15th ANNUAL INTERNATIONAL SYMPOSIUM

Celebrating Dr. Trevor Kletz’s 90th Birthday — In recognition of his continuing contribution to process safety awareness and research.

The 2012 International Symposium of the Mary Kay O’Connor Process Safety Center will be held at the College Station Hilton Conference Center on October 23-25, 2012.

Keynote speakers for the event have been named. Larry M. Stanton, Director of the Office of Emergency Management (OEM) US EPA, will be the keynote presenter on Tuesday, day one of the symposium.

On Wednesday, the Frank P. Lees Memorial Lecture will be presented by Dr. Nancy Leveson. Dr. Leveson is Professor of Aeronautics and Astronautics and Professor of Engineering Systems at MIT. She is also an elected member of the National Academy of Engineering (NAE).

Dr. Steve Flynn will be presenting the keynote presentation on Thursday, day three of the symposium. Dr. Flynn is the Vice President of Health Safety Security & Environment at BP.

The complete program is available online and in this newsletter.

Lees’ Loss Prevention in the Process Industries, 4th Edition has published!

After an extensive and in depth review process, the Lees’ 4th Edition has officially published. “It is a spectacular piece of work and I hope you will be rightly proud of your achievement. I am confident that the Fourth Edition will develop the reputation and value of the book, and more significantly will further aid the understanding, practice, and outcomes for all those working in, and with a stake in, the field of process safety. A noble end indeed.” said Jonathan Simpson, Publishing Director, Engineering, Elsevier Science & Technology Books. On the occasion of the release of this tome, Dr. Mannan commented, “The increasing complexities in industrial processes come with an obligation to match the complexities with adequate safety for society. This three-volume book is intended to give readers a comprehensive overview in process safety and loss prevention topics.”
In my last Director’s Corner, I introduced you to the, “Workshop on Process Safety Research Agenda for the 21st Century,” convened by the Center in October 2011. Hot off the presses - we have just released what we are convinced is a roadmap, “Process Safety Research Agenda for the 21st Century.” This is the product of the two-day workshop in October 2011 and a lot of follow-up hard work during the next six months. I extend my heartfelt gratitude to all the international experts who traveled from all over the world to participate in this unique effort. I sincerely believe these individuals represent the best-of-the-best in the field of process safety research. This publication is the product of a unique gathering and deliberations of some of the top authorities in the world who are studying various aspects of process safety. It provides a roadmap that outlines the process safety research and needs that will be critical in the coming years and the 21st century.

I invite all of you to read this extraordinary document. The Center has published an electronic copy of the book in its entirety at:

http://psc.tamu.edu/wp-content/uploads/Process_Safety_Research_Agenda.swf

We have also produced an introduction video as part of the press release announcing the release of the book located at:

http://www.youtube.com/watch?v=NdC-cGHJ8sk&list=UUTag-jXqBaGTKEsU8MAleOA&index=1&feature=plcp.

For those of you who would like to get a hard copy, please contact the Center and we will be happy to oblige as long as the printed copies last.

Also being released at the time this newsletter goes to press is the, “2012-2013 Research Highlights.” This document highlights the research of the Center’s talented, dedicated, and ambitious graduate students. Areas of research included are: dust explosions, LNG vapor dispersion modeling, predictive model for stress-corrosion cracking, aerosol cloud explosion and droplet dispersion, offshore facility siting and layout optimization and many others. As you can see from this list of research, our students are applying sound science to the real-world issues that are so important to the process industries and help address many of the issues raised in the, “Process Safety Research Agenda for the 21st Century.”

In this vein of looking at process safety from a global perspective, the Center and the Dwight Look College of Engineering met recently to discuss the Center’s work. Shortly after our discussions began, it was evident that the Center is doing research that touches on many areas of engineering and not solely in the area of chemical engineering. Therefore, the Dean approved the Mary Kay O’Connor Process Safety Center to be classified within the University System as a Tier 1 Center. A Tier 1 Center maintains interdisciplinary activities in several thematic areas, generally operating across multiple divisions. We are very pleased and appreciate the recognition for the research of the Center and the importance of this work across disciplines and to industry.

M. Sam Mannan
Summer, 2012
Of the research work going on at MKOPSC, many new research topics have been added for 2012. Three topics are highlighted here.

Amira Yousuf Chowdhury, a PhD student in Material Science Engineering is conducting research on: Shock Interaction with Dust Layers –

Secondary dust explosions can be far more destructive than a primary explosion due to the increased quantity and concentration of dispersed combustible dust making this a very important issue in the industries. Secondary dust explosions occur when the shock of an initial explosion dislodge more accumulated dust resulting in additional dust dispersed into the air. Therefore the problems of lifting and dispersing of a dust layer behind the propagating shock wave must be understood. This research aims to study shock interaction with dust layers. This research focuses on building experimental equipment with optical access to provide high speed flow visualization including measurement of dust dispersion, particle drag and shock attenuation. At the first step, literature review on existing shock-tube dust layer studies are being carried out.

Camilo Rosas, a PhD student in Material Science Engineering is conducting research on: Deflagration to Detonation Transition Studies –

When referring to explosions there are two different mechanisms. The first one is deflagration, which is a sub-sonic combustion wave with respect to the unburnt gas ahead of the flame. On a deflagration it is possible to distinguish the flame front and the shock front one from another. The second mechanism is detonation, which is a supersonic combustion wave propagating at 1500-2000m/s in fuel-air and can produce overpressures up to around 2 MPa. On a detonation the flame front and the shock front are coupled as one and is very hard to distinguish one from another. Additionally, if the appropriate conditions are given, it is possible to have an abrupt transition from deflagration to detonation. This research project will focus on the transition from deflagration to detonation, and will combine the theoretical, experimental and modeling approaches in order to achieve a better understanding of this phenomenon.

Shubharthi Barua, an MS student in Safety Engineering is conducting research on: Dynamic Operational Risk Assessment with Bayesian Network –

Oil/gas and petrochemical plants are complicated and dynamic in nature. Dynamic characteristics include aging of equipment/components, season changes, stochastic processes, operator response times, inspection and testing time intervals, sequential dependencies of equipment/components and timing of safety system operations, all of which are time dependent criteria that can influence dynamic processes. The conventional risk assessment methodologies can quantify dynamic changes in processes with limited capacity. Therefore, it is important to develop a method that can address time-dependent effects. The main objective of this study is to develop a dynamic operational risk assessment method. In this study, a new technique for dynamic operational risk assessment is proposed based on the Bayesian networks, a structure optimal suitable to organize cause-effect relations. The Bayesian network graphically describes the dependencies of variables and the dynamic Bayesian network capture change of variables over time. The developed Bayesian network based method can capture dynamic operational changes in process due to sequential dependency of one equipment/component on others. This study proposes to develop dynamic fault tree for a chemical process system/sub-system. The developed dynamic fault tree is then mapped in the Bayesian network and the dynamic Bayesian network is further developed to demonstrate dynamic operational risk assessment. A case study on a level control system is provided to illustrate this model.
MOU Signing to Establish a Process Safety Program and Facility in India

TEES Engineering News - Representatives from the Mary Kay O’Connor Process Safety Center and the Rajiv Gandhi Institute of Petroleum Technology (RGIPT), Rae Bareli, India signed a Memorandum of Understanding (MOU) on campus June 18. The MOU established a joint collaboration between the Rajiv Gandhi Institute of Petroleum Technology and the Texas Engineering Experiment Station (TEES) on behalf of the Mary Kay O’Connor Process Safety Center.

Introduction to Dust Explosion Hazards

An Introductory Seminar on Dust Explosion Hazards, presented by the Mary Kay O’Connor Process Safety Center and GexCon, will be offered this year prior to the symposium. The seminar, to be held October 22, is complimentary with your paid early symposium registration.

Study Abroad at Tianjin University in China

Dr. Sam Mannan traveled to Tianjin University in China where he taught Process Safety Engineering during the three-week study abroad program. The course was held May 14-June 11, 2012. Students from Texas A&M University traveled to China and attended the course along with students from Tianjin University. Students received full Texas A&M credit upon successful completion of the program.

While in China, Dr. Mannan also took the opportunity to visit the China University of Petroleum and SINOPEC to discuss research collaborations with the Center.

Conference to Focus on Scale-up of Chemical Processes


The 2-day event focused on the scale-up of chemical processes, including mixing considerations, kinetics, scale-down approaches, process safety and hazard evaluation of chemical processes. In addition, there is a workshop on process safety and scale-up.

The event featured world renowned speakers who shared their experience and knowledge as well as best practices in process safety.

On Day 2, participants toured the research labs at the Mary Kay O’Connor Process Safety Center.
Speaking Events

**Sept. 12-14, 2012**
*Controlling Mechanisms for Combustible Dust Fires and Explosion Hazards*
Speaker: Dr. Mentzer
3rd Process Safety Management Conference for the Chemical, Petrochemical, & Refining Industries
Houston, Texas ♦

**Sept. 25-26, 2012**
*New Frontiers In Process Safety Research*
Speaker: Dr. Mentzer
2012 HSE, Risk Management and Process Safety in Oil and Gas Conference
Houston, Texas ♦

**Oct. 4-5, 2012**
*Application of Inherently Safer Technology Rules in New Jersey and Contra Costa*
Speaker: Dr. Mannan
AIChE Regional Conference
South Shore Convention Center,
League City, TX ♦

**Oct. 12-13, 2012**
Speaker: Dr. Mannan
International Conference on Safety
IIT Gandhinagar, Ahmedabad, Gujarat, India

**Oct. 23-25, 2012**
*Beyond Regulatory Compliance, Making Safety Second Nature*
Mary Kay O'Connor Process Safety Center International Symposium
College Station, Texas ♦

**Nov. 12-15, 2012**
*Society’s Choices and Relationship to Risk*
Speaker: Dr. Mannan
Hazards XXIII Conference
North West, United Kingdom ♦

MKOPSC Consortium Members

**Partners**
- Air Products
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- Lockheed Martin
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- Lisam
- PPG Industries
- Riskbytes

More information on becoming a consortium member can be found at: [http://psc.tamu.edu/membership](http://psc.tamu.edu/membership), or by calling Ms. Valerie Green at: 979/845-6884
MKOPSC has recently had the opportunity to host many visitors to the Center and the Texas A&M campus. We would like to recognize our guests for their contribution and dedication to the Center’s mission of encouraging safer processes, equipment, procedures and management.

May

Dr. Qingsheng Wang, assistant professor with the Department of Fire Protection & Safety in the Department of Chemical Engineering at Oklahoma State University visited in May. He met with students about their research projects, and gave a presentation to the MKOPSC group.

Representatives from the Kazan State Technological University in Tatapctah, Russia arrived in May to attend a 3-week continuing education short course entitled Quantitative Risk Analysis. The course, led by Dr. William Rogers, was taught by several MKOPSC researchers. Attendees from Kazan State included Professors Galeev Ainur, Anton Nazarov, and Sergey Vilokhin.

June

Dr. Jai Gupta, director of the Rajiv Gandhi Institute of Petroleum Technology, Rae Areli, India visited the Center in June. He signed an MOU with TEES.

Dr. Mauricio Sánchez Silva, an associate professor with the Universidad de los Andes in Colombia, brought a group of engineering students from ECOPETROL to visit for the day on June 15. They listened to a presentation on Center activities and took a tour of the MKOPSC labs.

July

Dr. Richart Vazquez-Roman, a professor from the Instituto Tecnológico de Celaya in Mexico, visited the Center in July. He met with students to discuss their research goals.

Dr. Maria Papadaki spent a week in July at the Center working on research with students. She is from the University of Western Greece.

Dr. Khaliqur Rahman, retired professor with the Bangladesh University of Engineering and Technology, visited in July. He met with Center students and gave the presentation entitled “Vapor-Liquid Equilibrium - Non-ideal Binary Systems from P&T.”

On July 9, several representatives from agencies in Ningbo, China visited to learn more about the Center and tour the Brayton Fire Training Field. Those in the delegation included: Yufang Zheng, Deputy Director, Administrative Committee of Ningbo; Qichun Lin, Assistant Director, Ningbo Environmental Protection Bureau; Weifa Lou, Deputy Division Chief, Hazardous Chemicals Division of Ningbo Safety Production Bureau; Hongguo Chen, Director, Safety Production Bureau of Ningbo; Rongzhang Hu, Director, Zhenhai Environmental Protection Bureau of Ningbo; Min Zhu, Deputy Director, Administrative Committee of Ningbo; and, Shuqi Zhang, Chief Executive Officer, ISEA.

On July 13, Jim Harris, Gregg Sapp and Cactus Thomas from ConocoPhillips Company visited the Center to discuss LNG research. They also took a tour of the MKOPSC labs and the Brayton Fire Training Field.
Summer Internships

Many students have the opportunity to participate in internships this summer. Following is a list of those MKOPSC students and their host companies.

- Emrah Harputlu is interning with Mustang Engineering.
- Szu-Ying Huang is on internship at ABS
- Jiaojun Jiang is interning with Huntsman.

- Byung Kim has an internship with Shell.
- Hai Le is interning with Shell.
- Carmen Osorio is interning with Mustang Engineering
- Alba Pineda is interning with Shell
- William Pittman is interning with ExxonMobil
- Bin Zhang is interning with TAMUQ

Student News

Tony Rocha-Valadez, MKOPSC PhD student in Chemical Engineering, was chosen as a recipient of the 2012-2013 Texas A&M Energy Institute ConocoPhillips Fellowship award, part of the inaugural class of Texas A&M Energy Institute Fellows. Tony will display a poster of his research at the Water and Energy in Texas: Solutions from Texas A&M conference on October 3-4, 2012 at the Hilton College Station & Conference Center.

Diana Castellanos, MKOPSC PhD student in Material Science, received the Best Paper Award at the 9th ISHPMIE in Krakow, Poland. Diana’s paper “The Effect of Particle Size Polydispersity on the Explosibility Characteristic of Aluminium Dust” was selected as one of the five best papers by the Award Committee. While the committee focused on contributions from early-career researchers, its selections identified papers which were felt to be outstanding among all submissions and deserved recognition because of the quality of their scientific content and the clarity of the presentation.

New Students

The Center welcomes three new graduate students.

Monir Ahammad will be conducting research involving Chemical Kinetics Modeling of Pool Fires and Flammability Limits.

Two students join the Center this fall. Bibian Amaya is arriving here to study from the Universidad de los Andes, Colombia. Ryan Morten also joins the Center in August.

New distance learning students joining in Fall 2012 are Karl Scneidau and Jeffery Fox.
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Oil Site Safety
Presented by Brian Harding at the June 14, 2012 Steering Committee Meeting

Gas and oil storage sites pull oil from underground reservoirs and then separate it into multiple tanks. When oil is pulled up from the ground it has a variety of things mixed into it, such as water and other undesirable materials. The water is separated and the oil is stored in storage tanks until it is going to be used. These sites are all over the US, but predominantly in the South. Unfortunately, many of the sites have no fencing or signage warning people of the danger, and the storage tanks are built with very little protection.

Three cases have happened to people that were 25 years old or younger. In each case, people walked into storage sites not realizing the danger. In one instance, the tank exploded when a young man was looking into the tank and lit his cigarette lighter to get a better view. This ignited the flammable vapor above the liquid oil and caused the tank to explode. The presentation emphasized the importance of protecting the public from these sites using three layers of defense. These layers are: fences and gates as a physical barrier, signs depicting the danger as a mental barrier, and inherently safer tank design as a barrier even if people neglect the fences and signs.

Keeper Chemical Explosion in China
Presented by Ruochen Liu at the June 14, 2012 Steering Committee Meeting

At 8:40 am, at the Keeper Chemical Company in Zhao County, Heibei Province, China, a heating oil leak occurred around the discharge valve of a reactor. It was ignited by an unknown source, which led to an explosion of compounds in the reactor. Because of ammonium nitrate and guanidine nitrate in the area, a series of massive destructive blasts were triggered. The explosion completely demolished or severely damaged two workshops and a sulfuric acid storage tank. It caused 25 deaths and 46 injuries. Four people were missing and no further reports regarding them were issued. The State Administration of Work Safety determined the root causes that led to this incident were: insufficient process safety management, deficiencies of facilities layout, poor personnel training and inadequate inspection.

Donations

In early 2012, the Mary Kay O’Connor Process Safety Center acquired a new Mettler Toledo RC1e MidTemp high performance calorimeter. This calorimeter greatly expands the Center’s capacity for in-depth process safety research, especially in the areas of reactive chemicals and process scale up. System calibration and initial training for students and research scientists has been completed. This summer, as research was begun using the new calorimeter, the need for a cooling system became apparent. A cooling system allows more precise temperature control and full utilization of all functions of the calorimetric system. Upon learning of the Center’s need, The Dow Chemical Company graciously stepped in and donated a Neslab CFT-72 Refrigerated Circulator. Mr. Bill Efaw delivered the equipment during the August Steering Committee meeting. The refrigerated circulator is now successfully integrated into the calorimetric system and ready to run. We would like to express our sincere appreciation to Mr. Efaw and The Dow Chemical Company for their continued support of the Mary Kay O’Connor Process Safety Center’s programs and research.
Process Safety Curriculum in the United States

By Patricia B. Hasan

INTRODUCTION

In 2006, the Mary Kay O’Connor Process Safety Center (MKOPSC) at Texas A&M University conducted a survey of 164 United States colleges and universities to determine the status of process safety in the chemical engineering curricula at the various institutions. The survey addressed whether or not the academic institution in question offered process safety as a core course and/or an elective course, as well as whether or not the institution had future plans to add process safety to their curriculum. A brief summary of the findings is provided in Figure 1.

2006 Study Summary Findings

Of the 164 institutions contacted, 102 participated in the survey and submitted responses; this is a 62.2% response rate.

Of the 102 responding institutions, 40 offered process safety in at least a core course or an elective course. Therefore, 39.2% of responding institutions had a process safety curriculum available.

16 colleges and universities, or 15.7% of responding institutions, offered process safety only as a core course.

19 colleges and universities, or 18.6% of responding institutions, offered process safety only as an elective course.

5 colleges and universities, or 4.9% of responding institutions, offered process safety as both a core course and an elective course.

Figure 1: 2006 Study Summary Findings

It is noteworthy to mention that in Figure 1 the numbers are calculated using only the institutions who responded to the survey. However, a more accurate measure of institutions with process safety courses would also include those institutions that did not respond. Therefore, 24.4% of all institutions included in the study offer process safety as part of their curricula. Though it is difficult to gauge whether or not the non-respondents have a process safety curriculum, it is generally assumed and accepted for these purposes that the non-respondent institutions do not currently have any process safety courses.

It was clear that while process safety was making headway in United States academic institutions, there was still a long way to go in terms of having a process safety curriculum available in every engineering program. To test the growth of this curriculum, the MKOPSC conducted a follow-up study in 2012, consisting of the same survey questions from 2006. This report will outline the findings of the 2012 study and provide an analysis of the growth and changes in the availability of process safety in academic institutions across the United States.
METHODOLOGY

Before conducting the survey, the MKOPSC had to determine who was to be surveyed at each of the academic institutions and through which methods the survey would be delivered to the possible participants. In 2006, the primary method of delivery was through mail surveys and two follow-up phone call requests for participation. The individuals contacted were typically Department Head/Chairs of the institutions’ chemical engineering departments; if no individual name could be determined for the department, the survey was sent to the general office address. All contact information, including phone numbers and mailing addresses, were found using online searches of public information available at each academic institution’s website.

Participants for the 2012 study were chosen primarily through two methods. The first method was to reuse the list of respondents from the 2006 study. However, this was not always an accurate representation of the current personnel at each institution; many of the participants of the 2006 study had since retired or moved jobs in the six years between the two studies. Therefore, the second method was introduced, which was to use online searches of each institution’s public information to find new contacts to survey. Email address information was also recorded from these online searches.

For the 2012 study, the MKOPSC decided to reuse the survey tool from 2006 with one major modification to make it available online. The online software, Survey Monkey, was used to create an electronic version of the survey. This made it possible to send out a link to the online survey via email to the contact persons at each academic institution. With the widespread use of email and being constantly connected to the internet, it was believed a higher response rate would be achieved by making the survey more readily accessible.

The electronic version of the survey was delivered to the contact list via email. However, after several weeks it became apparent that this method alone would not suffice for obtaining a response rate comparable to the 2006 study. A phone campaign was utilized next, with the MKOPSC student workers assisting with making phone calls to the contact list and recording their survey responses. Finally, two mail-outs of the survey were the final methods used to gather responses. The mail-outs allowed the participant to either mail or fax back the completed survey. The use of these three delivery methods over a six-month period resulted in a response rate slightly higher than in 2006.

2012 Study Summary Findings

- Of the 164 institutions contacted, 106 participated in the survey and submitted responses; this is a **64.6% response rate**.
- Of the 106 responding institutions, **53** offer process safety in at least a core course or an elective course. Therefore, **50% of responding institutions had a process safety curriculum available**.
- **23** colleges and universities, or **21.7%** of responding institutions, offer process safety only as a core course.
- **24** colleges and universities, or **22.6%** of responding institutions, offer process safety only as an elective course.
- **6** colleges and universities, or **5.7%** of responding institutions, offer process safety as both a core course and an elective course.
- Again, the majority of process safety core and elective courses, **57.6%**, use the textbook by Crowl and Louvar, *Chemical Process Safety: Fundamentals with Applications*.

Figure 2: 2012 Study Summary Findings
SURVEY DATA & FINDINGS

Several data from the 2012 study are noteworthy, beginning with the response rate, which increased slightly over the 2006 data. Out of the 164 academic institutions contacted, 106 participated in the survey and submitted responses; this translates to a 64.6% response rate. One of the objectives of the 2012 study was tracking the changes in institutions that had responded in 2006. Of the 102 responding institutions in 2006, 74 responded again in 2012, which is a 72.5% recapture rate. While this is lower than hoped, attention must also be brought to the fact that there were 32 first-time responding institutions, which is a 51.6% first-time capture rate. Further discussion on the changes in the institutions that responded to the survey in both studies will be conducted in the Analysis section.

The MKOPSC contacted the same 164 colleges and universities in 2012 as in 2006 in order to more easily track changes. Figure 2 provides a summary of the key findings of the 2012 study. They will be discussed further and compared with the 2006 findings in the Analysis section.

ANALYSIS

The results of the 2012 study initially show positive growth of process safety curricula in the United States. In 2006, only 40 responding institutions offered process safety as a core or elective course; in 2012 that number increased to 53 responding institutions, which represents a total increase of 32.5% in the number of institutions that offer process safety in the United States. The number of institutions offering process safety as only a core course increased from 16 (15.7%) in 2006 to 23 (21.7%) in 2012, and the number of institutions offering process safety as only an elective course increased from 19 (18.6%) in 2006 to 24 (22.6%) in 2012. The area with the least amount of increase was institutions with process safety as both core and elective courses; in 2006 there were 5 (4.9%), and 2012 saw an increase to 6 (5.7%) of the responding institutions. These comparisons are shown graphically in Figure 3.

In addition to showing generalized growth, the MKOPSC is interested in tracking the progress of those institutions that responded in 2006. Of the 16 institutions that responded as having only a process safety core course in 2006, 10 (62.5%) continue to have only a core course, 3 (18.8%) have only an elective course, 1 (6.3%) has both a core and elective course, 1 (6.3%) has neither a core or elective course, and 1 (6.3%) did not respond in 2012.
Of the 19 institutions that responded as having only a process safety elective course in 2006, 12 (63.2%) continue to have only an elective course, 1 (5.3%) has both a core and an elective course, and 6 (31.6%) did not respond in 2012. Of the 5 institutions that responded as having both a core and an elective course in 2006, 2 (40%) continue to have a core and an elective course, 2 (40%) have only a core course, and 1 (20%) did not respond in 2012. Overall, of the 40 institutions that responded in 2006 as having a process safety curriculum, 31 of them responded similarly in 2012, creating a curriculum retention rate of 77.5%.

A final area that needs mentioning is the data on institutions’ future plans to create process safety courses. In 2006, 5 institutions claimed to have future plans to establish a process safety elective course. Of those 5, only 1 (20%) has actually acted on this intention and has created both a core course and an elective course. 1 institution (20%) still claims to have future intentions to create a process safety elective course, 2 (40%) currently do not have any process safety courses or any future plans to create courses, and 1 (20%) did not respond in 2012.

The number of academic institutions that claim to have future plans to create process safety courses nearly quadrupled in the 2012 study over the 2006 results. Nine institutions responded that they have plans to create a process safety core course, and eight institutions responded with future plans to create an elective course. This represents a 240% increase of academic institutions who are considering adding process safety to their curriculum, shown graphically in Figure 4. While actual growth of process safety courses across the United States is the main focus, it is interesting to note that many institutions are aware that process safety is an important piece of engineering and are working to turn future plans into current reality.

![Future Plans to Add Process Safety Courses](image)

**CONCLUSION**

Although 50% of responding institutions have a process safety course in their current curricula, this only amounts to 32.3% of all universities included in the study. While this shows a growth from approximately one-fourth in 2006 to approximately one-third in 2012 of United States academic institutions offering process safety, there is still a need for the remaining institutions to move towards this goal. It is necessary to teach students the fundamentals and tools they will need upon entering industry.

The Appendices have further information on this study, including the survey tool used, and a graphic representation of where process safety courses are being offered across the United States.
APPENDIX A – Survey Tool

Process Safety Curriculum Survey

The Mary Kay O’Connor Process Safety Center at Texas A&M University is conducting a survey. Please answer the following questions concerning the Process Safety curriculum available at your university.

The information collected will be used to develop a report on the "Status of the Process Safety Curriculum in the US". Upon request, we will make the results available to you at the conclusion of the study.

We appreciate your input and time spent on this survey.

1. Is Process Safety offered as a core course at your university?  Yes  No
   If yes, please provide
   Curriculum __________________________________________
   Course number(s) ______________________________________
   Course title(s) ________________________________________
   Textbook(s) used ______________________________________

2. Is Process Safety offered as an elective course?  Yes  No
   If yes, please provide
   Course number(s) ______________________________________
   Course title(s) ________________________________________
   Textbook(s) used ______________________________________

3. If Process Safety is not offered at all, are there any future plans to add as a
   Core course  Yes  No
   Elective course  Yes  No
   In which curriculums? __________________________________

Contact Information:

Name _________________________________________________
University _____________________________________________
Mailing Address _______________________________________
Phone ________________________________________________
Email ________________________________________________

Please return survey to Mary Kay O’Connor Process Safety Center, Texas A&M University
3122 TAMU, College Station, TX 77843-3122 • Fax: 979-458-1493
Safety Engineering Courses — FALL 2012

Classes run August 27—December 12, 2012. Register Now!

Distance Learning Objectives

These courses may be taken for either continuing education credit or academic credit. Continuing Education programs provide focused training in specialized areas of technology. These courses can be of value to satisfy current job skills requirements and professional governmental certification requirements. Where needed, we can provide CEU (Continuing Education Unit) certifications for these programs. You DO NOT need to apply to the university to gain a certificate. However, if you wish to take these courses for University credit, please contact us.

SENG 310: Industrial Hygiene Engineering

Application of scientific and engineering principles in the selection and design of control systems related to chemical, physical and ergonomic exposures in the process and manufacturing industries; relationships of criteria, analysis, and specifications for the assessment and control of occupational related illnesses. Prerequisites: CHEM 107; MATH 308; PHYS 208; or approval of instructor.

SENG 321: Industrial Safety Engineering

Concepts of designing, operating and maintaining optimally safe systems, risk management, economic impact, legislation, performance measurement and accident investigation/analysis; principles and practices in industrial hygiene engineering, fire protection engineering and introduction to systems safety engineering.

SENG 422: Fire Protection Engineering

Fire protection design concepts and considerations for chemical, petrochemical and hydrocarbon processing facilities. Special attention given to fire hazard analysis, fire risk assessment, fire protection features, and emergency response. Specific fire protection design considerations are studied for the various types of facilities and processes. Prerequisite: Instructor approval.

CHEN 455/655 – SENG 455/655: Process Safety Engineering

Applications of engineering principles to process safety and hazards analysis, mitigation, and prevention, with special emphasis on the chemical process industries; includes source modeling for leakage rates, dispersion, analysis, relief valve sizing, fire and explosion damage analysis, hazards identification, risk analysis, accident investigations.

CHEN 430 – SENG 430: Risk Analysis Safety Engineering

Concepts of risk and risk assessment, which uses all available information to provide a foundation for risk-informed and cost-effective engineering practices; examples and exercises are drawn from a variety of engineering areas.

Online registration: http://psc.tamu.edu/education/distance-learning/

For questions, contact:

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3122 TAMU - 244 Jack E. Brown Building
College Station, TX 77843-3122
Phone: (979) 458-1863
E-mail: triciahasan@tees.tamus.edu

http://psc.tamu.edu/education
Mary Kay O'Connor Process Safety Center

2012 INTERNATIONAL SYMPOSIUM

Beyond Regulatory Compliance, Making Safety Second Nature

October 23-25, 2012

Hilton Conference Center
College Station, Texas

Early registration discount ends September 24

Online Registration is available at:
http://psc.tamu.edu/symposia/2012-sym

2012 Symposium Sponsors

The symposium qualifies for 16.25 PDHs. The Texas Board of Professional Engineers requires 15 PDHS (including 1 PDH in Engineering Ethics). A one-hour session on Engineering Ethics is offered immediately following the symposium on Wednesday, October 24. See website for more information: http://psc.tamu.edu
TUESDAY, OCTOBER 23

8:00 AM  Keynote Lecture – Lawrence Stanton, Director of Emergency Management – U.S. Environmental Protection Agency

8:45 AM  General Session - George Famini, Director, Chemical Security Analysis Center, Department of Homeland Security


9:30 AM  State of the Center - Dr. Sam Mannan, Director

9:45 - 10:30 AM  Break and Exhibit Hall

10:30 AM  Track I
  Chairs: Ray Mentzer, Kathy Shell
  Safety Culture/Operational Discipline
  Operational Discipline: Improving Process Safety Management Implementation through Culture Change - Charlie Soczek, DuPont Sustainable Solutions

Track II
  Chairs: Michela Gentile, Kiran Krishna, Mike Marshall
  Hazard Assessment
  Back to the Future: Why are we doing this HAZOP? - Simon Lucchini, Fluor Canada

Track III
  Chairs: Sara Saxena, George King, Skip Early
  Offshore
  Deepwater Horizon: An Offshore Incident with Lessons for All High Hazard Industries - Kelly Wilson, Chemical Safety Board

Track IV
  Chairs: Marc Levin, Maureen Orr, Anjana Meel
  Process Management for Safety I
  Optimization of Hydrocarbon Detection System for Tank Farm Area - Patni Abhinandan, Cholamandalam MS Risk Services

11:00 AM  Track I
  How can any Organization Excel in Safety? - Reniers Genserik, University of Antwerp
  External Hazard Factors and Major Accidents: Domino, Na-Tech and Security Concerns - Alessandro Tognoli, Università di Bologna

Track II
  Chairs: Cholamandalam MS Risk Services Ltd
  Complex Phase Behavior in Aromatic Nitration Reactions and Reactor Behavior - William Pittman, MKOPSC

Track III
  Chairs: Dexter IBM
  Process Safety Indicators for Major Accident Prevention: A CB Perspective - Cheryl MacKenzie, Chemical Safety Board

Track IV
  Chairs: Chicago Risk Management
  A Strategy for Optimal Sensor Allocation to Detect Hazardous Gas Releases - Richard Vázquez Roman, Instituto Tecnológico de Celaya

11:30 AM  Track I
  Building a Culture of Safety - Michael Platt, Lockheed Martin Global Training and Logistics
  Process Safety Management for Offshore Installations - Chris Zdravistch, BMT Fluid Mechanics

Track II
  Chairs: ABB
  Helideck Operability Analysis for Offshore Installations, Franz Wang, MKOPSC

Track III
  Chairs: ExxonMobil
  Consistency of Root Cause Analysis in the Process Industry - Michael Guidry, PPG Industries

Track IV
  Chairs: Missouri University of Science & Technology
  MOC Work-in-Process Documentation - Best Practices - Ranier Hoffman, Gateway Group

12:00 PM  Track I
  Beyond PSM: Integrating Culture and Leadership into Process Incident Prevention - Scott Stricoff, BST
  Helideck Operability Analysis for Offshore Installations, Franz Zdravistch, BMT Fluid Mechanics

Track II
  Chairs: NovaChem
  Process Safety Management for Safety II
  Process Safety Management: Standardizing Safe Operating Limit Information – Mike Richardson, ConocoPhillips

Track III
  Chairs: Cameron
  Case Histories
  Chemical Release Prevention in Kanawha County, WV: A Local Program Could Detect Deficiencies beyond Existing Regulations – Johnnie Banks, Chemical Safety Board

Track IV
  Chairs: Massachusetts Institute of Technology
  Dust I
  Testing of Marginally Explosible Dusts: Evaluation of Overdriving and Realistic Ignition Sources in Process Facilities - Tim Myers, Exponent

12:30 - 2:00 PM  Lunch and Exhibit Hall (1.5 hrs)

2:00 PM  Track I
  Risk Assessment: Tool for Control Room Siting in Process Plant - Arshad Ayub, Cholamandalam MS Risk Services Ltd
  Risk Assessment: Tool for Control Room Siting in Process Plant - Arshad Ayub, Cholamandalam MS Risk Services Ltd

Track II
  Chairs: ABB
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  Process Safety Management: Standardizing Safe Operating Limit Information – Mike Richardson, ConocoPhillips

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  Chairs: ExxonMobil
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Track IV
  Chairs: Missouri University of Science & Technology
  Dust I
  Testing of Marginally Explosible Dusts: Evaluation of Overdriving and Realistic Ignition Sources in Process Facilities - Tim Myers, Exponent

2:30 PM  Track I
  Risk Assessment of Ethylene Oxide Storage - Prema Jain, Reliance Industries Limited
  Application of Safety Life cycle to Gas Plant Process - Prasad Gotei, Honeywell Process Solutions

Track II
 椅子: ABB
  Process Management for Safety II
  Process Safety Management: Standardizing Safe Operating Limit Information – Mike Richardson, ConocoPhillips

Track III
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Track IV
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3:00 PM  Track I
  Taking Domino Effect into Account in the Quantitative Risk Assessment of Storage Installations - Esteban Bernechea, UPC Barcelona Tech
  Management of Highly Toxic Materials - Charlie Soczek, DuPont Sustainable Solutions

Track II
  Chairs: ABB
  Process Management for Safety II
  Process Safety Management: Standardizing Safe Operating Limit Information – Mike Richardson, ConocoPhillips

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3:30 - 4:00 PM  Break and Exhibit Hall

4:00 PM  Track I
  Consequence Analysis I
  COPS - Critical Operating Parameters - Jeff Thomas, ExxonMobil

Track II
  Chairs: ABB
  Risk Assessment/LOPA I
  Anatomy of the Risk Matrix - Karl Van Scyoc, DNV

Track III
  Chairs: ExxonMobil
  Case Histories
  Opportunity Lost: Repeat Incidents Involving Combustible Dust in Metal Powder Facility Leads to Five Fatalities - Johnnie Banks, Chemical Safety Board

Track IV
  Chairs: Missouri University of Science & Technology
  Dust II
  Lean Risk Management: Are we Identifying Risks Accurately? - Ben Pobjlete, Cameron

4:30 PM  Track I
  Important Issues in Building Blast Upgrades - Yin Mao, Baker Risk
  MART: Major Accident Risk Tree for Investigation of Process Industries Accidents - Adam Markowski, University of Lodz

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5:00 PM  Track I
  Explosion and Fire at Caribbean Petroleum Tank Terminal - Vidisha Paresam, Chemical Safety Board
  Using LOPA to Identify the Greatest Risk - Elliot Wolf, NovaChem

Track II
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5:30 PM  Track I
  Emergency Management: Single-Source versus Multi-Source Incident Modeling and Management - Ross Coulman, CPD-Limited
  Zeroing in on the Correct Risk - Jack Chosnek, KnowledgeOne

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6:00-7:30 PM  Cocktail Reception
### Wednesday, October 24

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<tr>
<th>Time</th>
<th>Event</th>
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<tbody>
<tr>
<td>8:00 AM</td>
<td>Frank P. Lees Memorial Lecture - Dr. Nancy Leveson, Professor, Aeronautics and Astronautics, Professor, Engineering Systems, MIT</td>
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<tr>
<td>9:00 AM</td>
<td>Presentation of Annual Merit Award, Harry West Service Award, and the Lamiya Zahin Memorial Safety Scholarship, Dr. Sam Mannan, Director, MKOPSC</td>
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<td>9:30 AM - 2:00 PM</td>
<td>Lunch and Exhibit Hall (1.5 hrs)</td>
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<td>Engineering Ethics Session (1 hr)</td>
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### Tracks

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### 10:00 AM
- **Track I**: Functional Safety Organization for Predictably Executing the ISA 84 Safety Lifecycle - Kathy Shell, AE Solutions
- **Track II**: CFD Numerical Simulation on a Fire Accident in a Tank Farm - Wang Zheng, SINOPEC
- **Track III**: Conceptual Framework for an Effective Design Culture for Safety Systems - Bill Mostia, SIS-Tech
- **Track IV**: Analytical Study on Physical Mechanisms of LNG Forced Dispersion using Water Spray Application - Byung-Kyu Kim, MKOPSC

### 10:30 AM
- **Track I**: Life Cycle Management for Non-SIS IPL’s - Keith Farrell, Talisman Energy
- **Track II**: Phase Validation of Discharge and Atmospheric Dispersion for Carbon Dioxide Releases - Henk Witlox, DNV London
- **Track III**: Building a Process Safety Culture - Toufik Benmosbah, Qatar Gas
- **Track IV**: LNG Facility Siting Guidance - Andrew Kohout, FERC

### 11:00 AM
- **Track I**: Working Under Pressure (How do you manage pressure hazards?) - Angela Summers, SIS-Tech
- **Track II**: Analysis of Propane Sphere BLEVE after the Earthquake in Japan - Xinrui Li, MKOPSC
- **Track III**: Better Knowledge of Safe Operating Limits to Improve Human Reliability - Mark Tibbitts, PAS
- **Track IV**: CFD modeling and Medium Scale Experiments of Cryogenics Spills on Land - Omar Basha, TAMUQ

### 11:30 AM
- **Track I**: API RP 752 Building Siting Using f/N curves - Jeff Marx, Quest Consultants
- **Track II**: Laboratory Safety: Lessons Learned from a CSB Investigation - Mary Beth Mulcahy, Chemical Safety Board

### 12:00 PM - 1:30 PM
- **Track I**: Process Safety Management - Steve Arendt, ABB Consulting
- **Track II**: Warning Placards versus Safe Practices — Redefining Safety Hierarchy for Process Industries - Sunil Lakhiani, Exponent
- **Track III**: Multi-physics Computational Fluid Dynamics (CFD) for Two-Phase Jet fire and Radiation - Shiladitya Mukherjee, Atkins
- **Track IV**: Prevention is Better Than the Cure – The Longford Fire and Its Aftermath - Allan Hollonds, RasGas

### 1:30 PM - 2:30 PM
- **Track I**: Advanced Modeling of Separators for safe Design in Oil / Gas Production Plants - James Marriott, Process Systems Enterprise Ltd.
- **Track II**: The Effects of Wearing Respirators on Human Fine Motor, Visual, and Cognitive Performance - Anas Alghamri, Missouri University of Science & Technology
- **Track III**: Study on the prediction of Upper Explosion Limits of Hydrocarbons - Wei Xu, China Petroleum & Chemical
- **Track IV**: Deflagration to Detonation Transitions: Is my Facility at Risk of a DDT - Scott Davis, Gexcon

### 2:30 PM - 3:30 PM
- **Track I**: An Integrated Approach to PSM Implementation - Brian Rains, DuPont Sustainable Solutions
- **Track II**: Employing Expert Elicitation in Qualitative Analysis - Allan Coutts, URS-SMS
- **Track III**: The Impact of Inadequate Sleep on Worker Performance - Susan Murray, Missouri University of Science & Technology
- **Track IV**: Validation of the UN Test Method N.5 - Marcus Malow, BAM

### 3:30 PM - 4:00 PM
- **Track I**: How Can We Use The Information Provided by Process Performance Indicators? Possibilities and Limitations - Hans Pasman, MKOPSC
- **Track II**: Facilitating Consistent Siting Hazard Distance Predictions using the TNO Multi-Energy Model - Robin Pitblado, DNV
- **Track III**: Human Factors at the Airlines and in the Oil Field - Andrew Dingee, Contractor for BP, Red Team Safety
- **Track IV**: Combined use of Heat Flow Calorimetry and in-situ FTIR Spectroscopy for Complex Reactive Systems Studies - Maria Papadaki, University of Western Greece

### 4:00 PM - 5:00 PM
- **Track I**: Adoption of Recent Industry Guidance on Process Safety Key Performance Indicators: An LNG Operator’s Experience - Brett Doherty, RasGas
- **Track II**: Use of CFD in Onshore Facility Explosion Siting Studies - Irfan Shalk, MMI Engineering
- **Track III**: The Impact of Inadequate Sleep on Worker Performance - Susan Murray, Missouri University of Science & Technology
- **Track IV**: Validation of the UN Test Method N.5 - Marcus Malow, BAM

### 4:30 PM
- **Track I**: Public Health Impacts of Acute Petroleum Releases Using Data from the National Toxic Substance Incidents Program, 2010 - Aiyana Anderson, CDC
- **Track II**: Facility Siting Risk Reduction Decision Process - Craig Shell, AE Solutions
- **Track III**: Alarm Management: The Human Factors Challenge - Rob Turner, ABB Global Consulting UK
- **Track IV**: Water Induced Thermal Decomposition of Pyrotechnic Mixtures - Thermo Kinetics and Explosion Pathway - Mahadevan Surianarayanan, CLRI India
THURSDAY, OCTOBER 25 • 8:00AM - 8:30AM – Continental Breakfast

8:00AM Keynote Lecture - Dr. Steve Flynn, Vice President of Health, Safety, Security, and Environment, BP Global

9:15 - 10:00AM Break and Exhibit Hall - Break Sponsored by

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<tr>
<td>Inherent Safety</td>
<td>Risk Assessment/LOPA III</td>
<td>Metrics and Performance Drivers II</td>
<td>Process Management for Safety V</td>
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<tr>
<td>10:00AM A MINLP Approach for Layout Designs Based on the Integrated Inherent Safety Index and Domino Hazard Index - Julio de Lira, MKOPSC</td>
<td>Good to Great: Review and Improve LOPA Programs - Phillip Myers, Advantage Risk Solutions</td>
<td>Metrics and Culture Abstract - Kelly Keim, ExxonMobil</td>
<td>Designing Process Fixed Equipment with Maintenance in Mind - Russ Davis, Aon</td>
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<td>12:00 Noon - Close</td>
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Mary Kay O’Connor Process Safety Center invites you to EXHIBIT at the

2012 International Symposium

Beyond Regulatory Compliance, Making Safety Second Nature

October 23-25, 2012
Hilton Conference Center
College Station, Texas

Register Online:
http://psc.tamu.edu/symposia/2012-sym/exhibitors
http://psc.tamu.edu
Contact Donna Startz – donnas@tamu.edu • 979-845-5981
Calendar of Events

Upcoming Short Courses:  (For more info see: http://psc.tamu.edu/education/continuing-education)

GAS EXPLOSION HAZARDS ON OFFSHORE FACILITIES
AN ADVANCED COURSE
20th—21st AUGUST 2012
Presented by GexCon & Mary Kay O'Connor Process Safety Center

August 22, 2012
8:30am – 4:30pm
Reactive Chemical Hazards Assessment
Location: Cooper Technology Center
Houston, TX
Instructor: Dr. William Rogers
0.7 CEUs/ 7 PDHs

September 4-5, 2012
8:30am – 4:30pm
Pressure Relief Systems – Best Practices
Location: Siemens, Houston, TX
Instructor: Dr. Abdul Aldeeb
1.4 CEUs/ 14 PDHs

Symposia:

October 23-25, 2012
2012 INTERNATIONAL SYMPOSIUM
Mary Kay O'Connor
Process Safety Center
College Station Hilton Conference Center

January 22-24, 2013
68th Annual Instrumentation Symposium
for the Process Industries
Texas A&M University
College Station, TX

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