannan will visit the Rajiv Gandhi Institute of Petroleum Technology in Rae Barelli before continuing his travel to Dhaka Bangladesh.

The ICChE 2011 Third International Conference on Chemical Engineering, BUET, Dhaka will be held on December 29-30. Mannan will present the keynote address "Society's Choices and the Relationship to Risk." Following the conference will be the two day workshop on Risk Analysis and Process Safety.

After Dhaka, Bangladesh, Mannan will travel to Singapore to teach the 2-day course “Managing Risks Associated with Plant Operations and Maintenance Works in the Process Industries” hosted by the Society of Loss Prevention in the Oil, Chemical and Process Industries- Singapore.
Journal of Loss Prevention in the Process Industries

journal homepage: www.elsevier.com/locate/jlp

Call for Papers – Happy 90th Birthday, Trevor

A special issue of the Journal of Loss Prevention in the Process Industries is being planned to celebrate the 90th birthday of Professor Trevor Kletz (which will occur in October 2012). Papers are invited on any topic related to the scope of the journal – chemical and process plant safety. The only additional criterion is that the research described will have been motivated by some aspect of Trevor’s own work over the years. The relevance of Trevor’s process safety teachings with respect to the submitted manuscript should be briefly explained in the introduction and his work should be cited in the manuscript. Our intention is to celebrate Trevor’s many contributions to process safety research and practice in honour of his long and prolific career.

Manuscripts must be submitted by no later than December 31, 2011 using the Elsevier Editorial System (EES) available at http://ees.elsevier.com/jlp/. Be sure to select the appropriate choices from the drop-down menus for article type and requested editor. Also note the journal requirements for length and style (in particular the requirements for referencing) available at http://www.elsevier.com/wps/find/journaldescription.cws_home/30444/authorinstructions.

All submissions will be peer-reviewed in accordance with normal journal practice. It is our intention to have the submission, review and revision process completed by May 31, 2012 for publication of the special issue during July 2012. Depending on the response to this call for papers, it may not be possible to publish all submitted papers in the special issue. Should this happen, the journal editorial team will select the papers to appear on the special issue, with the remaining papers being considered for a regular issue of the journal.

Trevor is aware of the special issue and, in his words, is surprised, honoured and grateful for this recognition from his colleagues. Please pass this call for papers on to any of your personal contacts who might be interested in submitting a paper.

All queries should be addressed to Paul Amyotte (paul.amyotte@dal.ca) who is the editor for the special issue.
On January 22, 2010 a series of three accidents started at the DuPont Facility located at Belle, WV. The three incidents occurred in less than 33 hours and all of them were unrelated to each other.

The first incident was the release of methyl chloride. Fortunately, this accident did not lead to any injury or fatality. The CSB investigation determined the root causes of the event were 1) DuPont’s MOC process approved a design for the rupture disc alarm system that lacked sufficient reliability for minimizing the release of methyl chloride, and 2) DuPont did not resolve the “nuisance alarm” condition in a timely manner despite various safety reviews.

The second release was the liberation of 22-lbs approximately of 20% oleum from a sample line. As the first incident, there were no injuries reported by the company. After the investigation, it was found that the accident could have occurred due to 1) DuPont did not adhere to industry recommended practices to use electrical tracing instead of steam tracing, and 2) A defect in the piping, undetectable by routine non-destructive examination techniques, allowed for a loss of containment.

Finally, the last incident was the release of phosgene. Phosgene was used by DuPont to fabricate five different intermediate pesticides. On the day prior to the phosgene release, operators were experiencing flow problems with one of the hoses and began switching between cylinders to avoid disruption to the chemical process. In the course of switching cylinders the valve was closed on a partially full cylinder. However, the hose was not purged, allowing pressure to build as the liquid phosgene inside warmed up. Suddenly, the pressurized hose burst. Unfortunately, one operator died and two workers were exposed. After the investigation, the CSB found the possible causes of the release to be 1) DuPont relied on a maintenance software program to initiate the automatic change-out of phosgene hoses at the prescribed interval, 2) DuPont did not provide a back-up method to ensure timely change-out of the hoses, 3) A maintenance software program change was not documented or reviewed in accordance with the MOC process, and 4) The Belle Plant did not use the construction materials recommended by a corporate expert.

On August 28, 2009, a runaway chemical reaction occurred inside residue treater, causing severe explosion inside the Bayer CropScience facility Institute, West Virginia. Two workers were killed and eight people were injured during the explosion and the subsequent fire. Highly flammable solvent sprayed from the vessel and immediately ignited, causing an intense fire that burned for more than four hours. Moreover, more than 40,000 residents were advised to shelter-in-place for more than three hours. The overpressure damage was an impact as far as seven miles from explosion center.

During the case study, the chronology of the event leading to the accident were carefully reviewed and key incident detail information was analyzed to find the root cause of the tragedy. Root causes could be concluded into four categories, which are improper pre-startup safety review, human factor deficiencies, unit equipment deficiencies and Methomyl unit startup deficiencies. In addition, recommendations that were provided by agencies such as OSHA, EPA and Bayer CropScience itself, have been distilled and portrayed according to the key aspects mentioned in the presentation. The lessons learned from the incident, deficiencies existing within the procedure or management program, will help us avoid similar incidents in the future.
Following is a summary of the papers presented at the 2011 International Symposium.

Track chairs at the symposium were: George King with Huntsman Corp., Kathy Shell with AE Solutions, Kiran Krishna with Atkins, Marc Levin with Shell Global, Ammar Alkhawaldeh with MKOPSC, Maureen Orr with ATSDR/DHS/ SRB, Mhekeba Hager with OSHA, Ray Mentzer with MKOPSC, Sara Saxena with BP, Scott Ostrowski with ExxonMobil, Skip Early with Early Consulting, and Michela Gentile with BP.

“Hormesis: Its Significance for Risk Assessment and Regulatory Agencies” was presented by Edward J. Calabrese, Ph.D. with the University of Massachusetts, School of Public Health, Amherst. His presentation provided an assessment of hormesis, a dose-response concept that is characterized by a low-dose stimulation and a high-dose inhibition. He traced the historical foundations of hormesis, its quantitative features and mechanistic foundations, and its risk assessment implications. He discussed the argument that the hormetic dose response is the most fundamental dose response, significantly outcompeting other leading dose-response models in large-scale, head-to-head evaluations used by regulatory agencies such as the EPA and FDA. The hormetic dose response is highly generalizable, being independent of biological model, endpoint measured, chemical class, physical agent (e.g., radiation) and interindividual variability. Hormesis also provides a framework for the study and assessment of chemical mixtures, incorporating the concept of additivity and synergism.

“Operational Discipline Does Your Organization Do the Job Right Every Time?” was presented by Brian D. Rains with DuPont Sustainable Solutions. His presentation was intended to help safety professionals and leaders consider the robustness of their own organization’s Operating Discipline. He detailed how Operating Discipline is measured, monitored and improved within DuPont. In addition, tools and recommended actions were shared so that all attendees can be better equipped to strengthen their own organization’s Operating Discipline.

“Leading Indicators for Process Safety” was presented by Richard W. Prugh with Chilworth Global. Prugh said a wide variety of “lagging” indicators is available to management and engineers who are involved in process safety. However, as described in “Guidelines for Risk-Based Process Safety”, lagging indicators are useful only “when a highly responsive link exists” between (1) the compilation or calculation of the indicators and (2) managers of the processes at risk.

Further, use of lagging indicators to guide the process-safety effort “is likely to fail when the lagging indicators are low-frequency, high-consequence events, such as catastrophic accidents.” In contrast, good “leading” indicators can predict future performance, so that the process-safety effort can be properly directed, and limited resources can be effectively applied. An important descriptor of process safety culture is the effort that is devoted to monitoring leading (and lagging) indicators. Only with constant monitoring of these indicators can the safety of potentially-hazardous operations be maintained and improved.

“Learning from Past Performance – Using Human Factor Data to Guide and Drive Process Safety Improvements” was presented by A.W. Armstrong with Kestrel Management Services. Armstrong said Process Safety Management regulations were adopted to reduce the frequency and severity of accidents in the process industries. Like with any risk management program, PSM requires (in part) that risks be identified and evaluated, that procedures are put in place to ensure the safe completion of activities associated with the PSM-covered processes, and that incidents are investigated to identify causes so corrective measures can be implemented. What is missing from the PSM regulations is a basis for learning from past performance. He discussed how companies can learn from past performance by evaluating human factor data from multiple incidents within their operations and using these data to guide and drive process safety improvements.

“Shell’s Experience Implementing a Manual of Permitted Operations” was presented by Douglas Detman with Shell Exploration & Production Co. Detman said Shell Exploration & Production Co. (SEPCo) and Shell Canada Ltd. (SCAN) have developed and implemented a comprehensive risk management tool to provide standardized and consistent direction and guidance for their onshore and offshore operations personnel. This tool is called the Manual of Permitted Operations (MOPO) and can be applied when faced with conditions or conflicts in activities or operations that could threaten safe operations. He discussed what is in-
cluded in a MOPO. He said this tool is routinely used during work planning, approval, and during the work when conditions change, and does not add significantly to the time for completing those activities. MOPO is also used as a communication and training tool.

“Using LOPA to Analyze Past Catastrophic Accidents Including 2008 Mortgage Market Crisis and Space Shuttle Challenger Disaster” was presented by Siddharth Damle with Missouri University of Science & Technology. Damle said that it has been established in the chemical process industry that Layer of Protection Analysis (LOPA) is a helpful tool in analyzing systems safety. It is an effective semi-quantitative risk assessment and mitigation technique which involves independent layers of protection to maximize safety and minimize risk. LOPA has not yet been liberally applied to other industries outside the chemical process industry. Can the contributions of LOPA to the process industry be extrapolated to other industries? Is there a generic approach that could be used to analyze a broader assortment of hazardous situations? He discussed how to apply LOPA to past catastrophic accidents and how to evaluate the effectiveness of the application.

“Evaluating Loss of a Credited Independent Protection Layer (IPL)” was presented by John Kelley with ae-Solutions. Kelley said loss of a credited Independent Protection Layer (IPL) introduces a deviation from the safety calculations set forth from the Layer of Protection Analysis (LOPA) study. Evaluating the nature and degree of the loss in risk reduction is crucial for determining a safe path forward when operating a facility. He discussed a method where bypass time can be determined using a quantitative method per IPL and can account for total loss of IPL or bypassing individual instruments within an IPL.

“Equivalent Cloud Methods used for Explosion Risk and Consequence Studies” was presented by Olav Roald Hansen with GexCon. Hansen said the reactivity of a flammable gas mixture depends strongly on the concentration. Explosions can only take place between the flammability limits LFL and UFL (5% to 14% for methane), with by far the strongest explosions occurring near stoichiometry. When performing explosion studies to evaluate or minimize risk, optimizing design or ways to mitigate, many different approaches exist. Worst-case approaches assuming stoichiometric gas clouds filling the entire facility are often much too conservative and may lead to very expensive solutions. More refined approaches studying release scenarios leading to flammable clouds can give a more precise description of the risk (probabilistic approach) or worst-case consequences (realistic worst-case study). One main challenge with such approaches is that there can be thousands of potential release scenarios to study, e.g. variations of release location, direction, rate-profile, wind direction and strength. He discussed the concept of Equivalent Stoichiometric Clouds, to linearize the expected hazards from an arbitrary non-homogeneous, dispersed flammable gas clouds. He described different equivalent cloud methods, showed examples of use and validation, and discussed weaknesses and potential improvements.

“The Application of Pressure-Impulse Curves in a Blast Exceedance Analysis” was presented by Kendall M. Werts with Quest Consultants Inc. Werts said the magnitude of damage due to a vapor cloud explosion can be estimated in many ways, ranging from look-up tables to quantitative risk analysis. In many cases, a risk-based approach is useful because consequence modeling studies often indicate major problems for buildings at existing facilities. One of the most common risk-based methods, overpressure exceedance, incorporates a wide range of potential explosion scenarios coupled with the probability of each event to develop the probability of exceeding a given overpressure at specific locations. But this and other methods that only use overpressure may not represent an accurate building response. By combining the risk-based methodology of the exceedance analysis with pressure-impulse (P-I) curves, a better measure of building response can be generated. She discussed the application of P-I curves for building damage, and highlighted some of the benefits, as well as some of the potential problems, of using P-I curves.

“CFD to Model a Time Varying LNG Spill” was presented by Eric Peterson with Scandpower, Inc. Computational Fluid Dynamics (CFD) is used to assess the airborne dispersion of Liquefied Natural Gas (LNG) vapor. Peterson said an LNG release initially pours into a trench that provides barrier walls to restrict its horizontal spread while gravitationally guiding it to a sump. This finite duration release is modeled temporally to its completion, with the vapor concentration traced at the lower flammable limit (LFL) to the maximum spatial extent. He discussed the examination of the results that show how CFD handles the simultaneous complexity of time-varying characteristics LNG liquid and vapor in 3 dimensions.

“Facility Siting and Hidden Pathways for Hazardous Gas Migration” was presented by Russell A. Ogle with Exponent, Inc. Ogle said an important strategy for facility siting is to maintain a safe distance of separation between occupied buildings and process hazards. The objective can be stated simply: locate occupied buildings as far as possible from fire, explosion, and toxic release hazards. For process hazards lo-
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cated above ground, there are a number of consequence analysis models and guidance documents available to assist in the determination of safe separation distances. Underground hazards generally receive less attention in facility siting studies. A significant hazard that should be considered is the transport of hazardous gases by underground piping. For facilities where underground piping is used to transport hazardous gases, the potential threat that a leak poses to occupied buildings should be considered. He discussed several case studies showing how hazardous gas can follow preferential pathways and enter occupied buildings with devastating consequences.

“CFD Simulation of Gas Dispersion from Large-Scale Toxic Chemical Releases in Complex Environments” was presented by Filippo Gavelli with GexCon US. Gavelli said chemicals such as chlorine, ammonia, and others which are considered to be toxic inhalation hazard (TIH) materials are transported in large quantities throughout the United States, frequently traveling on railcars or tank trucks. A large-scale TIH release in or near a densely populated urban area could result in a large number of casualties; therefore, accurate modeling of these types of releases is of critical importance. He discussed the CFD model FLACS being used to evaluate the effect of local landscape on the dispersion of a vapor cloud from a large-scale TIH release in an urban environment. He presented the simulation results which showed a large difference between the realistic dispersion scenarios and an identical unobstructed dispersion scenario performed using the same software model. Neglecting the effects of landscape on the consequences of a large-scale TIH release can lead to an inefficient use of resources if the simplified modeling overestimates the actual hazard area, or – even worse – to unforeseen hazards and potential injuries or casualties, if the simplified model underpredicts the actual consequences.

“Selecting Hole Sizes for Consequence Studies” was presented by Oscar Sanguino with ExxonMobil Upstream Research Company. Sanguino said predicting release rates is the first step, and a crucial step, in consequence analysis. When the release is from an isolated volume of vessel and/or piping, the release rate decreases with time. There is often debate about what equivalent hole sizes should be used for a consequence study, and usually a range of hole sizes (3-4 values) is examined. He discussed the effect of hole size on the ultimate impact of hydrocarbon releases for several scenarios.

“Explosibility Index – Extension to Dust-Explosion Protection” was presented by Richard W. Prugh with Dekra-Chilworth Global. Prugh said the U. S. Bureau of Mines [USBM] developed the "Explosibility Index" to rank the relative hazards of different varieties of coal dust. To highlight differences in coal-dust properties, components of the Explosibility Index were separated into “Ignition Sensitivity” and “Explosion Severity”. He discussed the physico-chemical basis for these two indices. The characteristics of dusts have been utilized in comparing dusts of a wide variety of materials, from metals to pharmaceuticals. He also suggested a “matrix” method for determining the extent of explosion protection that should be provided, as functions of these indices.

“Operator Effectiveness” was presented by Hector Perez with PAS. Perez said the human-machine interface (HMI) is the collection of screens, graphic displays, keyboards, switches, and other technologies used by the operator to monitor and interact with the control system. The design of the HMI plays a critical role in determining the operator’s ability to effectively manage the process, particularly in response to abnormal situations. For several reasons, the current design and capability of most HMIs in the process industries, (including pipeline, petrochemical, power generation, pharmaceutical, etc.) are far from optimal for running these complicated processes. Most of these consist simply of P&ID-style graphics covered in numbers. Such displays provide large amounts of raw data and almost no real information. They provide inadequate situation awareness to the operator. He discussed the proper and effective design of the graphics used in modern SCADA and DCS control systems.

“Designers’ Roles in Plant Safety go beyond Regulatory Compliance – Case Finland” was presented by Yngve Malmén with the VTT Technical Research Centre of Finland. Malmén said, in general, it is the employer who is responsible for the safety of the workers. There are, however, also other parties that play a role in assuring the safety at industrial plants. He discussed the obligations and various roles of the so called “external designers” taking part in designing Finnish process plants. He describes some points in a newly written Finnish guidebook, such as safety management during the design procedure involving several parties and dissemination of safety-related information between the engineers and to other parties relying on it during the later stages of a process plant’s life cycle.

“Qatar Fertilizer Company Ammonia Storage System and Company overall Safety Performance” was presented by Iftikhar Hussain Turi with the Qatar Fertilizer Company. Turi said for the last forty three years Qatar Fertilizer Company (QAFCO) now a multi product company and a leading producer of ammonia and urea is diligently handling large volumes of anhydrous ammonia in process
as well as in bulk storage. Hundreds of tons of ammonia is shipped annually around the world. Keeping focus on safety while maintaining the organization growth, QAFCO management is successfully fostering a strong safety vision at all levels of organization by showing its commitment towards continues improvement, risk mitigation, employee’s engagement and implementing, adopting industry best practices and available technologies. He discussed how QAFCO continues to grow while improving and maintaining its safety and environmental record in the Mid East region.

“Optimal Scenario Based Gas Detector Placement in Process Facilities” was presented by Sean Legg with Texas A&M University, Chemical Engineering Dept. Legg said gas detection, specifically the detection of combustible and toxic gas release events, is a key component of modern process safety. He discussed this need by developing a multi-scenario, mixed-integer linear programming formulation for optimally placing gas detectors in petrochemical facilities. Given a large number of potential gas detector locations and a rigorous dispersion model with actual geometry from the process facility, hundreds of different scenarios were simulated using various software packages. He discussed the optimal results that were presented for the minimum number of sensors required to detect all scenarios, the minimum expected time to detect events using a fixed number of sensors, and a robust formulation that minimizes the maximum time to detection across all scenarios.

“Reliability Analysis of Escape, Evacuation, and Rescue (EER) Strategies in the Arctic Regions” was presented by Geun-woong Yun with Shell International Exploration and Production Inc. Yun said it has been reported that the Arctic regions store tremendous untapped oil and gas resources. To meet the increasing global demands of oil/gas energy, many countries and energy, companies have been paying attention to these Arctic regions. However, Arctic environmental conditions are significantly more severe than other areas with extremely low temperature, low visibility, shorter daylight, longer foggy weather, severe snow, and thick ice. Due to these conditions, conventional evacuation strategies from the offshore oil/gas platform may not be directly used in the Arctic. Therefore, to develop oil/gas resources in the Arctic, significant R&D efforts are required. He discussed the currently available EER crafts in the Arctic and addressed which combinations of these EER measures can have higher relative availability than others for year-round usage.

“PSM Metrics Impact on Process Safety Culture” was presented by Dawn Wurst with Flint Hills Resources. Wurst said five years ago our facility recognized the need to expand from a PSM Program managed by a small group to a PSM Culture owned by the full facility. Development and implementation of effective and consistent PSM metrics were utilized to achieve (1) Set the vision for a PSM Culture, (2) Gauge basic awareness, (3) Educate on basic PSM elements, (4) Identify gaps via near miss incidents and (5) Build momentum for improvement- an effective ‘Case for Change’ short of a major incident. She discussed the path of her facility through these five points and provided example tools, methods, and results of each step along the way towards PSM culture improvement.

“Public Health Consequences of Acute Hydrofluoric Acid Releases” was presented by Ayana R Anderson with Agency for Toxic Substance and Disease Registry. Anderson said hydrofluoric acid—also known as hydrogen fluoride, fluoric acid, and fluorohydric acid—is a colorless, fuming liquid or gas with a strong, irritating odor. HF is a corrosive and toxic substance and is more hazardous than most chemicals in 7 out of 9 ranking systems. HF has many domestic and industrial uses. If improperly released, HF can cause extremely adverse health outcomes and in severe cases, when not properly and immediately treated, HF exposure can result in death. She explained that describing the public health implications associated with HF events can increase the awareness of its potential dangers. Our analysis uses the ATSDR’s Hazardous Substances Emergency Event Surveillance system and the National Toxic Substance Incidents Program to describe the public health implications of acute HF releases. In addition, this analysis compares HF events with other acid and nonacid events to explore the magnitude of HF’s toxicity.

“Linking Incident Investigation to Risk Assessment” was presented by Robin Pitblado with DNV. Pitblado said incident investigation processes are well established and use a variety of tools to progress down through immediate causes to identify more basic management system defi-
ciencies. Most modern safety management systems are now risk–based, but incident investigation tools have not adapted as quickly to this new risk-based structure. He described a novel, straightforward and structured approach that adapts a traditional root cause analysis technique to understand the role of barriers in incidents. The Bow Ties diagram is a powerful risk tool that defines the full set of barriers that either prevent a serious event from occurring or mitigate its possible outcomes. He described a method designed for simplicity and application by Supervisor grade staff, enabling the potential for every incident to be assessed for barrier and safety management system root causes.

“A Collaborative Framework for Enabling Efficient Information Extraction in Accident Databases” was presented by Rafael Batres with Toyohashi University of Technology. Batres said many accident databases have been developed to maintain and retrieve records on process plant incidents. However, existing databases use categories based on keyword matching which produces false positives and false negatives. False positives occur when the database retrieves records that should not be matched. False negatives are obtained when the database fails to match and retrieve records that should have been matched. He used examples to explain the factors that produce mismatches and discusses possible solutions.

“Economic Assessment of Inherently Safe Membrane Reactor Technology Options Integrated into IGCC Power Plants” was presented by Reyyan Koc with Worcester Polytechnic Institute. Koc said Pd/alloy-based (Pd/Cu, Pd/Au) membrane reactors embedded into Integrated Gasification Combined Cycle (IGCC) plants (IGCC-MR) would enable the storage and/or use of the energy value of H2 to produce electricity while the CO2 enriched retentate exit stream would be particularly suitable for high pressure CO2 capture-sequestration. There is undoubtedly a lack of operating experience associated with IGCC-MR plants because they have not yet been tested/operated on an industrial-scale. Therefore, sound process intensification principles/practices should be followed not only to enhance process system performance but also to ensure process safety and economic feasibility of an IGCC-MR plant. She discussed a comprehensive process economic assessment framework for an inherently safe membrane Pd/alloy-based reactor integrated into an IGCC plant. In particular, a detailed Net Present Value (NPV) model has been developed to evaluate the economic viability of an IGCC-MR plant where the membrane reactor module design conforms to basic inherent safety principles.

“Inherent Safety – How Safe or Secure is Enough?” was presented by David A. Moore with AcuTech Consulting Group. Moore said inherent safety as a regulatory concept has known complicating issues, such as the lack of metrics to judge the adequacy of the efforts employed. More so, experience has shown that the public and regulators may not be satisfied with inherent safety improvements even if they are substantial reductions in risk. The key expectation with most persons exposed to a potential release is that the reduction of risk results in zero exposure to them. The final expectation is the reduction of consequences v. the reduction of risk in total. Inherent safety becomes the preferred mechanism in the eyes of the public for achieving that reduction. While this is a natural expectation, it is hardly achievable in any practical way for the majority of complex industrial risks without substantial sacrifice on the part of the site, particularly if it is an existing installation. From the public’s opinion, these sacrifices are expected. Incidents cause an impetus for emboldening the public to demand greater safety and security, and create step changes in the evolution of process safety. He discussed several experiences in inherent safety where, despite substantial progress in the reduction of risk, the public or regulators were not satisfied. The key reason for this is the lack of any accepted methodology, set of criteria, and requirement for ‘tolerable risk’ decision-making and this, combined with public outrage on the issue, results in an environment which will occur more frequently in the future as the degree of risk tolerance is diminishing.

“Fischer-Tropsch Synthesis Reactors” was presented by Natalie A. Hamad with Texas A&M University, Chemical Engineering Dept. Hamad said Fisher-Tropsch Synthesis (FTS) is a primary pathway for gas-to-liquid (GTL) technology. In order to overcome commercial problems associated with reaction and transport phenomena, the use of supercritical solvents has been proposed to increase chemical conversion and improve temperature control. One of the major challenges in designing the supercritical FTS systems is the solvent selection. Numerous alternatives exist and should be screened based on relevant criteria. She discussed the goal to identify an optimal supercritical solvent or a mixture of solvents that minimizes the cost while satisfying safety constraints.

“Fault Diagnosis of Chemical Processes via Artificial Immune System” was presented by Dai Yiyang with Tsinghua University. Yiyang said in the nearly four decades, various process models and algorithms for fault diagnosis have been developed to eliminate any potential hazards to ensure that the chemical process runs safely. In general, the diagnostic methods can be classified as quan-
titative model based methods, qualitative model based methods and process history based methods. However, very few fault diagnosis systems have been applied widely to the chemical process so far. He discussed a new fault diagnostic system based on artificial immune system for the chemical process. The traditional negative selection algorithm of artificial immune system is used for fault detection. When a fault is detected, time-sampled artificial immune system will be used in fault diagnosis phase. A dynamic chemical simulation model was built by Honeywell’s UniSim platform, and validated the efficiency of the diagnostic system.

“Managing Process Data for Critical Indicators and Metrics” was presented by Tom Drake with The Drake Group. Drake said data is prevalent in industry and is a key to safe and profitable operations. Developing critical indicators and metrics for process safety can provide the most important tools for operating facilities with fire, explosion, spill or release potential. He discussed the important elements in understanding data and its application to process safety.

“Rationalized Design of Alarm Sensor Allocation Consistent with Hazard Scenarios” was presented by Tetsuo Fuchino with Tokyo Institute of Technology. Fuchino said chemical processes have potential hazards, and are designed to avoid that a given potential hazard evolves into an incident. An independent protection layer is aimed at preventing incidents by protecting against a particular type of hazardous event. He discussed a business process model that was designed for being conscious of the independent protection layer.

“Preventing Disaster: Creating Organizational Energy to Find Defective Safety Culture and Overcome Organizational Inertia” was presented by Bob Wittkower with J P Kenny. Wittkower said the 2010 Deepwater Horizon explosion and loss and the Piper Alpha Disaster of 1988 resulted in sweeping changes across the industry, both in their respective countries and around the world. Changes were in reaction to these major events from the event itself and the governmental actions that compelled changes to the industry. Latent in these histories is an unsolved and pragmatic question: Could each of these disasters have been avoided where management shapes a permanent safety culture to not lose the rationale or articulation of risks? He described career experiences to offer rational pragmatic options illustrated through case histories to delivery of this performance management process. Conclusions and recommendations for methodologies are provided as these are integrated into the modern integrity management process that includes organizational strategies and integrity management assessment software technologies.

“Quantifying Human Performance in Initiating Events and Independent Protection Layers” was presented by Philip M. Myers with Advantage Risk Solutions, Inc. Myers said Layer of Protection Analysis (LOPA) is widely used within the process industries as a simplified method to address risks and determine the sufficiency of protection layers. LOPA brings a consistent approach with added objectivity and a greater degree of understanding of the scenarios and risks as compared to purely qualitative studies such as Process Hazard Analyses. LOPA can be used to address a wide range of risk issues and serves as a highly effective aid to decision making. Incorporation of human performance within LOPA is recognized as an important, though often challenging aspect of the analysis. The human role in potential initiating events or within human independent protection layers is important throughout the process industries, and becomes even more critical for batch processing facilities and in non-routine operations. He explained that the human role is key to process safety and the control of risks, necessitating the inclusion and quantification of human actions in independent protection layers for most companies. An extension into Human Reliability Analysis was discussed, including methods to develop Human Error Probabilities specific to the process safety culture and operations at a given plant site.

“BBN, a Tool to Make LOPA More Effective, QRA More Transparent and Flexible, and Therefore to Make Safety More Definable!” was presented by Hans Pasman with the Mary Kay O’Connor Process Safety Center. Pasman said quantitative risk analysis is in principle an ideal method to map one’s risks, but it has limitations due to the complexity of models, scarcity of data, remaining uncertainties, and above all because effort, cost, and time requirements are heavy. Also, software is not cheap, the calculations are not quite transparent, and the flexibility to look at various scenarios and at preventive and protective options is limited. So, the method is considered as a last resort for determination of risks. Simpler methods such as LOPA that focus on a particular scenario and assessment of protection for a defined initiating event are more popular. LOPA may however not cover the whole range of credible scenarios, and calamitous surprises may emerge. In the past few decennia, Artificial Intelligence university groups, such as the Decision Systems Laboratory of the University of Pittsburgh, have developed Bayesian approaches to support decision making in situations where one has to weigh gains and costs versus risks. He described the details of such an approach and provided some examples of both discrete random variables, such as the probability values in a LOPA, and continuous distributions, which can better reflect the uncertainty in data.
“Leveraging PHA and LOPA Data for Operating Limit Tables” was presented by Carolyn Presgraves with AE Solutions. Presgraves said Safe Operating Limit Tables are a key piece of process safety information and help ensure the operators have the information required to keep a process running safely and respond correctly in the event of a deviation. OSHA 1910.119 covers specific requirements for which data these Operating Limit documents need to include. PSM facilities are finding, through agency inspections and audits that their existing operating limit tables are not in compliance with the standards. Common trouble spots include the consequence of a deviation and the response expected from automated safety functions in addition to the operator. The Process Hazard Analysis (PHA) and Layer of Protection Analysis (LOPA) studies can provide important information to be included in the Operating Limit documents. She discussed how key information included in the PHA and LOPA documentation can be leveraged to more efficiently manage Operating Limit table creation and maintenance. She also described how triggers can be added to the PHA and LOPA process to initiate Operating Limit table updates.

CONTAM Analysis of Smoke Control Systems” was presented by Qing-sheng Wang with the Department of Fire Protection and Safety at Oklahoma State University. Wang said smoke often migrates through elevator hoist ways to higher levels during building fires, and is more hazardous than the fire itself. It has been identified that most fire-related deaths are attributable to smoke inhalation rather than burns. An engineered smoke control system, is an integral part of a facility’s fire protection features to reduce these hazards. CONTAM was developed for indoor air-quality applications but it has been extensively used for smoke control application. He discussed the uses of smoke control systems.

“Simulation of Hydrogen and Methane Mixtures Explosion Using CFD Models” was presented by Camilo Rosas with the Mary Kay O’Connor Process Safety Center. Rosas said hydrogen and liquefied natural gas are considered the forefront alternatives in energy sources and fuels. However, hydrogen is the most desirable between the two alternatives; since combustion of natural gas is environmentally benign. In order to increase the public acceptance of hydrogen as a fuel, hydrogen/methane mixtures are being gradually introduced into the market. This mixture creates a lower risk, higher performing, and cleaner fuel. Further, this mixture allows a simpler transition from current fuel energies, e.g. pure NG to pure H2, without eradicating current technology. He discussed his research to theoretically investigate the explosion characteristics of hydrogen-methane mixtures, using the flame acceleration simulator (FLACS), which is a computational fluid dynamics (CFD) model.

“Mitigation of Vapour Cloud Explosions Using Flame Inhibitors” was presented by Trygve Skjold with GexCon AS. Skjold said very few measures are taken to mitigate the possible consequences of vapour cloud explosions. The main attention is given to prediction of the consequences, which is used to consider strengthening structurally or re-locate occupied buildings such as control rooms. However little is undertaken to limit the consequences of vapour cloud explosions directly such as by limiting the maximum size of congested areas, introducing physical barriers to limit the size of the flammable cloud or by directly affecting flame propagation by the introduction of water deluge upon confirmed gas detection. He discussed a recent alternative suggestion that was made for the use of flame inhibitors by either injection into the flame directly or by injection into the developing flammable gas cloud upon pre-ignition gas detection. He gave an overview of experimental results, highlighting the potential of the use of flame inhibitors limiting the possible consequences of vapour cloud explosions.

“Determination of Effectiveness of Safety Control Measures on Offshore Platforms” was presented by Vitor De Toledo with Dalhousie University. De Toledo said that being known for having a high degree of congestion and confinement, an offshore platform has a critical design in terms of installation/field configuration. If a release of potentially dangerous flammable material takes place and it finds an ignition source, the release of energy due to fire and explosion can have catastrophic effects due to flame acceleration and overpressure. Consequently, both parameters are functions of congestion and confinement. He discussed a study focused on determination of the effectiveness of safety measures applied in fire and explosion scenarios that may result in losses of personnel, assets, business operations and the environment.

“BOEMRE Compliance and Beyond: Focusing on Real not Paper Safety” was presented by Michael Stormonth with RiskTec Solutions. Stormonth said that the Workplace Safety Rule (30 CFR 250.1902) finalized in October 2010 by the Bureau of Ocean Energy Management, Regulatory and Enforcement specifically requires drilling and production operators of
offshore facilities in the Gulf of Mexico to have a Safety and Environmental Management System in effect on or before November 15, 2011. He discussed what it will take to comply with BOEMRE’s Workplace Safety Rule and how that relates to an effective Health, Safety and Environmental Case, the role of the HSE Case given the new Rule and what lies beyond compliance. He described real examples from around the world with an emphasis on how to avoid common shortcomings and ensure that the process is not just a paper exercise, but results in a real step change in safety performance and culture.

“Process Safety Offshore: The Happening Place” was presented by Ian Sutton with AMEC Paragon. Sutton said the process industries all use Safety Management Systems. However, the manner in which such systems work differ quite considerably. The onshore chemical and refining industries generally use the term phrase Process Safety Management. The offshore oil and gas industry in Europe, Australasia and Southeast Asia manage safety through the use of Safety Cases; while the offshore oil and gas industry on the U.S. Outer Continental Shelf use the Safety and Environmental Management Program system. He explained that no single approach is inherently better than any other. Each addresses the needs of the specific industries in the context of their own regulatory requirements, types of technology and historical background.

“Scientific Challenges Underpinning LNG Safety” was presented by Jennifer Wen with the Centre for Fire and Explosion Studies at Kingston University. Wen said the emergence of liquefied natural gas to fill the growing gap in natural gas supply has led to renewed interest in LNG safety. The capacity of LNG for yielding large volumes of gas (a ration of 600:1 at standard temperature and pressure) has made it an extremely important component of the NG industry but also necessitates high safety standards in its handling and transport. She reviewed previous research on the challenges of transport and tank storage and discussed the scientific challenges and research needs which could have significant impact both within and beyond the academic sphere.

“Laboratory Scale Analysis of the influence of Different Heat Transfer Mechanisms on Liquid Nitrogen Vaporization Rate” was presented by Carmen Osorio with the Mary Kay O’Connor Process Safety Center. Osorio said the prediction of the potential hazards associated with accidental liquefied natural gas spills has motivated a number of different studies including experimental and numerical approaches. Most of these studies focus on dispersion predictions, however there is limited information regarding source term of LNG – liquid spill and vaporization. She discussed the need of further improvements on the understanding of these phenomena and the quantification of the most important parameters that can affect them.

“Modelling of a Cryogenic Liquid Pool Boiling Using CFD Code” was presented by Yi Liu with the Mary Kay O’Connor Process Safety Center. Liu said a boiling model of cryogenic liquid was developed by Computational Fluid Dynamic (CFD) code to study the source term model of a cryogen spill. Three different boiling stages were identified, and for each, the heat flux rate was calculated. He discussed the results that are comparable to the experimental data from literature. The developed numerical model seems to have a good ability to predict complex physical process such as the pool vaporization of cryogenic liquid spilled on the ground. The model includes an effect of the changing ground temperature on the vaporization rate of cryogenic liquid.

“Process Safety for the Common Folk” was presented by Jack Chosnek with KnowledgeOne. Chosnek said process safety is a discipline that requires a relatively high degree of competence in engineering and as such sometimes gets misapplied, or even worse, not used at all because of that lack of knowledge. This seems to be prevalent in smaller and medium-sized companies whose resources are more limited than at large companies, although during tough economic times not enough resources are applied even in those larger companies. The effect is a potentially very serious impact on the employees’ health and well being as well as on others, such as the neighboring communities. He discussed what can be done, where the priorities should be put, and the proposed tools to use.

“Excellence in Pressure Relief Systems Management through Evergreening Program” was presented by Mike Marshall with Marathon Petroleum Company. Marshall said most oil and gas refining and petrochemical organizations have a Process Safety Management program that stems from the requirements outlined under OSHA’s 29 CFR 1910.119. Some have a very extensive program that covers most of the 14 elements of PSM and is managed via an integrated platform while others follow an ad hoc approach that does not span all of the
elements or is disjointed. Recent incidents in the industry have elevated the importance of maintaining accurate and current pressure relief systems documentation. Thus, an evergreen program for relief systems documentation was created that is customized to fit the needs and resources of the operating company and has the ability to relate to the other PSI elements. He discussed the drivers and the benefits of having an evergreening program for pressure relief systems documentation and explored the interdependency of evergreening elements.

“Effective Process Equipment Inspection & Testing” was presented by Russ Davis with Aon Energy Risk Engineering. Davis said inspection and testing of process equipment must be effective or the resources expended are wasted. Typical inspection protocols for fixed process equipment include a visual internal, visual external and an on-stream inspection. These inspections may not be effective in detecting damage to process equipment. He discussed the typical inspection protocol which can result in an extended business interruption and extensive repair costs. An effective mechanical integrity inspection or test must be specific for the potential damage mechanisms that may affect the integrity of the equipment being tested. A risk based inspection program can assist in the identification of high risk equipment and in the development of specific equipment plans. A SEP specifies the inspection and testing protocol most likely to detect damage.

“Improving Process Safety from the Ground Up” was presented by Karen Study with The Dow Chemical Company. Davis said improving process safety performance for a business is a huge task. The single most important factor to achieve success is the ability to foster a deep understanding of process safety principles and how to apply these principles in a practical manner at the plant level. One way the Dow Chemical Company has approached this effort is by developing Process Safety Teams. One team is aligned with each business and includes at least one representative from each plant within a business as well as key management and technical personnel for the business. The team is led by a process safety expert and the primary team goal is to improve sustainable process safety performance for the particular business. She described the team makeup and purpose as well as the mechanics of how the teams function and the success we have seen as a result of these teams. She also provided a “how to” guide for use at companies struggling to improve their process safety performance.

“Case Study: One Checklist Item Can Make a Difference” was presented by Clyde Young with John M. Campbell & Co. Young discussed a case study of a consultation to prepare a large wastewater reclamation facility’s Risk Management Plan for submission to US Environmental Protection Agency. He said during the Process Hazards Analysis (PHA), a simple checklist item was explored and during the ensuing discussion, it was determined that a potential release of flammable material might occur. A recommendation was created to address the scenario. Very soon after the PHA was concluded and before management analyzed and addressed the recommendation, the identified scenario did occur. Operator intervention may have prevented a potential release of 80,000 pounds of Chlorine and 54,000 pounds of Sulfur Dioxide. He described the events and lessons learned.

“Insulation Failure on a Cryogenic Propane Tank” was presented by David J Bleakley with ConocoPhillips Norge. Bleakley said in June 2010, a failure was experienced of the insulation system on a 23,000 Tonne cryogenic propane storage tank in the UK (Operating at -40°C and 35mbar). Over a 1 week period, the tank suffered a catastrophic deterioration of its insulation system; with up to 60% of the insulation collapsing exposing the tank shell. A formal investigation was conducted to determine the root causes of this failure; and to generate corrective actions to prevent recurrence. One of the major findings relates to the propensity of cellular glass type insulation materials to absorb water; which can then be subject to a deteriorating freeze/thaw mechanism over time, as both tank level and ambient temperatures change. He discussed the recommendations from the investigation include ensuring that cladding replacement strategies consider multiple selection criteria, such as: weather protection, vapour barrier capability, prevention of freeze-thaw mechanisms of the insulation fabric, structural integrity (including potential to provide additional support to insulation system) and fire protection benefit (pressure relief considerations).

“Safety Control System for Safer and Reliable Facilities” was presented by Rajan Batra with Chevron Corporation. Batra said in the current environment, companies cannot afford an incident in which people are injured, safety is compromised, the environment is polluted or assets are damaged. A safety system is required that can protect a company's assets, its capital investments, its people and the environment. This is an environment in which failure is not an option and safety systems should be designed to prevent hazardous events. He described a Safety Instrumented System (SIS), which is a safety system made of sensors, logic solver and final elements, which is categorically designed and used to prevent or mitigate potentially hazardous events to protect
people or the environment or prevent damage to process equipment or company assets. The Safety Instrumented System detects abnormal process conditions and automatically returns the process to a safe state.

“What Else is Needed besides a SIL Evaluation?” was presented by David E. Fauerby with URS Safety Management Solutions. Fauerby said the concept of the Safety Instrumented Function (SIF) associated with a Safety Instrumented System (SIS) is that the instrumentation will provide an interlock actuation, relief of pressure action, or some other function to prevent the process from becoming unstable or dangerous, or that it will provide an alarm so that compensatory actions may be taken prior to the process reaching a Safety / Design Limit. A Safety Integrity Level (SIL) evaluation performed in accordance with ANSI/ISA-84.00.01 / IEC 61511 determines the probability that the SIS will take action when commanded to do so. He discussed the performance characteristics of the SIS equipment and their impact on the ability of the SIS to perform its designated SIF before the process approaches the Safety / Design Limit.

“Safety Instrumented Function Reliability and the Art of Confusion” was presented by Simon Lucchini with Fluor. Lucchini said IEC 61511 is a widely accepted and utilized international standard that addresses the application of safety instrumented systems for process industries. This standard has “two concepts which are fundamental to its application; safety lifecycle and safety integrity levels.” An effective Safety Requirement Specification (SRS), which is developed throughout the life cycle of a Safety Instrumented System (SIS), is used to define both the functional and integrity requirements. As challenging as it seems to define these requirements once this information is known the next steps in designing and then verifying the Safety Instrumented Functions (SIF) can be even more difficult. He discussed the validity of the reliability equations on which many operating and maintenance decisions about safety functions are based and said it is suggested that the governing failure mechanisms may be more influenced by systematic rather than random factors.

“Use of Fuzzy Logic on SIF Failure” was presented by Prasad Goteti, with Honeywell Process Solutions. Goteti discussed an instance in a process plant where the Level indicating instrument on a tank failed to indicate the correct level and the redundant High Level sensing device also did not respond while filling a Tank. This is a perfect scenario to have a Tank overfill and overflow which is of course an undesirable event for any site. If this tank contains a combustible fluid, the overflow could lead to an explosion if the fluid comes in contact with an ignition source. Based on the failure rates of the level sensing devices and other parameters, a Safety Integrity Level analysis may have verified that the two protection layers, the Level transmitter connected to a Basic Process Control System (BPCS) and second connected to a Safety Instrumented System are sufficient to mitigate the Risk from such an incident based on the customer’s Tolerable Risk criteria. While those calculations are not incorrect, during a real time failure of the designed protection layers, wouldn’t it be nice to have a “backup plan” which could be automatically generated based on the instances at that time? He explained that with the use of Fuzzy logic, it is possible to come up with such a “backup plan” in real time and contain the incident like that of a Tank overflow.

“Layer of Protection Analysis: A Look Back to the Beginning and a Look Forward to the Future” was presented by A. M. (Art) Dowell, III. Dowell explained that layer of protection analysis (LOPA) is a simplified process risk assessment technique that was developed late in the 20th century and continues to be popular well into the 21st century. He discussed the origins of LOPA -- what were the needs that prompted its development? -- and the future of LOPA -- what needs will it fulfill in the future and what are the pressing issues in its use?

“Fire and Explosion hazard Analysis – An Integrated Approach; Aligned Fire and Explosion Safety Concepts – Fact or Fiction?” was presented by J.W. Lottermann with REMBE®, Inc. Lottermann said regardless of different global standards and regulations, the protection of the employees against the hazards of fires and explosions gains in importance in the operational fire and explosion protection. In addition, employment of protection safety measures shall reduce property damages and losses arising from business interruption following fires and explosions (business continuity). He discussed how fire and explosion hazards can be systematically and coherently analyzed in order to generate integrated fire and explosion safety concepts. Since combustible dust handling facilities are endangered by both fires and explosions, he described the recently developed approach using such facilities to show typical mistakes done in practice. For this purpose the explosion protection is systematically analyzed and exemplified with regard to structural fire prevention, technical fire protection and fire fighting activities of fire brigades.
“Major Damages in Chemical and Oil Complexes after 2011 Tohoku Earthquakes of Japan” was presented by Xinrui Li with the Mary Kay O’Connor Process Safety Center. Li said the March 11th earthquake of 2011 in the Tohoku area of Japan has alerted the entire world to the danger of earthquakes. She discussed the information collected on destruction associated with several chemical and oil complexes on the Pacific coastline, which may provide primary data for future analysis and assessment.

“Uncertainty in LOPA Studies” was presented by Randy Freeman with S&PP Consulting. Freeman said 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). The methodology 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 but representative estimates of the failure probability of protective systems. When these results are presented to management for concurrence with the conclusions and for funding of recommendations, management sometimes asks questions. He discussed a framework to answer the questions and presented guidance on methods to incorporate an uncertainty analysis into a LOPA or QRA study.

“10 Years of LOPA – What Have We Learned and Where Are We Going?” was presented by Annette Kyle with Aon Energy Risk Engineering. Kyle stated that a new CCPS (Center for Chemical Process Safety) book entitled Guidelines for Non-SIS Independent Protection Layers will soon be published. We are expecting that this new publication will impact how Layer of Protection Analysis (LOPA) is practiced across the industry. The new book will be the first major supplement to the CCPS/AIChe concept book on LOPA issued in 2001 (Layer of Protection Analysis: Simplified Process Risk Assessment). She discussed the evolution of some of the issues resulting from the application of the LOPA method over the last 10 years by its practitioners and where we might be going in the future.

“Impacts to the Chemical, Petroleum, and LNG Industry from the Japanese Earthquake and Tsunami of 2011” was presented by David A. Moore with AcuTech Consulting Group. Moore stated that the Japanese earthquake and resulting tsunami of 2011 will stand as another significant test of the resilience of the global chemical and petroleum industry to maintain operations in light of substantial stress. In this case, a widespread initial and follow-on series of seismic events caused such disruptions as widespread loss of power, extreme ground shaking causing failures and fires and explosions, and later, a lack of supplies and personnel. Based on an analysis of the industry experiences along with interviews and reports from operators, he discussed the effects of the earthquake, tsunami, radionuclide fallout and subsequent disruptions the Japanese industry experienced and the ways in which forward planning assisted them in recovery and resilience, and the impacts on the global value chain. The safety and security community can learn valuable lessons from these extreme experiences and apply them in design, emergency planning, resilency, operations, and risk management.

“Two-Phase Jet Releases, Droplet Dispersion and Rainout - I. Overview And Model /Validation” was presented by Henk Witlox and Mike Harper with DNV Software. Witlox explained that many accidents involve two-phase releases of hazardous chemicals into the atmosphere. He described the results of the fourth phase of a Joint Industry Project (JIP) on liquid jets and two-phase droplet dispersion. The objective of Phase IV of the JIP was to generate experimental rainout data for non-flashing experiments, and to develop recommendations for the best methodology to predict rainout. He discussed that the adopted rainout methods comprised both methods including explicit modelling of the droplets using an extended version of Phast dispersion model UDM, as well as more simple methods based on rainout correlations without droplet modelling.

In “Two-Phase Jet Releases, Droplet Dispersion and Rainout - II. Rainout Experiments,” Witlox described the results of the first experimental stage of Phase IV of a Joint Industry Project (JIP) on liquid jets and two-phase droplet dispersion. The objective of this stage of the JIP was to generate experimental rainout data for non-flashing water and xylene experiments. He said instead of the PDA method used earlier in the JIP, a photographic technique was applied in an attempt to include measurement of the larger (non-spherical) droplets that enabled a more accurate evaluation of the initial droplet size distribution and a much clearer understanding of the droplet morphology.

“Large Scale Experiments on Hydrogen Jet Fires for Pipeline Safety” was presented by Seungho Jung with Air Products. Jung said hydrogen is widely used in the refining and chemical industries. It also has great potential as an alternative energy carrier since it is clean burning and produces near-zero greenhouse gas emissions.
sions. Pipelines are the most economic way to deliver large quantities of hydrogen to industrial customers. As hydrogen becomes widely used as a transportation fuel, a pipeline infrastructure will be required for distribution. He explained that a study of hydrogen jet fires is motivated by the need to adequately assess the consequences of a potential underground hydrogen pipeline failure and discussed the details of the experiments from which the data are being used to improve our modeling of the thermal radiation from hydrogen jet fires.

“Risk Criteria, Protection Layers and Conditional Modifiers” was presented by William Hearn with SIS-TECH Solutions. Hearn explained that risk analysis assesses the likelihood and consequence of events. The acceptability of the identified risk is determined by comparing it to a specified risk tolerance. The criteria applied depend on the analysis boundary, which may be loss of containment or extend to the harm posed by the loss of containment. Risk analyses generally begin with a determination of the likelihood that a hazardous event could result in loss of containment or some other undesirable consequence. He gave a brief introduction to risk analysis concepts to provide a foundation for a discussion of the typical analysis boundaries and associated risk criteria and discussed how the analysis boundary and risk criteria affect the consideration of protection layers, enabling conditions, and conditional modifiers.

“A Formulation to Optimize the Risk Reduction Process Based on LOPA” was presented by Clementina Ramirez-Marengo with the Mary Kay O’Connor Process Safety Center. Ramirez discussed a mixed integer nonlinear programming (MINLP) model used to improve the computational use of the layer of protection analysis (LOPA). She explained that the model focuses on improving the analysis process and decision making to obtain the optimal solution in the safeguards selection that satisfies the requirements to be considered as IPL’s. The optimization is based on economic and risk tolerance criteria. She described a case study to validate the proposed approach.

“Risk: Calibrating Likelihood and Consequence” was presented by Michael Schmidt with Missouri University of Science and Technology. Schmidt said a fundamental premise of risk assessment is that risk is a function of likelihood and consequence. Layer of Protection Analysis in particular is performed on specific scenarios, or cause-consequence pairs, yet most analysts accept that an analysis may consider many consequences. He explained that one approach to risk assessment is to establish a benchmark impact, assign a tolerable frequency to the benchmark impact, and then develop a family of impact categories based on that benchmark. He also discussed the financial impacts and considerations for including or excluding them from methods like LOPA and proposed some approaches to establishing environmental impact categories, which have been notoriously difficult to do well.

“The Use of the FDS Computational Fluid Dynamics Code in Complex Fire Geometries” was presented by Benjamin Ishii with Quest Consultants Inc. Ishii said the historical siting and spacing rules for bulk storage facilities have been effective for simple systems such as tank farms, where each bulk storage tank has its own impoundment system. When multiple tanks are located in a single impoundment, this rule of thumb approach may be effective in protecting nearby tanks or structures in some instances, but not in others. The use of solid flame models have been an advancement over the rule of thumb approach and have been helpful in resolving siting issues related to multiple tank impoundments, but these models have their limitations as well. He discussed the development of the available pool fire models and presented a comparison of the results obtained using the rule of thumb, solid flame, and CFD modeling methodologies.

“A Study of Spreading and In situ Burning in an Ice Channel” was presented by Peter Bellino with Worcester Polytechnic Institute. Bellino said in situ burning is one method of oil spill mitigation that is particularly relevant in arctic and sub-arctic conditions where traditional equipment used in oil spill cleanup may not be practical. A series of bench scale tests using a 100 cm long ice channel were conducted to study the effects of varying ice channel widths on the spread and burning rate of an oil mixture, to mimic sea ice conditions that may be found in higher latitudes. Results suggest that spread rates of oil in ice channels, follow a Froude-number type of scaling relationship. The heat loss due to ice melting at the channel walls decreases the mass loss rate by 90 percent when compared with a normal free burn without the presence of ice. In addition to the heat sink effect, the melting of ice causes a widening of the channel width which increases the total surface area of the oil. This causes an increase in the mass burning rate per unit area as the channel widens with time. He discussed the implication of these results on in situ burning of oil in icy conditions.

“Using CFD to Analyze Gas Detector Placement in Process Facilities” was presented by Scott Davis with GexCon US. Davis said gas detectors are used in process facilities to automatically alarm and initiate safety measures in response to hazardous leaks. Safety measures can
include emergency system shutdown (ESD), evacuation of personnel, system isolation and venting of the affected area. In the absence of effective leak detection, facilities are susceptible to a potentially significant and disproportional increase accumulation of toxic gases and flammable gases. Fires and explosions can cause injury to personnel and have the potential to escalate the hazard to neighboring vessels, piping or equipment. The areas that need gas detection coverage can be determined by modeling the dispersion of gases from potential leaks using CFD. He discussed a method that utilizes FLACS simulations to optimize gas sensor locations in order to maximize the likelihood of early detection of gas clouds that are at levels of concern.

“The Maximum Design Leak (MDL) Approach to Leak Size Selection” was presented by Gary Fitzgerald with ABSG Consulting, Inc. Fitzgerald said when performing consequence-based facility siting analyses, determining the Maximum Credible Events (MCEs) to evaluate is one of the most important decisions to make. In defining MCEs, the assumed leak size is arguably the single most important decision made but also has a high degree of subjectivity. He discussed a methodology using existing risk-based tools to determine leak sizes of different MCEs in a consequence-based study. The resulting leak size is the Maximum Design Leak (MDL) which would be used in determining potential consequences and remedial actions. He presented a case study using actual refining industry data as an example of its application and how results may appear in a refining application.

“PRV Chatter Incidents” was presented by Brad Otis with Shell Global Solutions. Otis said API-520 recommends limiting Pressure Relief Valve inlet pressure losses to 3% of set. It also allows use of an engineering analysis to assess PRV installations that have inlet losses greater than 3% of set. This is an important issue for industry since studies have shown that a sizeable fraction of existing vapor relief PRV installations have inlet losses greater than 3% and yet they have not had significant chatter issues. He reviewed survey data on 42 liquid relief PRV chatter incidents within the refining industry that occurred prior to 1976 and an additional 20 cases of PRV chatter (liquid and vapor relief) within industry since 1976. The data clearly illustrate that the predominant risk with PRV chatter is with installations relieving liquid, not vapor. He discussed recommendations on improving guidance for the design/installation of relief systems that have liquid relief.

“A Critical Evaluation of Combustible Dust Test Methods” was presented by C. B. Parnell, Jr with Texas A&M University. Parnell said tests have been conducted by the Center for Agricultural Air Quality Engineering and Science and by a commercial laboratory to determine if dust in cotton gins (gin dust) was a combustible dust. The CAAQES laboratory used the criterion that a combustible dust must have a minimum explosive concentration (MEC) to be a combustible dust. It was concluded that gin dust did not have a MEC. Hence, gin dust was not a combustible dust. Safety Consulting Engineers Inc. were contracted to perform combustible dust testing of gin dust. This commercial laboratory reported no deflagrations with the Hartman tube for 110 tests for gin dust concentrations ranging from 208 to 16,700 grams per cubic meter (g/m$^3$). The testing laboratory’s results from the 20-L chamber testing indicated that gin dust was a combustible dust. He discussed the conflicting results. Pressure as a consequence of the igniter flame reacting with combustible particles in the cloud can exceed the thresholds that would indicate that a deflagration occurred in the test chamber when it did not. Using pressure rise as the indicator that a deflagration occurred in the 20-L test chamber can lead to a conclusion that a non-combustible dust is combustible when it is not.

“Public Health Implications of Dust Explosions Using Chemical Incident Surveillance Systems” was presented by Ayana Anderson with ATSDR/DHS. Anderson said dust explosions are initiated by rapid combustion of flammable particulates suspended in air. Some materials that can cause dust explosions are natural organics, synthetic materials, coal, peat, and metals. Despite more than 100 years of extensive research on preventing and mitigating dust explosions in industries that manufacture, use, and/or handle dusts and powders, the explosive hazard of combustible dust is not well known. Describing public health implications associated with such incidents will help industries understand the magnitude of danger posed by dust explosions. She discussed the analysis that focuses on the public health implications of dust explosions recorded in the Agency for Toxic Substance and Disease Registry (ATSDR)’s Hazardous Substance Emergency Events Surveillance (HSEES) system and National Toxic Substance Incidents Program (NTSIP).

“Key Safety Issues for Combustible Dust Handling” was presented by Molly Myers with ioMosaic. Myers said for the past few years OSHA has been conducting focused
inspections at facilities which generate or handle combustible dusts as part of a National Emphasis Program for Combustible Dusts (NEP). Some of these facilities were not even aware that they were handling combustible dusts and may not be familiar with the necessary safeguards to safely handle these materials. She reviewed the background for this NEP, some of the common findings and made some suggestions for safely dealing with combustible dusts to minimize the likelihood of a citation, should OSHA visit your facility.

“Correlating Turbulence Flow Field in Dust Explosion Vessels of Different Size” was presented by Diana Castellanos with the Mary Kay O’Connor Process Safety Center. Castellanos said the turbulent flow field inside a 20 L and a 36 L vessel has been compared using computational fluid dynamics (CFD) simulations. Different factors affect the turbulence parameters during a dust explosion test, including the size and shape of the vessel, characteristics of the dispersion system, and the operating conditions for the equipment. She discussed the effect of the operating conditions on the initial turbulence prior to ignition and the experiments performed. The dispersion process was simulated with air in the 20 L vessel using the CFD code FLACS (Flame Acceleration Simulator) to achieve atmospheric pressure after dispersion. Subsequently, propane-air explosions at different ignition delay times were simulated. Once the simulated results agreed with available experimental data, the same dispersion system was implemented into a geometry representing the 36 L vessel, and the operating conditions were adapted based on the experimental procedure for this equipment. Finally, the turbulence predictions obtained from FLACS for the 20 L and the 36 L vessels were compared with empirical correlations of the turbulence decay in a 20 L vessel. Despite the differences in geometry, size, and operating conditions, the equipment studied presented similar turbulence levels after the dispersion was completed, particularly when the explosion was triggered between 60 and 200 ms after onset of dispersion. This methodology can be useful to calibrate equipment where turbulence plays an important role in the course of events, and practical for obtaining information about a system when expensive experimental equipment is not available.

“A Constant Pressure Dust Explosion Experiment” was presented by Trygve Skjold with GexCon AS Norway. Skjold described an apparatus for investigating dust explosions at near constant pressure conditions. Combustible dust is dispersed with pressurised air from a reservoir to form an explosive mixture inside a transparent latex balloon. After a certain delay time, the turbulent dust cloud is ignited by a chemical igniter. A digital high-speed camera records the propagating flame and the expansion of the balloon. He said experiments were performed with two types of dust, Lycopodium spores and maize starch, as well as with propane-air mixtures under initially quiescent and turbulent conditions. The results are primarily qualitative in nature, but they nevertheless demonstrate both similarities and differences between premixed combustion of gaseous and solid fuels, and highlight some fundamental challenges for future dust explosion research.

“Uncertainty Techniques in Liquefied Natural Gas (LNG) Dispersion Calculations” was presented by Dorota Siuta with the Mary Kay O’Connor Process Safety Center. Siuta said the dynamic development of the LNG sector increases the risk of major accidents. Uncontrolled releases of LNG during the processes of manufacturing, distribution, storage, and regasification can pose a serious threat to people, facilities, and the environment. Therefore, an important goal is to determine hazard zones and the extent of potential consequences associated with a release of LNG. The key issue is to estimate these with the least level of uncertainty. The largest part of uncertainty comes from the modeling of LNG release sources and performing dispersion calculations. She discussed a general procedure for calculating the release rate and duration time of the LNG release, pool spreading, vaporization, as well as dispersion, taking into consideration the uncertainty and presented a case study, concerning an LNG release, that illustrates the application of the proposed techniques.

“Application of Computational Fluid Dynamics Modeling in Forced Dispersion of LNG Vapor Cloud” was presented by Byung Kyu Kim with the Mary Kay O’Connor Process Safety Center. Kim said the safety and security of Liquefied Natural Gas (LNG) facilities have prompted the needs for continued study in LNG mitigation systems. Water spray curtain has been widely recognized as one of the effective measures for dispersing the LNG vapor cloud and reducing the LNG vapor exclusion zone. Currently, there are no engineering guidelines available for water curtain applications in the LNG industry due to a lack of understanding of the complex interactions between the LNG vapor cloud and water droplets. He discussed his work that applies the computational fluid dynamics (CFD) modeling to investigate the dominant mechanisms observed in the forced dispersion of LNG vapor using the upward-oriented full-cone spray nozzles.
“Numerical Study of Compressed CO2 Pipeline Decompression Characteristics Using CFD-DECOM” was presented by Jennifer Wen with Kingston University. Wen said there is growing world-wide interest for carbon capture and storage (CCS). The critical link between capture and storage is the transportation of the captured CO2 over long distances. The most economical means is through pipelines either as dense phase fluid or as a gas. Therefore the need has arisen to address the risk of potential loss of containment scenarios that can be environmentally damaging. She discussed a CFD based pipeline blowdown model that has been developed and validated against experimental data for rich gas, gaseous and dense phase carbon dioxide. Predictions carried out for some previously tested blowdown scenarios are found to be in reasonably good agreement with the experimental data.

“Comparisons of Non-isothermal and Isothermal Kinetic Model for Evaluating the Thermal Hazard of 1,1-Di (tert-butylperoxy) cyclohexane by DSC” was presented by C.P. Lin with Asia University. Lin said 1,1-Di (tert-butylperoxy) cyclohexane (DTBPH) has been widely employed in the chemical industry. Unfortunately, organic peroxides have been involved in many serious fires and explosions in manufacturing processes, storage, and transportation. He discussed his study that investigated the thermokinetic parameters by isothermal kinetic and non-isothermal kinetic simulation, using differential scanning calorimetry (DSC) tests. From the results, DTBPH of the optimal conditions to avoid violent runaway reactions during the storage and transportation was determined. This study established the features of thermal decomposition that could be executed as a reduction of energy potential and storage conditions in view of loss prevention.

“Chemically Unstable Gases and Gas Mixtures –New Categories in the GHS” was presented by Maria Molnarne with BAM Federal Institute for Materials Research and Testing in Germany. Molnarne said in connection with the use of chemically unstable gases (especially acetylene and ethylene oxide) accidents keep on happening. She discussed the investigation of accidents which showed that the chemical instability of flammable gases played an important role in the severity of accidents. Therefore, this hazardous property was included in the global harmonization of the classification of chemicals. The classification of chemically unstable flammable gases and mixtures is an amendment to Chapter 2.2 “Flammable gases” of the UN Globally Harmonized System of Classification and Labelling of Chemicals (GHS) [2], because most chemically unstable gases are flammable as well. The proposal to add them to the GHS originated from the experts of an informal working group of the UN Sub-Committee of Expert on the GHS (UNSCEGHS) headed by BAM, Germany. The UNSCEGHS has decided to include it in the Fourth Revised Edition of the GHS. The respective method for determining whether a gas is chemically unstable or not, is included in the UN Manual of Tests and Criteria. She presented some experimental investigations of these gases, the test methods, examples of new classifications and results from CHEMSAFE.

“If One Drop Is Too Much, How About Six?” was presented by Jonathan Henson with Maersk Drilling. He said in December 2009 and January 2010, a Maersk rig suffered six dropped object incidents. Each of the drop objects exceeded 40 Joules. While no one got hurt, it was unacceptable to our own safety culture and the client’s expectations. We had to improve and ensure it wouldn’t happen again. The consequences of failing to correct the dropped object situation would have put our operation in jeopardy. He discussed the six dropped object incidents, their root causes and actions implemented.

“Human Factors Issues in the Management of Emergency Response at High Hazard Installations” was presented by Martin Robb with Atkins Inc. Robb discussed the Human Factors issues involved in emergency responses at high hazard installations, in particular offshore installations. Human Factors is an important consideration in the event of an emergency because these events are highly safety critical situations and human errors may lead to severe consequences, emergency response operations such as decision making, response activities and safeguards to errors consist primarily of human operations and, although the tasks involved are relatively simple, they are often carried out under extreme circumstances and in a harsh or even hazardous physical environment.

“A Practitioner’s Approach to Utilizing Leading Indicators to Drive Safety Performance” was presented by Jack Toellner with ExxonMobil Development Company. Toellner said ExxonMobil Development Company has worked closely with multiple contractors and business partners around the world to implement the use of leading safety indicators which have been a key element in ExxonMobil Development Company’s world class success in safety. He explained the two basic areas of trailing and leading indicators. He discussed the mathematical fundamentals of leading safety indicators, introduced examples
of analytical tools that support the use of leading safety indicators, and presented a case study that demonstrates the potential of driving performance through the use of leading safety indicators, and communicated lessons learned in the application of leading safety indicators.

“MOC Scoping—Getting it Right” was presented by Rainer Hoff with Gateway Consulting Group, Inc. Hoff said Management of Change, or MOC, is one of the most complex business processes at chemical plants and refineries. In the U.S., MOC is required by a number of agencies including PHMSA, the EPA, and most commonly, OSHA. It is a given that MOC must address safety/regulatory concerns, however, some attention should be focused on the efficiency aspects of the MOC business process. He discussed a lifecycle approach for characterizing MOC.

“Implementing Instrument and Process Control Mechanical Integrity and Reliability Improvement” was presented by Bill Hearn with SIS-TECH Solutions. Hearn said successful and sustainable implementation of mechanical integrity for instrumentation and controls require well-defined interactions involving people, equipment and work practices across the entire lifecycle. Companies, which document and master these interactions, have the opportunity to add millions of dollars to their annual operating income, while at the same time improving operational safety. He discussed the results of a recent industry survey that indicates few companies are focusing resources on instrumentation and controls reliability and in general industry appears to be heading in the wrong direction.

“Getting Away From Alarm Management Infomercials Real-time Implementation in Today’s Process Plants” was presented by Lawrence Stegman, with PAS. Stegman said modern processing plants have made great strides with initiatives to improve their overall manufacturing and maintenance processes, however, these initiatives have primarily concentrated around technology and efficiency improvements. One area that has recently been identified as needing attention is mitigation of abnormal situations. While technology improvements are important, plant equipment, mechanical and electronic, has a mortality rate. Failures in these systems can cause situations outside the designed operating windows. This is where mitigation of abnormal situations is important and is primarily driven by the human operator. Alarm systems are the key method to inform the operator of these emerging abnormal situations. He discussed the function of alarm systems in the decision making process during an abnormal situations.

“Process Safety Evolution – An Air Products Case Study” was presented by Shakeel Kadri with Air Products. Kadri said that Air Products has developed a very robust Process Safety Risk Management program and culture over the years. He discussed the journey, that started in the mid-seventies, when the then CEO challenged the organization to improve its safety performance akin to the safety performance of the best companies in chemical industry. The focus of the journey was heightened after experiencing two very tragic process safety incidents. He described how Air Products’ process safety program was taken from standards based to systems based, onward to risk based, and now driving into a culture based and how lessons are incorporated, both internal and external, to continually strengthen the process safety risk management, the unique challenges and opportunities being seen in the global arena, and the leadership actions being taking to sustain this global program.

“Process Safety in a Volatile & Ever Changing World” was presented by John Prows with Huntsman Corp.
# 2011 - 2012 Continuing Education Schedule

Classes offered in Houston, TX and at your facility!

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<th>Date</th>
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<th>Class</th>
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<th>Facility*</th>
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<td>8/17</td>
<td>3111</td>
<td>Reactive Chemical Hazards Assessment</td>
<td>Dr. Bill Rogers</td>
<td>PCCT Center</td>
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<tr>
<td>9/6 - 9/7</td>
<td>3102</td>
<td>Pressure Relief Systems - Best Practices</td>
<td>Dr. Abdol Akeleeb</td>
<td>Siemens</td>
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<td>9/13 - 9/14</td>
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<td>10/4</td>
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<td>10/4 - 10/5</td>
<td>4132</td>
<td>Gas Explosion Hazards for LNG Facilities</td>
<td>Dr. Scott Davis</td>
<td>TAMU – Qatar</td>
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<tr>
<td>10/11 - 10/12</td>
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<td>Mr. Adrian Sepeda</td>
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<td>10/13</td>
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<td>Management of Change</td>
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<tr>
<td>10/18</td>
<td>3121</td>
<td>Reducing Human Error in Process Safety</td>
<td>Mr. A. W. Armstrong</td>
<td>PCCT Center</td>
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<tr>
<td>11/15 - 11/16</td>
<td>2042</td>
<td>Layer of Protection Analysis</td>
<td>Dr. Angela Summers</td>
<td>SIS-TECH</td>
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| 2012     |               |                                                            |                   |                   |
| Feb      | 1011          | Combustible Dust Explosion Hazard Awareness                | MKD/PSDC Staff    | Texas A&M Univ.   |
| 2/7 - 2/8| 2052          | Process Hazard Analysis Leadership Training               | Mr. Skip Early    | PCCT Center       |
| 2/21 - 2/22| 1082         | Process Safety Management - Fundamentals                  | Mr. Adrian Sepeda | PCCT Center       |
| 2/23     | 1041          | Management of Change                                       | Mr. Adrian Sepeda | PCCT Center       |
| 3/13 - 3/14| 3102        | Pressure Relief Systems - Best Practices                  | Dr. Abdol Akeleeb | Siemens           |
| 3/27     | 3121          | Reducing Human Error in Process Safety                     | Mr. A. W. Armstrong | PCCT Center      |
| 3/27 - 3/29| 2072        | SIS Implementation                                         | Dr. Angela Summers | SIS-TECH         |
| 4/5      | 4132          | Transfer of Hazardous Chemicals                            | Mr. Thurman/Mr. Lingo | PCCT Center     |
| 4/17 - 4/18| 2042         | Layer of Protection Analysis                              | Dr. Angela Summers | SIS-TECH         |
| 4/17 - 4/19| 1082         | Process Safety Management - Fundamentals                  | Mr. Adrian Sepeda | PCCT Center       |
| 4/19     | 1041          | Management of Change                                       | Mr. Adrian Sepeda | PCCT Center       |
| 5/6      | 1142          | What Went Wrong? Learning from Chemical Plant Incidents   | Mr. Roy Sanders   | PCCT Center       |
| 5/15 - 5/16| 2082        | SIL Verification                                           | Dr. Angela Summers | SIS-TECH         |
| 5/22     | 4061          | Engineering Decision Making                                | Dr. Bill Rogers   | PCCT Center       |
| August   | 4072          | Gas Explosion Hazards on Offshore Facilities              | Dr. Scott Davis   | Texas A&M Univ.   |
| 8/15     | 3111          | Reactive Chemical Hazards Assessment                       | Dr. Bill Rogers   | PCCT Center       |
| 8/20 - 8/29| 1082         | Process Safety Management - Fundamentals                  | Mr. Adrian Sepeda | PCCT Center       |
| 8/30     | 1041          | Management of Change                                       | Mr. Adrian Sepeda | PCCT Center       |

## CUSTOMIZED COURSES

All courses above are available to be delivered at your company site! The instructor travels to the facility and the short course is tailored to the specific needs of the facility.

*Facilities in Houston, TX:

SIS-TECH Solutions - 11621 Featherwood Drive, Suite 120
Siemens - 4515 SW Freeway, Suite 900
Phoenix Contact Custom of Technology (PCCT) Center - 3993 W. Sam Houston Pkwy, Suite 510

[http://psc.tamu.edu/education/schedule-of-classes-registration](http://psc.tamu.edu/education/schedule-of-classes-registration)
Upcoming Events

January 24-26, 2012
67th Annual Instrumentation Symposium for the Process Industries
Texas A&M University
College Station, TX

Early Registration Through December 15

February 7-8
8:30am – 4:30pm
2052 Process Hazard Analysis Leadership Training
Instructor: Mr. William F. Early
Location: Phoenix Contact; 3993 W. Sam Houston Pkwy N., Suite 500, Houston, TX
1.4 CEUs/14 PDHs
Register for this course

February 21-22
8:30am – 4:30pm
1082 Process Safety Management – Fundamentals
Instructor: Mr. Adrian Sepeda
Location: Phoenix Contact; 3993 W. Sam Houston Pkwy N., Suite 500, Houston, TX
1.4 CEUs/14 PDHs
Register for this course

February
8:30am – 4:30pm
1011 Combustible Dust Explosion Hazard Awareness
Instructor: MKOPSC
Location: Texas A&M University College Station, TX

Contact:
Mary Kay O'Conner Process Safety Center
Texas A&M University
3122 TAMU
College Station, TX 77843-3122
Phone: 979/845-3489

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