Second Symposium Addresses Safety Goals


Approximately 300 people from industry, academia, and government agencies attended the symposium. Visitors came from as far away as Israel, Australia, and Trinidad.

Dr. Ray Anthony, Chemical Engineering Department Head, welcomed the attendees and provided a brief overview of the Chemical Engineering Department at Texas A&M University as well as process safety related research.

Dr. Sam Mannan, Director of the Center, gave the State of the Center address. He said, “The Center programs and activities have come a long way in the past year. Projects undertaken by the Center are already showing promise and will have far-reaching impact. Of special note is the National Chemical Safety Goals project which includes the development of national chemical safety goals, development of measurement systems to measure progress, and development of targeted reduction goals.”

Dr. Gerald Poje

On the first day of the Symposium, a keynote address was given by Dr. Gerald Poje, member of the United States Chemical Safety and Hazard Investigation Board. He said that the Center's activities fill a much needed void. He challenged everyone in the chemical industry to work toward better and more creative funding of process safety research programmes.” Among the most crucial safety research issues, Poje highlighted the need for internal review of database projects and studies of reactive chemicals. (Symposium continued on page 18)
We, at the Mary Kay O’Connor Process Safety Center appreciate the support and assistance given to us by various organizations and individuals. A major part of the support for various programs and activities of the Center comes from annual membership dues. Organizations can become members of the Center at the Partner, Sponsor, or Advisor level. Small business and individual memberships are also available. Details about membership benefits, membership criteria, and annual dues are available on request.

A lot of exciting things are happening at the Center. The Center recently welcomed The Chlorine Institute as a supporting member.

The Second Annual Symposium, held at the George Bush Presidential Conference Center on October 26-27, 1999, was again a tremendous success. The Symposium was attended by approximately 300 people from all over the US as well as overseas. The 1999 Symposium also featured an exhibit area for display of process safety-related technology, software, and tools. Evaluations submitted by the Symposium attendees provided complimentary comments about the quality and content of the papers and the smooth arrangements. We are indebted to many organizations and individuals for the success of the Symposium. First and foremost, the cosponsoring organizations:

- American Society of Safety Engineers
- Occupational Safety and Health Administration
- USEPA – Chemical Emergency Preparedness and Prevention Office
- US Chemical Safety and Hazard Investigation Board
- Voluntary Protection Program Participants’ Association

We are also indebted to the following organizations for sponsoring different events at the Symposium:

- RMT, Inc. – Cocktail hour
- Arthur D. Little, Inc. – Lunch
- Warren-Forthought, Inc. – Lunch
- General Physics Corporation – Breakfast
- AcuTech – Breakfast
- Quest Consultants – Coffee Break
- Loss Control Associates – Coffee Break

The Symposium Planning Committee worked hard in making sure that the symposium went without any glitches. We owe our gratitude to them.

- David Chung, USEPA, Chemical Emergency Preparedness and Prevention Office
- Skip Early, Early Consulting LLC
- Skipper Kendrick, Bell Helicopter/American Society of Safety Engineers
- Sanjeev Mohindra, Arthur D. Little, Inc.
- Chap Pierce, Occupational Safety and Health Administration
- Kathy Shell, RMT, Inc.
- Robert L. Smith, Ashland, Inc.

The Center research activities are also gaining energy and new life. In addition, to our ongoing research work, we were awarded two new contracts. The first one is from Parsons Engineering to conduct Quantitative Risk Assessment for chemical demilitarization processes. The other one is from the Advanced Technology Program of the State of Texas to conduct Aerosol Modeling for high viscosity heat transfer fluids. Outline for these research projects will be provided in the upcoming issues of Centerline.

We have issued a Call for Papers for our next symposium, Beyond Regulatory Compliance, Making Safety Second Nature, which will be held on October 24-25, 2000 at the Reed Arena at Texas A&M Unvisity in College Station, Texas. More information can be found in this newsletter and on our website at http://process-safety.tamu.edu.

M. Sam Mannan
Mr. Herb Fox, President of Murphy Oil, USA addressed the 1999 Symposium attendees during the cocktail hour. Murphy Oil Corporation is a worldwide, two billion dollar, New York Stock Exchange, fully integrated oil and gas company. The cocktail hour was sponsored by RMT, Inc. The following is an excerpt from Mr. Fox’s presentation:

I have had the opportunity to review the abstracts for the 1999 Annual Symposium and attend some of today’s presentations. The level of expertise, the quality of the presentations and the dedication of the attendees totally supports my feeling that progress in this field since the mid-70’s has been exponential. I am a firm believer that success in process safety management, environmental programs, and community relations is not only critical but synergistic to a well-managed company and results in better operations, improved financial results, and happier stockholders.

I have been around the industry, as my white hair would indicate, for decades and seen the evolution of safety and process safety management from a back room office at a local refinery to board level concern and reporting and full integration into corporate culture. I believe that any company with the intent of growing, surviving, and satisfying stockholders must be dedicated to and produce bottom line results relative to the safety of its employees, the protection of the environment, and the concerns of the neighbors and communities in which we operate. Murphy has accepted this challenge, implemented programs in our unique style and is in the process of moving to the forefront of the refining industry by implementing next year the Responsible Care Program.

The first challenge I would leave you with is “stick to the knitting.” Do not stray from the original program mission which is simple – providing a safer, better workplace for our employees, our neighbors, and our communities. Avoid falling into the ever so common trap that creates bureaucracy, excess paperwork, high cost and pseudo success in lieu of the real goal.

The second challenge is to target and motivate employees to buy-in to these well-designed programs. All too often we find that a system failure, an accident, or a release is the result of an outstanding employee simply going his own way and not following the programs and established procedures.

In summary, I challenge you to be lean, focused, and cost-effective. Avoid bureaucracy at all cost and recognize that employee buy-in is an area that needs attention. Safety is synonymous with success, profitability, and growth in this global and competitive industry.

In closing, again I complement Dr. Sam Mannan and the Mary Kay O’Connor Process Safety Center staff and in particular, Mike O’Connor, for their support and leadership in this most important and critical area to the chemical and refining industries. In its brief history the Center has shown tremendous initiative on wide-ranging issues and projects, not the least of which, symposiums such as this that allow the exchange of ideas, outstanding presentations, and the opportunity for top professionals to interface, are invaluable contributions from the Center.
Papers Presented at Annual Symposium Represent State-of-the-Art on a Wide Spectrum of Issues

Papers presented at the 1999 Annual Symposium of the Mary Kay O’Connor Process Safety Center represented state-of-the-art technology on a wide spectrum of issues.

Mr. Bill Hoyle of the U.S. Chemical Safety Board made a presentation on, “Identifying the Underlying System-based Causes of Human Errors in Major Chemical Incidents.” Hoyle said that media coverage of major chemical incidents almost always concludes that human errors caused these incidents. The mistaken belief that human errors are the root causes of industrial incidents reflects, in part, a national emphasis on individual responsibility coupled with society’s desire to assign blame and hand out punishment. Effective human factors programs recognize that the blame game is an obstacle to the prevention of chemical incidents. A properly conducted investigation of chemical incidents should focus primarily on systems performance, not individual performance. By concentrating on safety system problems and needed improvements, opportunities for prevention of similar incidents are maximized.

Mr. Danny C. White of RMT Inc Abstract presented a paper entitled, “Inherently Safe Design: A Common Sense Approach.” White said that most safety professionals associate Inherently Safer Design (ISD) with preliminary design of new processes. Indeed, in most cases, ISD concepts can have the greatest impacts in the early stages of process design. However, it is important to always consider ISD even for mature processes. In many instances processes can be made inherently safer with minor modifications. Mature processes can also become less inherently safe over time due to lack of maintenance of key systems or from or from out-of-date information. White discussed some common sense approaches for applying ISD techniques to mature processes and day-to-day operations.

Dr. David Leggett of the Hazard Evaluation Laboratories presented a paper on “Accident Severity Index.” Leggett said that all reactive chemical accidents do not have the same severity. However, each accident is often reported with equal weight regardless of its actual and/or potential impact on a company’s business operations. Sometimes an attempt is made to identify accidents involving a significant injury and/or result in a financial impact greater than $50M. This general lack of discrimination in the reporting could give rise to the impression that an increasing number of reported incidents is due to decreasing awareness of the company’s process safety program. There is much positive about encouraging folks to report incidents and accidents, including minor excursions from planned operations. Consequently, the absolute number of reported events is expected to increase. This increased reporting activity could also be construed as a worsening in process safety program compliance, whereas the overall severity of accidents reported may well be decreasing due to an actual increase in awareness of process safety issues. The Accident Severity Index project addresses this paradox of an increased number of accidents actually being a
sign of a healthy and active program with folks paying attention to the Reactive Chemicals aspect of their work and activities. It is the goal of this project to provide a tracking and evaluation system for process safety incidents and accidents. In order to accomplish this it is very necessary to assess the actual and potential severity of an accident, in an objective manner, using the information obtained from an incident investigation. Leggett’s presentation included a description of a prototype database and assessment system.

Mr. David Moore of AcuTech, Inc. presented a paper entitled, “Inherently Safer Design Practices in Process Hazard Analysis.” Moore said that inherently safer design concepts are particularly useful for risk reduction and are highly recognized and recommended by safety professionals as a first choice in process design practices. These concepts can be easily applied, particularly in the design phase of a process, and may have very powerful benefits at relatively low cost. In the practice of engineering new or modified processes, however, these concepts are often not incorporated in a structured manner. Without knowledge or insight of these concepts, engineers may be retaining unnecessary risk or employing less reliable and more expensive alternatives to reducing risk. Moore’s paper recommends ways to incorporate inherently safer design concepts into process hazard analysis.

Mr. Dennis C. Hendershot of Rohm and Haas Company presented a very thought-provoking paper entitled, “Was Murphy Wrong? Thoughts on the Application of Murphy’s Law to the Operation and Design of Chemical Plants.” Hendershot said, “We’ve all heard of Murphy’s Law.” It has been stated in various forms, generally something like “If something can go wrong, it will go wrong, and at the worst possible time.” We often quote Murphy’s Law, often in a light-hearted or joking context. But, do we really believe it? What effect does our belief in Murphy’s Law have on how we actually operate and design chemical plants? Is our application of Murphy’s Law appropriate? How should we be using Murphy’s Law?

Dr. Angela Summers of SIS-TECH Consulting presented a paper entitled, “Regulations, Standards, and Safety Instrumented Systems.” Summers said that the field of SIS design is rapidly evolving to meet the new ANSI/ISA S84.01-1997 standard and the draft IEC 1508/1511 standards. The race for standards compliance is marked with the finish line of “good engineering practices” and “highly recommended practices.” As we race toward compliance, industry must work hard to prevent the creation and acceptance of new design paradigms, which could threaten the economics of plant operation and could erode the effectiveness of SIS designs. This presentation addressed the goals of the standards that shape our SIS designs today. Summers also sounded a caution about the potential paradigms that could undermine industry’s attempts to meet the new standards.

Dr. John C. Crawford of the Sandia National Laboratories presented a paper entitled, “The Three Dimensions of Surety: Reliability, Safety, & Security.” Crawford said that the design of this Nation’s nuclear weapons demands a high degree of predictability in all aspects of their expected environments. Over the years, nuclear design engineers have developed a concept of “surety” that unifies and guides all elements of the design, storage, (Papers continued on page 12)
The Steering Committee of the Mary Kay O’Connor Process Safety Center established two awards, the Merit Award and Service Award, which were presented for the first time at the 1998 Annual Symposium. 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 are not required to be associated with the Center, but must fit within the Center’s mission, “Making Safety Second Nature.” The award is meant to underscore the importance of promoting and recognizing significant contributions and accomplishments of practitioners and researchers worldwide.

The Service Award was established by the Steering Committee to honor and recognize individuals who have contributed directly to the success of the Center and have played significant role in advancing the Center’s mission.

The 1999 Merit Award was presented to Dr. Walter B. Howard. In presenting the Merit Award, Texas A&M University Chemical Engineering Department Head Dr. Ray Anthony said, “The celebration of Dr. Howard’s accomplishments will hopefully be another catalyst in improving process safety in the process industries.”

The 1999 Service Award was presented to Mr. T. Michael O’Connor. Dr. Anthony said, “The establishment of the Center was made possible because of Mike’s generosity. He continues to help the Center and the Chemical Engineering Department in many ways. He is a true friend and supporter.”
CALL FOR PAPERS

BEYOND REGULATORY COMPLIANCE:
MAKING SAFETY SECOND NATURE

Symposium
October 24-25, 2000
Reed Arena - Texas A&M University

Sponsored by
Mary Kay O’Connor Process Safety Center

Chemical Engineering Division
Texas Engineering Experiment Station
Texas A&M University System

In cooperation with
American Society of Safety Engineers
Occupational Safety and Health Administration
US Chemical Safety and Hazard Investigation Board
US Environmental Protection Agency
Voluntary Protection Program Participants’ Association

This symposium will present state-of-the-art technology advancements, lessons learned and innovative techniques for improving process safety & controlling process plant risk.

Program Sessions: Program sessions are divided into the following topics for each industry segment represented at the symposium.

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<th>AFFECTED INDUSTRIES</th>
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Abstracts are due no later than February 25, 2000

Send abstracts to Dr. Sam Mannan,
Email: mannan@tamu.edu    Phone: (409) 862-3985   Fax: (409) 458-1493
Chemical Engineering Department, Texas A&M University
College Station, Texas 77843-3122

Additional information available on internet at http://process-safety.tamu.edu

Exhibition space for displaying equipment, software, and materials is available. For further information on exhibition space, contact Ms. Donna Startz. E-mail: donnas@tamu.edu    Phone: (409) 845-3489
Executive Forum Meets
In Conjunction with Annual Symposium

The Executive Forum of the Mary Kay O’Connor Process Safety Center met on October 26, 1999 at the George Bush Presidential Conference Center in conjunction with the 1999 Annual Symposium. Dr. Rick Deans, Chair of the Executive Forum, chaired the meeting. The meeting was preceded by a dinner at a local restaurant on the evening of October 25, 1999.

The forum members discussed process safety issues impacting the industry. In general, the meeting participants agreed that while there is a need for a lot more work in the fields of process safety and risk management, it is also true that significant progress has been made in recent years. Industry’s programs and the commitment of senior management has been critical in moving process safety issues to the forefront. In addition, many industry/government-sponsored programs have also been beneficial in increasing awareness. For example, OSHA’s Voluntary Protection Program promotes employee involvement in aspects of process safety. For many in the industry, zero fatalities and zero releases is the minimum acceptable goal.

Dr. Deans started the meeting by explaining the role and operating norms for the Executive Forum and encouraged dialogue in interim between meetings. He also asked forum members to provide input before the next meeting on Center vision, mission, and goals. Dr. Sam Mannan provided a brief overview about the State of the Center which included discussion of technical activities and a summary of the financial status of the Center.

There was wide consensus to add more members to the Executive Forum to reflect a broad-base of industry segments. Another idea is to review accident history by SIC codes of different industry sectors to determine need for improvement in process safety and determine value for membership in Center.

There was widespread consensus that the Center’s work should be independent, non-biased, credible, and based on sound-science stature. All efforts should be aligned to their objective.

Thanks for the Support and Prayers

In the terrible Bonfire accident of November 18, 1999, our University suffered the tragic loss of twelve fine individuals. In addition, twenty-seven students sustained physical injuries and numerous other members of our Aggie family have experienced emotional trauma as a result of the accident. In the days following the Bonfire tragedy, it has been inspiring to witness the outpouring of emotion and support for all those affected by the accident. While nothing can ever replace the loss experienced by the families of our fallen students, I trust it has been of some comfort to them to know that heartfelt expressions of caring and concern poured into the campus from all corners. The "specialness" of our Aggie community that we call the Aggie Spirit was palpable throughout the ordeal and was made evident far beyond the boundaries of our campus.

We appreciate the support, prayers, and kind thoughts received via personal messages, voice mails, and other media during these trying days. Many of those who contacted us at the Center from within the U.S. and overseas not only provided messages of comfort and offered prayers but also expressed a sincere desire to help. We, at the Center, are indebted to our friends for this support. While every effort will be made to respond to each message individually, we take this opportunity to recognize everyone for these heartfelt expressions of sorrow and support.
The Technical Advisory Committee of the Mary Kay O’Connor Process Safety Center met at the Zachry Engineering Center in College Station on October 25, 1999. Dr. Harry West, Chair of the Technical Advisory Committee, chaired the meeting. Dr. Ray Anthony, Chemical Engineering Department Head welcomed the participants and presented some recent statistics of TAMU and Chemical Engineering students. Currently, Texas A&M graduates about 3% of all new chemical engineers in the United States. Dr. Sam Mannan provided a summary of the Center’s operations since August 1, 1997. Thirty people are on Center’s payroll, many of them part-time.

Research areas include the National Chemical Program Assessment Project to identify and pursue national chemical safety goals. The first Roundtable meeting of the stakeholder group of 45 members was held in June 1999 and the second meeting will be held on October 28 at the Bush Conference Center.

The Center recently started work on a project on Quantitative Risk Assessment (QRA) for the Army for chemical demilitarization processes, which requires destruction of chemical weapons systems.

The Committee discussed the Continuing Education activities of the Center. Courses must be focused towards special needs of each industry, and knowledge of products must be communicated. This can be accomplished through websites and newsletters. Also, e-mail messages sent six to eight weeks in advance to certain people who will inform their constituents.

Dr. William Rogers summarized the Center graduate research in the areas of databases, silane releases, aerosol formations, and reactive chemicals. Dr. Ray Anthony asserted that there is a large reservoir of talent at TAMU, and the administration is supportive of departmental and inter-departmental research. Politics does not hinder progress at TAMU. Projects of national interest should have high priority.

After lunch, the attendees were invited to attend a tour of the Center’s facilities, which include the Library, Computer and Software Laboratory, Reactive Chemicals Laboratory, and Aerosol Laboratory.

The Committee evaluated four proposed research projects. Dr. John Wagner, Professor of Nuclear Engineering at TAMU, presented a proposal on, “A Study of Charge Generation During Filling of Small-Scale Polyethylene Insulated Tanks.” Target container is the 55 gal polyethylene drum and will include studies with a dip tube and turbulent filling through a metal feed line. Fluid conductivity measurements are difficult to do and are subject to large experimental variations.

Questions for the committee to consider are, 1) Is this an area of great need in industry? 2) Is this proposal the place to start, and 3) How will this work be funded? Opinions were that this is an area of industrial need, and the fillers and users of plastic containers need training for safe practices. The Subcommittee for Electrostatic Hazards, which includes Dr. Walter Howard, Mr. Bud Slye, Mr. Skip Early, and Mr. Robert L. Smith, will provide their responses to the proposal and explore funding possibilities.

Dr. Walter Howard presented a proposal on, “Three Aspects of Gaseous Combustion Venting.” He said that there are three areas of special ignorance: 1) Combustion venting of flammable materials in low strength, full size enclosures, such as buildings. 2) Combustion venting for intermediate-strength, gas-phase catalytic oxidation reactors with test volume = 4 m³, and 3) Burst pressures of container rupture disks under conditions of large pressurization rates caused by combustion. Under these dynamic conditions, the disks burst at much higher pressures than the rated burst rates, which were measured under static conditions.

Several technologies would be involved in this testing, so interdepartmental collaboration is needed with graduate student participation in each department. An industrial consortium would be needed to provide the funding for these full-scale tests.

Dr. Sam Mannan gave an overview of two additional projects for consideration: Abnormal Situation Management (ASM) and Quantitative Risk Analysis of Process Safeguards (QRA).

TAC continued on page 19
Mr. Lucas Osborn of Texas A&M University won the 1999 SACHE student essay award for undergraduate chemical engineering students. The award is sponsored by the SACHE Committee, American Institute of Chemical Engineers and the Center for Chemical Process Safety. The award includes $500 for the student and a plaque for the department. Students are required to prepare a 1500 word maximum essay on one of the following topics:

- Safety in the Unit Operations Laboratory
- Integration of safety in undergraduate courses
- Safety relevance in undergraduate education
- Most important safety concept taught in the University
- What can industry do to help Universities add safety to their courses?

Osborn’s award-winning essay is reproduced in its entirety below.

**Process Safety in Education**

Lucas Osborn  
Chemical Engineering Department  
Texas A&M University  
College Station, Texas 77843-3122

Throughout the evolution of the chemical industry, safety has often been treated as an afterthought. It is the tag-along in a group of kids on the playground: at times annoying yet unavoidable. Safety in the chemical industry has matured greatly since it was first forced into management’s calculation of “the bottom line.” However, it seems the incorporation of safety in the process industry cannot completely remove itself from the unwarranted stigma of “being a nuisance.”

There may be several reasons for industry’s occasionally negative response to the safety issue. First, hindsight is always 20/20. In other words, when people view a catastrophic event (such as the Bhopal, India accident), they tend to balk at the idea that their company would have been so negligent. Second, and more important, is the fact that safety in the industry is often handled as an afterthought. For instance, a process may be designed, and then be reviewed by a “safety engineer” whose job is to evaluate the integrity of the process. Certainly most engineers incorporate some obvious rules of thumb in their design, but if safety is to be a truly integrated effort, then all engineers must be intimate with the principles of safety in every aspect of their work. To incorporate safety at all levels requires every engineer to have a firm foundation in safety as it relates to the process industry. Indeed, safety must become second nature to engineers educated in the United States, much like algebra and English.

For all engineers to be familiar with safety, it must be incorporated into the university curriculum. To award a student a degree in engineering without including safety education as a requirement is to award a person a driver’s license without requiring him or her to know the traffic laws. For instance, the “Rules of Professional Conduct for Professional Engineers” in the state of Louisiana states that “Registrants shall hold paramount the safety, health, and welfare of the public… [and] recognize that their primary obligation is to protect the safety, health, and welfare of the public.” How can an engineer hope to agree to this statement, having little or no training in safety?

The answer lies in a simple but concerted effort at the university level. Like any other skill, safety in engineering requires practice and repetition. Practice helps one to perform the task, and repetition makes the
The Mary Kay O’Connor Process Safety Center is pleased to announce the course schedule for the year 2000. In addition to our previously offered courses, we have added two new classes: *Serious Incident Prevention* and *Quantitative Risk Assessment*. With the new continuing education schedule and offering, the Center continues its commitment to increasing knowledge and awareness of process hazards and safety for all sectors of society. It is also a goal of the Center to respond to special requests for training. Please feel free to contact us regarding specific training needs at your facility.

Training classes are two days in length and are held at the TEEX Training Center at 2002 Wayside Drive in Houston. Following is the continuing education schedule for 2000:

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<th>COURSE TITLE</th>
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<td>Hazard Assessment</td>
<td>Jan 10-11, June 19-20</td>
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<td>ISA 8401-Application of Safety</td>
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<td>Instrumented Systems for the Process Industry</td>
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<td>Maintenance/Mechanical Integrity</td>
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<td>Management of Change</td>
<td>May 8-9, Nov 6-7</td>
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<td>Process Hazard Analysis</td>
<td>Jan 24-25, July 10-11</td>
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<tr>
<td>Quantitative Risk Analysis</td>
<td>Feb 7-8, Oct 2-3</td>
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<tr>
<td>Relief System Design</td>
<td>April 10-11, Sept 11-12</td>
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<td>Root Cause Incident Investigation</td>
<td>May 22-23, Sept 25-26</td>
</tr>
<tr>
<td>Serious Incident Prevention</td>
<td>Feb 28-29, July 24-25</td>
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Detailed course information and instructor biographies can be found on our website at: http://process-safety.tamu.edu. If you have questions regarding continuing education please feel free to contact Teresa Baldwin by phone at (409) 458-1863 or email: teresa@psc.tamu.edu.
transportation, deployment, and retirement of nuclear devices. In this context, nuclear surety includes the dimensions of reliability, safety, and security. Reliability encompasses the performance of the system under normal (or expected) environments; Safety encompasses the performance of the system under abnormal (natural or accidental) environments; and Security encompasses the performance of the system under malevolent (or attack) environments. Obviously the ultimate level of surety attained in nuclear weapons or any other specific complex system will depend upon a combination of the surety inherent in the design and the surety achieved through operational procedures and restrictions. The most fundamental elements of surety, and the focal points of this paper, are those elements that are an integral part of the system design and hence those elements that are included in the early stages of the system evolution.

Sandia scientists and engineers are now in the process of examining the methodologies for surety design in nuclear weapons and the experiences gained over the past 40 years to determine how to make them applicable to other complex systems that demand a high degree of surety and predictability in all credible environments.

Dr. Marc Levin of Equilon presented his recent findings on, “Further calorimetric evaluation of polymer/oligomer decomposition: APTAC Testing.” The behavior of polymers and oligomers subjected to elevated temperatures in an air-free environment has recently been studied to characterize the energetics of polymer/oligomer decomposition. This work was pursued to test a widely-held notion that polymer decomposition is endothermic in nature. The study focused exclusively on hydrocarbon and oxygenated species tested in an open pan, DSC/TGA. Selected species have now been tested in the APTAC, a calorimeter designed to provide an adiabatic environment for runaway reaction characterization. Comparison of results with those from the DSC/TGA reveals confirmation of energetics in some cases and startling differences in others. For example, in both the DSC/TGA and the APTAC, double bond and glycidyl groups are found to lead to exothermic reaction of polymer. However, polymers with polyether or polyester functionalities exhibited exothermic decomposition behavior in the APTAC—in contrast to the DSC/TGA results. These findings reinforce the hypothesis that loss of heat by vaporization and removal of reactive intermediates by carrier gas in the DSC/TGA can confound the observed energetics of polymer/oligomer reaction. Furthermore, the type of functional groups present in a polymers/oligomers can strongly influence the reaction energetics.

Dr. Mark Abkowitz of Vanderbilt University presented a paper entitled, “Risk Assessment and Emergency Management Information Tools for Planning and Real-Time Applications.” Abkowitz said that manufacturers, transporters and regulators of hazardous materials, as well as other stakeholders, are recognizing the value of risk-based decision making to improve safety performance. Attention is being focused on the entire life cycle, including the production, storage, consumption and disposal of hazardous raw materials, intermediates, finished products and wastes. Two important components of risk-based decision making in this context are the ability to properly assess the risks associated within an operation and to effectively manage incidents should...
they occur. Pro-active risk management programs approach these considerations from both an advanced planning and real-time perspectives. Abkowitz’s presentation focused on the need for these risk management tools, how they are being developed, what is available off-the-shelf today, and the value-added they provide towards protecting human health and the environment. Abkowitz presented case studies to illustrate common uses of these tools in risk assessment and emergency management applications covering both planning and real-time situations.

Dr. Osvaldo A. Bascur of OSI Software presented a paper entitled, “Real Time Information Management to Increase Productivity in Industrial Plants.” Bascur said that intelligent systems (IS) technologies have received much attention in a wide range of process engineering applications including process operations. With the revolutionary progress in information and computer technologies applying the latest technologies in industrial complexes has become a serious challenge to both management and technical teams. Objects and components are changing the way everyone relates to their computer and networks. Bascur presented a description of a data hierarchy to transform data into information, then knowledge for action. A new continuous improvement and innovation loop emerges as a close loop for active decision making and collaboration. Results translate in extended sub critical equipment availability, increase production by faster detection of process bottlenecks and operating costs reduction.

Dr. Patrick J. McNulty of the University of Pennsylvania presented a paper entitled, “Evaluating the Use of Third Parties to Measure Process Safety Management in Small Firms.” McNulty described a pilot experiment designed to investigate the use of third party auditors to inspect facilities that use hazardous chemicals in order to ensure the chemicals are handled properly and the facilities have process safety programs in place to protect the health and safety of the public and to mitigate the consequences of accidents that do occur. The research examines the market forces and regulatory infrastructure necessary to attract third party auditors, the financial and regulatory incentives necessary for small firms to use third parties, and the potential benefits to employees, shareholders, regulatory agencies and communities.

Dr. Tasnim Hassan of North Carolina State University presented a paper on, “Issues Related to Ratcheting in Piping Components.” Hassan said that ratcheting is a phenomenon, which is defined as the accumulation of deformation or strain with cycles. When a piping component is subjected to a force-controlled cycle, deformation may accumulate in the component (global ratcheting), or when a point in a component is subjected to a stress-controlled cycle, strain may accumulate at that point (local ratcheting). It has been demonstrated experimentally that ratcheting may cause structural instability (global failure) or fatigue failure (local failure) of a component. The ratcheting phenomenon has been known to researchers from the turn of the twentieth century, but the implication of the phenomenon to safe design of a structure is yet to be fully explored. One main reason of lagging behind in this area is the general belief of the phenomenon of shakedown, which is defined as the complete cessation of ratcheting after few cycles. In this paper materials test data, which contradict the concept of shakedown, are presented. Influence of ratcheting on fatigue failure of straight pipes and elbows are discussed through
ensample of test data. Areas in the ASME Boiler and Pressure Vessels Code, Section III, Division 1-Subsection NB, which address design issues related to ratcheting are discussed. Finally, a rational method to incorporate ratcheting into piping design is presented.

Ms. Eboni McCray of the Mary Kay O’Connor Process Safety Center, Texas A&M University presented a paper entitled, “Use of Accident Databases for the Systematic Evaluation of Chemical Accidents.” McCray said that in response to the occurrence of several catastrophic chemical accidents in the 1980’s, numerous regulatory measures have been taken to improve the safety of the chemical industry. Government agencies such as the Occupational Safety and Health Administration (OSHA) and the US Environmental Protection Agency (EPA) have developed safety programs and legislation to provide chemical facilities with explicit safety guidelines. During this time, the facilities have been required to report any releases, accidents, and other hazardous issues to various government and public agencies. As a result of this reporting, countless databases have emerged, each with its own data-collecting method and chronology. McCray contends that a thorough investigation of these databases will offer insight into the state of industrial safety since the implementation of these mandates. Developing a “timeline” that chronicles chemical accidents facilitates a clear and concise assessment of those chemical safety programs being followed. The study of accident databases will allow for the development of realistic programs that are sensitive to public, environmental, and employee issues, as well as to chemical industry objectives.

Mr. Franco Tamanini of the Factory Mutual Research Corporation presented a paper on, “Development of Performance-Based Protection Standards from Recent FMRC Research on the Hazards of Silane Releases.” Tamanini said that existing design recommendations for the protection of ventilated enclosures in the silane industry were found to prescribe ventilation requirements based on outdated and, in some instances, misinterpreted data. Extensive research was carried out by FMRC (under partial support from SEMATECH) to develop improved protection guidelines for silane handling systems through enhanced understanding of the behavior of releases of this pyrophoric gas. The work has addressed and generated new information on three aspects of the problem: the prompt ignition behavior of silane; the reactivity characteristics of quiescent silane/air mixtures; and the rates of reaction of silane leaked into enclosures with and without explosion venting, in the presence of ventilation air flow. After developing correlations and generalizations of the test data with the assistance of models, this new knowledge was used as the foundation for a new set of performance-based protection guidelines for implementation by Factory Mutual loss prevention consultants worldwide. Because of their departure from rigid prescriptions, these guidelines provide the designer with the ability to evaluate different protection solutions and select the one that is most appropriate for the particular situation of interest.

Mr. Ian Nimmo of Honeywell presented a paper entitled “21st Century Land Warrior Technology for the 21st Century Refinery Operator: Abnormal Situation Management and the Digital Battlefield.” Nimmo said that each day, at refineries around the world, process operations personnel are putting on protective clothing and stepping out into a
world consisting of the biggest chemistry set an individual could imagine. The role of operating personnel varies from plant to plant, company to company, but they all have one thing in common; they are all human and all suffer from fatigue, vigilance deprivation and human error. Their role can be related to that of infantry soldier. Both monitor communication networks and instrumentation, interact with complex computer technology, and must participate in or coordinate multi-disciplinary forces under harsh and dangerous, often life-threatening conditions.

The US armed forces are revolutionizing their fighting forces and the way they fight wars with the application of advanced communication, information processing, sensor, and display technologies. The Force XXI soldier (21st Century Land Warrior) will carry a fully integrated fighting system that includes a body worn computer, multi-band-spread-spectrum-secure radio, multi-spectral sensors, and both head-mounted and hand held displays. The objective of this technology revolution is to integrate the soldier into the digital battlefield information network and effect a quantum leap in soldier effectiveness and survivability as well as battle unit command and control.

These same technologies and communication architecture’s are immediately applicable to improving refinery operations in both abnormal and routine situations. Field operators can have both their effectiveness and safety enhanced, particularly during abnormal situations, through the use of improved communication networks, Portable Information Processing Systems (PIPS), and portable hands free sensors and displays.

Mr. Ian Sutton of Southwestern Books presented a paper on “Linking Engineering Standards with Process Safety Management Systems.” Sutton said that the techniques of Process Safety Management (PSM) are now an integral part of the operations of process plants in the United States. As the name implies, Process Safety Management is fundamentally a management standard; it provides a framework which plant management can use to minimize the number of uncontrolled deviations from design or operating intent. As a management standard, PSM tends to be most effective in areas involving the performance of human beings and organizations, for example, operating procedures, training and the control of contract workers.

However this management focus of PSM, along with the non-prescriptive nature of the regulations in this area, means that process safety decisions tend to be based on the judgement and experience of the people working at a site or on a project. These decisions may lack quantitative, engineering rigor.

Sutton’s paper suggests that the integration of engineering standards from organizations such as ASME, NFPA and API can help improve the quality of process safety analyses. Similarly, the use or process safety techniques will help design engineers utilize those same standards more effectively during the design process, particularly when a variance is being called for.

Mr. Jack Buller of the The National Board of Boiler And Pressure Vessel Inspectors presented a paper on “Mechanical Integrity Inspection for Pressure Retaining Equipment.” Buller discussed the benefits of having a solid mechanical integrity inspection program for pressure equipment such as boilers, pressure vessels, piping, and safety relief devices. Buller explained why such a program improves the safety of operations and adds to the reliability of equipment. Buller also provided a review of code of constructions, regulatory requirements, practices and inspection procedures, and an overview of three accidents attributed to lack of inspection.

Mr. Jack Stout of Nexus Engineering presented a paper entitled, “Expert Systems in
Abnormal Situation and Production Management Applications.” Stout discussed how expert system technologies are causing manufacturers to rethink their process automation, reliability management, and abnormal situation management strategies. Initially applied to narrowly focused applications, expert systems are now being deployed across the plant site to provide a broad range of benefits. Developing an understanding of the role expert systems technologies are playing in industrial automation will enable users to implement automation projects meeting their immediate objectives while building an automation architecture to address their future requirements. The presentation also discussed the opportunities, benefits, and experiences in the implementation of expert systems for production management, and abnormal situation management practices.

Mr. Jeffrey Caplan of General Physics Corporation presented a paper on, “Significant Event Elimination Program.” Caplan said that the objective of the Significant Event Elimination Program (SEE) is to eliminate the recurrence of events which have had a significant impact on the safe or economic operation of a plant, and to ensure that measures are taken to prevent similar events on similar equipment. As such, the SEE program is an important part of a Continuous Improvement Program. SEE includes a method to prioritize plant events, including “near misses,” based upon their safety, environmental, health, and production impact. The prioritization addresses both one-time events and repetitive events. The highest priority events are then analyzed using root cause failure analysis (RCFA), reliability-centered maintenance (RCM), and/or other appropriate analysis tools. The analysis provides recommendations that can be used to prevent, inhibit, predict, or find future problems, thereby improving the safety, environmental, and/or economic operation of the plant. The SEE process includes two major steps: Event Prioritization (including ongoing data collection and analysis), and Event Analysis.

Mr. John Cornwell of Quest Consultants presented a paper entitled, “Real-Time Modeling During Emergency Situations: Is This a Good Idea?” Cornwell said that over the past decade, several attempts have been made to develop computer models that would provide “real-
Ms. Lizbeth Cisneros of the Mary Kay O’Connor Process Safety Center, Texas A&M University System presented a paper entitled, “Thermal Runaway Reaction Studies.” Cisneros discussed reaction profiles and heat generation behavior for the purposes of early detection of potential thermal runaway systems and for rapid testing of substances in industry for safe processes and compatible storage. She also presented experimental results of exothermic reaction tests using the Reactive System Screening Tool (RSST) and Automatic Pressure Tracking Adiabatic Calorimeter (APTAC) conducted at the Mary Kay O’Connor Process Safety Center Laboratory at Texas A&M University.

Dr. Harry West of the Mary Kay O’Connor Process Safety Center, Texas A&M University presented a paper entitled, “Spontaneously Combustible Substances, a Database Update.” West said that a database of spontaneous combustible substances has been developed. Over 100 substances commonly found in the chemical processing industry have been included. Spontaneous combustion includes the several related phenomena such as spontaneous heating/ignition, spontaneous oxidation, pyrophoric gases, pyrophoric liquids, pyrophoric nonmetals, pyrophoric metals, and moisture reactive metals.

Among the information included in the database are: range of conditions for spontaneous combustion; avoidance techniques; mitigation procedures; references to detail studies.

Several case histories covering various industries that have experienced these spontaneously combustible materials are detailed.
Mr. Orville M. Slye of Loss Control Associates presented a paper entitled, “Process Safety for the Small Business.” Slye said that the application of Process Safety to a small chemical business is a substantial management and technical task that can easily overwhelm the management of the enterprise. Small Businesses lack the technology and manpower resources of larger organizations, which limits their ability to implement a complete Process Safety Management program.

Mr. Quentin Baker of Wilfred-Baker Engineering presented a paper entitled, “Inherently Safer Design in Plant Layout and Facility Siting.” Baker said that Inherently Safer Design concepts can be applied to plant layout and facility siting. Passive and inherently safer plant layout design practices can lessen the adverse effects of toxic and flammables releases. Baker provided several categories of inherently safer design and specific examples of good practices.

Mr. Roy Sanders of PPG Industries presented a paper entitled, “Destructive Deeds from Water and Steam.” Sanders’ paper reviews a few basics on the hazards of water and steam within the chemical and petroleum refinery industries. To the youthful, this paper can be instructive with eye-opening reality of fundamentals. To more seasoned individuals these case histories can serve as a reminder of the potential hazards of water and steam using vivid examples, which were costly in disappointments, dollars, professional reputation and injuries.

Mr. Jim Makris, Director of the Chemical Emergency Preparedness and Prevention Office of the US Environmental Protection Agency delivered the keynote address for the second day. Makris said the industry has recognised that it has a moral obligation to the public and said, “You are in a community. They provide roads and schools and you provide jobs. It's a good relationship.” He urged the industry to concentrate on the product stewardship components of its own Responsible Care program.

The Symposium included sessions on current as well as advances in process safety issues, including management systems as well as technologies. Some of these sessions were Abnormal Situation Management; Inherently Safer Design; Impact of Small Business Incidents on the Chemical Industry; Human Factors/ Human Factors Engineering; Benchmarking Process Safety Programs; Reactive Chemicals; Application of Expert Systems, Software and Information Management in Chemical Safety; Process Safety Issues in the High-Tech Industry; and Chemical Safety in Transportation. Evaluations submitted by the attendees indicated a very high degree of satisfaction with the technical content of the sessions.
task second nature. Safety should be incorporated as early as the students’ freshmen year. At this level, the students prove to be open-minded since they are embarking on the first of four (or five, or six!) years of their college education. At this level, the seeds can be planted. For instance, professors of introductory classes can include simple case studies and perhaps videos of accidents. These “stories” contain a high entertainment value in that they can hold the students’ attention with fireballs and explosions, while at the same time making the student aware of the importance of safety. Professors must be careful not to get too technical at this stage, since the freshmen have not developed all of the background to analyze these accidents in depth. The purpose of these exercises is to start the student thinking in terms of safety and the consequences of negligence.

Continuing into the students’ second and third year classes, the emphasis on safety should remain. At this level, students begin core classes such as Thermodynamics, Fluid Mechanics, and Heat and Mass Transfer. At this level, professors can begin to introduce more technical calculations. For instance, problems relating to the material in class can be introduced to the students, with an extra requirement that the safety of the process be evaluated based upon the answer that is calculated. This is a critical stage where students can be molded from simple computers that spit out numbers into thinkers and evaluators. Perhaps the most important aspect of this stage is the professor. A genuinely motivated professor will have an impact on many students, whereas a professor who mentions safety as the students walk out the door will only perpetuate the relaxed view of safety that many engineers already hold.

Finally, as the students reach their senior year, they should be required to complete a course such as our senior-level Process Safety Engineering. This course serves as a culmination of four years of engineering studies. When I took the course, the class had to start from “the ground up” so to speak. However, if some of the safety lessons have already been introduced to students, this course would allow the students to delve deeper into process safety. The curricula should introduce the major concerns of safety in the process industry, including explosions, static electricity, toxicity, ventilation, etc. Little emphasis should be placed on rigorous calculations. Instead, thinking and evaluation should be the main concerns of this course. This course should leave to student with knowledge of the potential dangers of processes as well as the resources to evaluate any process from its inception.

Safety in the process industry has improved over the years such that the chemical industry has become one of the safest fields according to many OSHA ratings. However, a commitment to safety requires arming students with the proper weapons at an early stage. Only when safety becomes second nature can one truly agree to “hold paramount the safety, health, and welfare of the public.” The responsibility lies with everyone: the student, the professor, and the industry leaders. Much like the “fire triangle” requires all three sides for combustion, this “safety triangle” requires all three sides for success.
2000 CALENDAR

January 18-19, 2000
Chemical Safety Program Assessment Project Roundtable Meeting
George Bush Presidential Conference Center, College Station, TX

March 22, 2000
Mary Kay O'Connor Process Safety Center • Technical Advisory Committee Meeting
Zachry Engineering Center, Texas A&M University, College Station, TX

October 24-25, 2000
Mary Kay O’Connor Process Safety Center
2000 Symposium
Reed Arena, Texas A&M University, College Station, TX