Understanding the Explosion Hazards of Aerosols

Aerosols Incidents

Heat transfer fluids (HTFs) are widely used in the process and manufacturing industries and are capable of forming aerosols when they leak to atmospheric pressure. Vapors of HTFs are flammable above their flash points and have well defined flammability limits. Eichhorn (1955) recognized over four decades ago, however, that aerosols can explode at temperatures well below their flash points. Febo and Valiulis (1995) and others, including Vincent and Howard (1976), have called for research to quantify the aerosol explosion potential of heat transfer fluids.

Mist or aerosol explosions have resulted in enormous losses to the chemical process and manufacturing industries. Such aerosol incidents have been well documented, but little is known about the mechanisms for explosions of heterogeneous mixtures of vapor and droplets. It is therefore critical that the behavior of aerosols be studied and strategies developed for reduction of aerosol explosion hazards and increased safety of handling fluids that can produce aerosols.

Center Research

Research conducted by the Center has established functional relations between the operating conditions and the drop-size distributions of HTF aerosols and has made possible models to relate aerosol droplet sizes and formation distances to bulk pressures, temperatures, fluid properties, orifice sizes, and ambient conditions (Sukmarg, 2000; Krishna, 2001; Krishna et al., 2001; Sukmarg et al., 2002). Predictive correlations from this research will be useful to determine conditions at which HTFs can generate significant aerosol droplets for wide ranges of flame propagation velocities. This information will help guide selection of less hazardous HTFs for given operating conditions (Krishna et al, 2001). Knowledge of the fluid atomization process also will help guide the proposed research on the explosive nature of aerosols. As potentially hazardous conditions are identified, effective prevention and control measures will be developed.

Proposed Flammability Research

While it has been postulated that heterogeneous aerosol mixture explosions can be more devastating than homogeneous vapor explosions, there is presently no supporting experimental evidence (Eichhorn, 1955; Vincent and Howard, 1976; Febo and Valiulis, 1995). At issue is the prediction that the flame propagation speeds in aerosols are higher for a transitional droplet size range than speeds in vapor-air mixtures. Existing theory specifies a kinetically controlled premixed combustion mode.

(Continued on Page 4)
I am pleased to report about a number of different things, each one of which in its own way demonstrates progress and accomplishments for the Center. First, I and others in the Center are pleased to welcome Dr. J.P. Gupta as a visiting scholar at the Center starting June 2002. Currently a Visiting Fellow in Chemical Engineering at Loughborough University, UK, Dr. Gupta is on leave from the Indian Institute of Technology (IIT) Kanpur, India, where he is a Professor of Chemical Engineering. He did his B.Tech. (IIT, Kanpur, India, 1966), M.S.E. (University of Michigan, Ann Arbor, USA, 1967), and Ph.D. (University of Pennsylvania, Philadelphia, USA, 1971). He worked as a research engineer with UOP Des Plaines, USA (1967-68) in petroleum refining operations and taught at the University of Pennsylvania, Philadelphia, USA (1971-72) before joining IIT Kanpur in 1972. He has also been a Visiting Professor at the National Autonomous University, UNAM, Mexico City; the University of Michigan, Ann Arbor, USA; and the National University of the South UNS, Bahia Blanca, Argentina, the last one as a UNIDO Expert. He has been a consultant to companies in India and USA. He has published/presented over 100 papers, authored 4 books and edited 2 books. He has presented papers, chaired sessions and/or delivered invited keynote lectures in Conferences on all the six continents. Dr. J.P. Gupta has accepted an offer from the Chemical Engineering Department and the Center to spend a year with us starting June 2002. He will be teaching a course for the department. In addition, he will spend his remaining time working with the Center graduate students on various research projects. Dr. Gupta has a long track record of outstanding work in the area of process safety. I believe that Dr. Gupta’s visit here will be quite beneficial to the Center and the goals of the Center.

I am pleased to announce an agreement under which effective this year, all papers submitted for the Annual Symposium of the Center will be automatically peer-reviewed for publication in a special issue of the Journal of Hazardous Materials. This is a significant milestone that is an indicator of the growing quality and impact of the Symposium papers. In addition, it is also important to note that as a result of this agreement, ideas and research accomplishments presented at the Symposium will have an even more far-reaching impact.

I am also pleased to announce that I have undertaken the responsibility for editing the 3rd edition of the F P Lees’ Loss Prevention in the Process Industries. The 1st and 2nd edition of this classic chemical/process safety tome “Loss Prevention in the Process Industries” was edited by Frank Lees. Since Frank Lees passed away, the publishers have asked me to help them revise the three-volume set by bringing it up to date with the regulatory and technological advances in the United States, Europe, and elsewhere in the world. While I consider it a privilege and honor to work on this masterpiece, I know full well that I need help getting this massive undertaking accomplished. In that respect I want to acknowledge the assistance being given to me by many people in the process safety community.

Finally, the Center in collaboration with Region VI of USEPA and OSHA held an outreach conference on April 16, 2002, in Houston, Texas at the Pasadena Conference Center. Approximately 200 attendees at the day-long conference heard presentations and participated in discussions on evolving issues regarding process safety management and risk management programs. Details about the conference are provided elsewhere in this newsletter. This conference indicates the power of collaboration between various stakeholder groups for the common cause of improvements in process safety. In addition, the presentations and discussions at the conference again underscored the fact that the process safety management program and the risk management program are still evolving and such conferences are essential for establishing benchmarks.
Executive Forum Holds Spring Meeting

The Executive Forum of the Mary Kay O’Connor Process Safety Center held its Spring Meeting on March 19, 2002, at the Equestrian Center in Katy, Texas. The meeting was chaired by the Chair of the Executive Forum, Mr. Jim Bayer. The meeting was followed by a joint dinner with the Technical Advisory Committee.

The Forum discussed a proposal for the establishment of an NSF-funded Engineering Research Center for Resilient Engineered Systems. The mission of the Center would be to conduct research in order to develop methods for systematic identification and assessment of vulnerable systems and structures, especially critical infrastructure. The multidisciplinary efforts would be aimed at improving design and operation to increase resilience of all engineered systems. The net result would be an improvement in response to disasters by design and improved planning.

The Forum also discussed right-to-know issues in the light of the new security threats after the events of September 2001. There was wide-spread consensus among the Forum members that best defense at the plant is for employees to know and understand as well as for neighbors in the community. However, members questioned the benefit of putting the information on the internet. Right-to-know should be tempered with a need-to-know consideration. The Forum also discussed the development of the “Right Safety Culture” and its impact on process plant safety performance. The Spring Forum meeting ended with a discussion on issues regarding inherent safety and the pros and cons of legislating inherent safety.

Technical Advisory Committee Meets

The Technical Advisory Committee of the Mary Kay O’Connor Process Safety Center held its Spring Meeting on March 20, 2002, at the Equestrian Center in Katy, Texas. The meeting was chaired by Dr. Harry West.

The Committee was given an update on the progress in graduate research projects. The Committee members discussed the projects and provided input regarding further activities. The Committee also spent some time discussing potential new research projects. In addition, the committee provided guidance and brainstorming ideas regarding the 2002 symposium. A discussion was also held about the production of the 3rd edition of the F. P. Lees Loss Prevention Volumes. Finally, a discussion was held about the progress in the development and release of the National Chemical Safety Program Reports.

RECENT PUBLICATIONS


Howdy! My name is Kiran Krishna, and I am a graduate research assistant in the Aerosol Explosion Hazards Laboratory of the Mary Kay O’Connor Process Safety Center.

Pursuing a doctorate in chemical engineering has given me a chance to reexamine a number of phenomena that fascinate me, and untangle some of their mysteries. I can attest that the pursuit of doctoral study is a significant commitment. It is far more than just an investment of time. At the Center, you are encouraged to think deeply, to go further, and to look at concepts in a new and critical way.

When I reflect on how I have acquired the skills I need to shape my own future, and make so many close friends, I feel very lucky and grateful to be part of the Center. The intellectual environment and people at the Center are phenomenal. You learn a ton from the students, the staff, and the professors. The greatest outcome from working at the Center is that on graduation you gain credibility with and access to an amazing network of people. All told, it has been an extremely inspirational experience.

Research: Investigating the Explosion Hazards of Aerosols

Mist or aerosol explosions have resulted in enormous losses to the chemical process industry. Such aerosol explosions have been well documented, but little is known about the mechanisms behind them. This lack of knowledge about the explosive nature of such mists has itself become a cause for such accidents. It has therefore become vital that the hazardous nature of aerosols be studied in depth, in order to develop strategies to reduce the aerosol explosion hazard.

The achievements of the Aerosol Explosion Hazards Laboratory include, relating process conditions and fluid properties to aerosol formation, developing correlations to predict aerosol formation, and establishing thumb rules for the selection of heat transfer fluids to reduce their explosion hazard. The research is now focusing on combustion of aerosols. The aim is to understand the conditions and the mechanisms that result in aerosol explosions and to develop strategies to reduce such hazards, thereby improving process safety.

Aerosols - Continued from page 1

for fine droplets below 8 micron, as shown in Figure 1, where the aerosol behaves like a vapor, and a mass transfer controlled diffusion mode for larger drops above 15 micron, where the aerosol first vaporizes and then combusts. But in the ‘transition range’, which for this example is between 8 and 15 micron, the flame speeds would be significantly enhanced (Polymeropoulos, 1984).

Small droplets ahead of the flame front evaporate quickly, because of heat radiated from the flame front, and then combust. Smaller droplets have higher surface area per unit volume as compared to larger droplets and are therefore exposed to higher heat transfer flux. On the other hand, evaporation of larger droplets ahead of the flame front is relatively slow, because of a smaller surface area to volume ratio, and flame speed is significantly reduced because of the smaller amount of vapor to advance the flame front.

In the transition range between the smaller and larger droplets, some droplets are small enough to generate significant vapor from the flame front radiation, but are large enough to remain as a droplet mist following the evaporation. Also, flames can accelerate when constricted by obstacles such as this droplet mist (Burgoyne and Cohen, 1954). In addition to a flame acceleration due to obstacles, the droplets may also vaporize extremely rapidly thereby appearing to ignite directly. Because of a higher enthalpy concentration in the liquid state, the flame front is provided additional thrust with enhanced speed. (Chan and Jou, 1988, 1989; Laster and Annamalai, 1989).

HTFs are generally low volatile fluids with high boiling points and should exhibit a relatively large flame speed enhancement in the transition range, according to the theorized mechanism. Experimental support for this theory would demonstrate that aerosol explosions can be more devastating than vapor explosions and help to dramatize the hazards of aerosols.

Continued on page 10
Mary Kay O’Connor Process Safety Center

BEYOND REGULATORY COMPLIANCE, MAKING SAFETY SECOND NATURE

October 29 - 30, 2002

Reed Arena • Texas A&M University
College Station, Texas

URL:  http://process-safety.tamu.edu
<table>
<thead>
<tr>
<th>Time</th>
<th>Session</th>
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<tr>
<td>8:00 - 10:00AM</td>
<td><strong>Morning</strong></td>
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<tr>
<td>8:00AM</td>
<td>“Learning From Experience”, Tutorial and Discussion led by Dr. Trevor Kletz</td>
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<td>9:30AM</td>
<td>State of the Center: Research Program, Current Activities, and Future Direction Dr. Sam Mannan, Director, Mary Kay O’Connor Process Safety Center</td>
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<td>10:30 - 12 Noon</td>
<td><strong>Track I</strong> - Chairs: David Chung and Skip Early</td>
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<td>• “Process Safety Management in the Pipeline Industry: Parallels and Differences Between Pipeline Integrity Management (IM P) Rule of the Office of Pipeline Safety and the PSM/RMP Approach for Process Facilities, G.B. DeWolf, URS Corporation</td>
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<td>• “Experiences in the Regulation of Inherent Safety,” D. Moore, AcuTech Consulting Group</td>
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<td>1:00 - 2:30PM</td>
<td><strong>Track II</strong> - Chairs: Mike Marshall, Rob Smith, &amp; Hunter Hild</td>
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<td>• “Implementing API RP 580 Risk Based Inspection,” J. Alderman, RRS Engineering</td>
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<td></td>
<td>• “API Risk Based Inspection,” L. Kaley, M&amp;M Engineering</td>
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<td>3:00 - 5:00PM</td>
<td><strong>Track III</strong> - Chairs: Kathy Shell and Jack Vernon</td>
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<td>• “Improved Radiation Calculation for Zone Model Prediction of Flashover,” V. Novozhilov, Nanyang Technological University</td>
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<td>5:00 - 7:00PM</td>
<td><strong>General Session - Case Histories</strong></td>
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<td>• “Simultaneously Improving Safety Awareness, Safety Attitudes, and Business Results – A Case Study,” W. Abouamin and M. Boult, DNV (USA), Inc.</td>
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<td><strong>Process Management for Safety</strong></td>
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<td>• “The Long Term Solution to Corporate Wide EH&amp;S: Effective &amp; Practical Information Management Tools,” A.A. Ahmad, Berwanger, Inc.</td>
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<td>• “Preview of Updated Incident Investigation Guidelines,” J. Philley Baker Engineering and Risk Consultants</td>
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<td>• Benefits of Automating Process Safety Management (PSM) and Integrating with Operating Procedures and Drawings, D. Drerup and M. Bearrow, Data Systems and Solution and B. Hughes, FileNET Corporation</td>
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<tr>
<td>5:00 - 7:00PM</td>
<td><strong>Reception</strong></td>
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Co-Sponsors
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<tr>
<th>Time</th>
<th>Track I Chairs: David Chung and Skip Early</th>
<th>Track II - Chairs: Mike Marshall, Rob Smith, &amp; Hunter Hild</th>
<th>Track III Chairs: Kathy Shell and Jack Vernon</th>
</tr>
</thead>
</table>
| 8:00 - 10:00 AM | General Session - Chemical Plant Security  
   - "Chemical Plant Vulnerability Assessment Project," C.D. Jaeger, Sandia National Laboratories  
   - "Securing the Use and Manufacture of Hazardous Materials," D. Belonger, Center for Chemical Process Safety, American Institute of Chemical Engineers  
   - "Right-to-Know, or Blueprint for Terror?", W.A. Anderson, T.C. Poindexter, and R.A. Keller, Winston and Strawn  
   - "Inherent Safety Index for Transportation of Chemicals," M. Gentile, W.J. Rogers, and M.S. Mannan, Mary Kay O’Connor Process Safety Center  
   - Inherent Safety of Dikes Against Catastrophic Failure of Storage Tanks," M. Moosemiller and T. Whipple, DNV (USA), Inc. | Reactive Chemicals - I  
   - "Studies on Decomposition Reactions Catalyzed by Fe Ion in Aqueous Solution of Unstable Chemicals Such as Hydroxylamine, Y. Fujimoto, M. Kumasaki, and T. Ando, National Institute of Industrial Safety  
   - "Ethylene Oxide Reactivity With Iron Oxides," M.E. Levin, Shell Global Solutions (US) Inc.  
   - "Evaluation of Styrene-Acrylonitrile Copolymerization Thermal Stability and Runaway Behavior," A.A. Aldeeb, W.J. Rogers, and M.S. Mannan, Mary Kay O’Connor Process Safety Center |
| 10:30 - 12 Noon | Novel Applications of Incident Databases  
   - "Use of Failure Rate and Human Error Databases to Develop Safety Metrics and Performance Measurement Systems," N. Keren, H.H. West, and M.S. Mannan Mary Kay O’Connor Process Safety Center | Risk Assessment - I  
   - "Probabilistic Fault Tree Analysis," S. Mohindra, Arthur D. Little, Inc.  
   - "Decomposition of Hydroxylamine/Water Solution added Metal Ion," Y. Iwata and H. Koseki, National Research Institute of Fire and Disaster  
   - "Scale-up Models for Relief Sizing," S.R. Saraf, W.J. Rogers, and M.S. Mannan, Mary Kay O’Connor Process Safety Center |
| 1:00 - 2:30 PM | Risk Assessment - II  
   - "Quantitative Process Risk Screening Tool," A.H. Poppen, 3M Industrial Markets Group  
   - "The Importance of Multiphase and Multi-Component Modeling in Consequence and Risk Analysis," D.W. Johnson and J.D. Marx, Quest Consultants, Inc. | Novel Applications of Incident Databases  
   - "Foundations for World Class Safety Performance," D. Berube, Saudi Aramco  
   - "Fitting Safety Into Project Engineering," D. Govind, Qatar Petroleum  
   - "Benefits of Visualization and Real-Time Metrics," D. Drerup and M. Bearrow, Data Systems and Solutions |
| 3:00 - 5:00 PM | Metal Fires  
   - "Lessons Learned from Titanium Fires," M. d’Angremond, Dow Chemical Company  
   - "Industry Efforts to Develop Best Practices for Titanium Packing," S. Ostrowski, ExxonMobil Chemical Company and M.S. Mannan, Mary Kay O’Connor Process Safety Center  
   - "Foundations for World Class Safety Performance," D. Berube, Saudi Aramco  
   - "Fitting Safety Into Project Engineering," D. Govind, Qatar Petroleum  
   - "Benefits of Visualization and Real-Time Metrics," D. Drerup and M. Bearrow, Data Systems and Solutions |
2002 SYMPOSIUM REGISTRATION
Mary Kay O’Connor Process Safety Center
BEYOND REGULATORY COMPLIANCE, MAKING SAFETY SECOND NATURE
October 29-30, 2002
Reed Arena • Texas A&M University • College Station, Texas

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Mailing Address

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Telephone | Fax | E-Mail Address

Additional Persons Registering: ($50.00 discount per person when registering five or more from the same organization)

2) _______________________________________________ 4) _______________________________________________
3) _______________________________________________ 5) _______________________________________________

Please indicate preferred track for session attendance:

Day 1 - First Session: Track I  Track II  Track III  Day 2 - First Session:  Track I  Track II  Track III
Second Session: Track I  Track II  Track III  Second Session:  Track I  Track II  Track III
Third Session: General Session

REGISTRATION FEES  (Fee includes refreshments, lunch, handouts and proceedings)

- Received by September 30, 2002 - $395.00 per person  •  Received after September 30, 2002 $450.00 per person
- Purchase of printed proceedings and CD-ROM (set) only - $65.00
- Payment by Check (payable to Mary Kay O’Connor Process Safety Center)

Total Enclosed $____________________

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Send payment to:
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Attention: Donna Startz
3574 TAMU
College Station, TX 77843-3574
-or-
Phone: (979) 845-5981
Fax: (979) 458-1493
E-mail: donnas@tamu.edu

Accommodations:
When making reservations, please indicate that you are attending the Mary Kay O’Connor Process Safety Center Symposium.

Rooms have been blocked at the following motels:

- Hilton  • (979) 693-7500  • Single rate: $80 (hotel shuttle available)
- Holiday Inn Express  • (979) 846-8700  • Single rate: $69 (hotel shuttle available)
- Manor House Inn  • (979) 764-9540  • Flat rate: $56 (hotel shuttle available)
- Hampton Inn  • (979) 846-0184  • Single rate $67 (hotel shuttle available)
- La Quinta Inn  • (979) 696-7777  • Single rate: $69 (hotel shuttle available)
- Quality Suites  • (979) 695-9500  • Flat rate: $80
- Vineyard Court  • (979) 693-1220  • Single rate: $80
- Ramada Inn  • (979) 693-9891  • Flat rate: $58

Rooms will be released to the general public after September 27, 2002

Travel:
You can travel to College Station by flying into the Easterwood Airport in College Station from the Houston Intercontinental or the Dallas/FortWorth Airport. Also, you can drive from Houston International, which is about an hour and a half drive.

Parking: Complimentary parking is available at Reed Arena during the Symposium.

For more information: Contact Donna Startz at E-mail: donnas@tamu.edu  •  Phone: (979) 845-5981
http://process-safety.tamu.edu
Center, EPA and OSHA Hosts
Process Safety/Risk Management Seminar

On April 16, 2002 individuals from government and industry met to discuss current issues in process safety and risk management. OSHA, EPA and the Mary Kay O’Connor Process Safety Center jointly sponsored this outreach seminar. The one-day seminar brought together various viewpoints on regulatory compliance, lessons learned and issues of concern. Experts from industry and members of the regulatory community responded to questions throughout the panel styled presentations.

Opening remarks from Sam Coleman, EPA’s Director of Compliance Assurance and Enforcement, and Ray Skinner, OSHA Region 6 Area Director, complimented the progress made in process safety and risk management and stressed the need to continue the efforts. Dr. Sam Mannan, Director of the Mary Kay O’Connor Process Safety Center, recapped the journey of PSM and RMP from their start to date.

Tim Overton from Dow Chemical presented their experiences in PSM/RMP implementation. Dow’s long history of process safety began with their founder and many of his patent efforts. Tim discussed their successful approach centering on hazard elimination and mitigation/ emergency preparedness encompassing design, operation, and maintenance. Presenting a smaller company’s approach was Terry Sain from Enichem Elastomers. Terry provided guidance on implementation with a small staff and foreign ownership.

Les Rucker of Valero Energy presented a mechanical integrity case study involving a hydrogen sulfide release leading to a serious employee exposure from a vessel, which was not properly protected per the original specifications. This presentation set the stage for Henry Ingram to discuss Shell Chemical Company’s efforts to learn from incidents on a worldwide basis. Individual sites provide information to an electronic repository of incident and near-miss information. While not completely implemented, Shell is receiving good information and sees tools of this nature as the future of learning from incidents. Randy Burrow’s presentation on a case study on corrosion under insulation at Shell’s Deer Park Refinery rounded out the discussions on company experiences.

Russ Elveston of OSHA, Jim Belke of EPA and Barry Feldman of EPA presented their viewpoints of agency expectations and common compliance findings at both the regional and national levels. Russ and Barry then discussed some case studies leading the way to an interesting open discussion of current issues.

PHAs have always provided for interesting discussions. Dave Moore of AcuTech Consulting presented ideas for handling emerging issues, strengths and weaknesses of the methodology and some common pitfalls. Russ Elveston showed that PHA methodologies and level of detail are the 2nd and 6th most often cited areas of process safety. Documentation makes an easy trail to follow. John Alderman of RRS Engineering presented facility siting observations from the past eight years. John pointed out the need for companies to establish risk criteria and to make better use of aggregate risk in making decisions.

Harry West of the Mary Kay O’Connor Process Safety Center and Terry Wilkins of OSHA talked about the pitfalls of management of change. As companies continue to struggle with mechanical integrity, John Vorderbrueggen of General Physics spoke on pushing the system beyond the design limits and other common program shortcomings. Terry Wilkins of OSHA closed this session with a presentation on OSHA’s intent in the mechanical integrity portion of the standard.

John Cornwell of Quest Consultants had an informative presentation on communicating risk and developing a trusting relationship. John pointed out some common problems and their potential solutions using a case study of an LPG Depot. Jack Vernon of ABS Consulting closed the afternoon session with a spirited discussion of the meaning of RAGAGEP and its place in a PSM/RMP program.

For more information of the seminar or to view the presentations, please visit the Center’s website at http://process-safety.tamu.edu.
A better understanding of aerosol combustion behavior is vital to the prevention of aerosol explosions. Identifying the transition ranges for various fluids can help develop strategies to prevent such droplet sizes from being generated. Aerosol droplets sizes produced through leaks in process systems are closely related to the operating conditions and the fluid and thermal properties. Using the developed correlations that predict aerosol formation as a function of atomization conditions, safety guidelines to selecting less hazardous HTFs and their operation conditions will be established.

**Aerosol Research Objectives**

HTFs are used in almost every chemical process and manufacturing industry and the workforce employed by the industry is very large. This workforce is constantly exposed to the potential hazards of aerosol explosions. Therefore, systematic laboratory studies are crucial for design criteria to eliminate or reduce aerosol explosion hazards from the workplace.

Current Research at the Mary Kay O'Connor Process Safety Center research employs advanced optical diagnostic and high-speed visualization techniques to study the flammability and explosion characteristics of selected HTFs, by experimentally measuring the flame speeds as functions of the aerosol droplet sizes and air-to-fuel concentration ratios. A proposed apparatus for these flammability measurements is shown in Figure 2. The overall goal of this research is to
understand the conditions and mechanisms of aerosol explosions and to establish design guidelines for the selection and use of heat transfer fluids to improve safety of their use in industry.

**Literature Cited**


**Nominations Sought for 2002 Merit and Service Awards**

The Steering Committee of the Mary Kay O’Connor Process Safety Center has established two awards of recognition, the Merit Award and the Service Award. The annual Merit Award recognizes an individual who has made significant contributions to the advancement of education, research, or service activities related to process safety concepts and/or technologies. The contributions or accomplishments leading to the annual Merit Award need not be associated with the Center but must fit within the central theme of the Center, i.e., Making Safety Second Nature. In establishing the Merit Award, the Steering Committee underscores the importance of promoting and recognizing significant contributions and accomplishments of practitioners and researchers worldwide.

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

Please submit nominations for the 2002 Merit and Service Awards to:

**Dr. Sam Mannan**
Mary Kay O’Connor Process Safety Center  
Chemical Engineering Department  
Texas A&M University  
College Station, Texas 77843-3122  
**e-mail:** mannan@tamu.edu

In addition to providing names and contact address for nominees, a biographical sketch of the nominee should be provided, as well as a statement of why the nominee deserves to be recognized. Please submit nominations no later than August 15, 2002. Both the Merit and Service Award will be presented in conjunction with the Annual Symposium to be held on October 29-30, 2002 at the Reed Arena in College Station.
## Mary Kay O'Connor Process Safety Center
### 2002 Continuing Education Calendar

#### May
- **14-15** · Root Cause Incident Investigation - Jack Philley
- **21-22** · Serious Incident Prevention - For Operating Managers and Safety Professionals - Thomas Burns

#### August
- **20-21** · Inherently Safer Design - Dennis Hendershot
- **27-28** · Management of Change - Steve Emerson

#### September
- **5-6** · Systematic Assessment of Reactive Chemical Hazards - Sam Mannan and Bill Rogers
- **10-11** · ISA8401-Application of Safety Instrumented Systems for the Process Industry - Charles Hardin
- **24-25** · Serious Incident Prevention - For Operating Managers and Safety Professionals - Thomas Burns

#### October
- **1-2** · Understanding and Preventing Fires and Explosions in Petrochemical Plants - Gary Pilkington
- **8-9** · Process Hazard Analysis - Skip Early

#### November
- **5-7** · ISA8401-Application of Safety Instrumented Systems for the Process Industry (extended version) - Charles Hardin
- **12-13** · IEC Regulations - Angela Summers

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### Locations:
- TEEX Training Facility or IBT Facility, both in Houston, TX

### All classes run:
- 9:00AM - 4:00PM
  - (Unless otherwise noted)

### Registration Fees:
- Early Registration (4 weeks prior) - $395.00 per person
- Regular Registration - $450.00 per person

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### 2002 Meetings and Events Calendar

<table>
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<th>Date</th>
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| October 28, 2002 (Mon.) | Executive Forum Meeting, 10AM  
CE/TTI Bldg., Texas A&M University, College Station, TX |
| October 29 - 30, 2002 | 2002 Symposium  
Reed Arena, Texas A&M University, College Station, TX |
| October 31, 2002 (Wed.) | Technical Advisory Committee Meeting  
Zachry Engineering Bldg., Texas A&M University, College Station, TX |

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For more information or to register, contact Mary Cass:
- **mary-cass@tamu.edu**
- **(979) 458-1863**