

# SACHE News

## Safety and Chemical Engineering Education - Fall 1999

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### Status of SACHE

J. F. LOUVAR, CHAIR  
CCPS UNDERGRADUATE EDUCATION COMMITTEE

### 1999 Workshop

Our 1999 faculty workshop in Freeport, Texas, (Dow Chemical Plant) was an outstanding success. Based on faculty feedback and our own assessment, this was our best workshop. The plant tours, lectures, and planned interactions were great. We had 23 professors and 2 graduate students; they all left with a new or renewed interest in chemical process safety.

The Dow Chemical Company is to be commended for its hospitality, including excellent tours and presentations. Anderson, Greenwood & Company (Safford, TX) is also thanked for facilitating a day session on relief valve technology.

The theme of this 1999 workshop included chemical reactivity hazards, process hazards analysis, and emergency relief system design. There was a good balance between plant tours and lectures.

### 2000 Workshop

As a result of our successes with these workshops, we're planning another one in the fall of the year 2000. The theme of this workshop will be "safety designs," including business considerations, PFDs, P&IDs, safety reviews, and special design considerations. Workshop participants will interface with and have detailed discussions with company specialists in chemical plant design.

Anyone interested in attending the year 2000 workshop should contact D. Crowl (crowl@mtu.edu).

### 1999 Products

Our SACHE member universities will receive the following 1999 products:

- Free CCPS book of choice
- AIChE Safety Course at half price
- CD-ROM, Loss Prevention Symposium Papers (Freeman and Hendershot)
- Pocket Guide to Chemical Hazards - NIOSH
- Workshop - Opportunity to attend
- Video/CD-ROM on Explosion Venting Research (Howard and Louvar)
- Elements of Ergonomics Programs (NIOSH)
- Video - Reactive Chemicals (Willey)
- 1999 Texas Loss Prevention Symposium Papers (Darby)

These are all good products. Hopefully you will have an opportunity to review them. At a minimum, I suggest that you have a few of your students review them and give 10 minute summaries in your classes.

### SACHE Reception at AIChE National Meeting

Each department chair (or SACHE interface) should plan to send one or two of your faculty to our reception at the fall annual meeting in Dallas (November 2 from 4:30 to 6:30 p.m.). We plan to have wine and hors d'oeuvres prior to giving you a status of SACHE. We will also have breakout meetings to acquire your ideas and suggestions concerning SACHE and our products.

### Feedback from Readers

We would appreciate feedback (for our newsletter) from anyone concerning chemical process safety. Send your experiences to J. Wagner (jwagner@ceat.okstate.edu). We would like to use this newsletter to share classroom experiences, student summer job experiences, research experiences, accidents experiences, etc.

**TABLE OF CONTENTS**  
*VOLUME 9, NO. 1 – OCTOBER 1999*

	Page
<b>Status of SACHE</b>	1
<b>1999 SACHE Workshop for Chemical Engineering Faculty</b>	3
<b>Student Essay Award</b>	3
<b>Process Safety in Education</b>	4
<b>New SACHE Modules</b>	5
<b><i>Process Safety Progress on the Internet</i></b>	<b>5</b>
<b><i>SACHE News Shared with Chemistry Departments</i></b>	<b>6</b>
<b>Chemical Reactivity Worksheet</b>	6
<b>SACHE Workshop 2000 - A Working Safety Symposium</b>	6
<b>SACHE Speakers Bureau</b>	7
<b>1999 SACHE Members</b>	8

SACHE, or Safety and Chemical Engineering Education, is a project under the auspices of AIChE's Center for Chemical Process Safety (CCPS). SACHE's charter is to enhance the presentation of process safety in undergraduate education.

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The opinions expressed in the articles contained in the *SACHE News* are not necessarily the opinions of the Center for Chemical Process Safety or the American Institute of Chemical Engineers.

Articles related to any aspects of safety in the academic community are solicited from both the academic and industrial community for publication in *SACHE News*. Material should be sent directly to the editor for consideration.

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## 1999 SACHE Workshop for Chemical Engineering Faculty

RON DARBY

The 3 ½ day Workshop for Chemical Engineering Faculty on Process Safety was held on May 16-19, 1999, at the Dow Chemical Company in Freeport, Texas, and Anderson Greenwood Crosby in Stafford, Texas. There were 25 participants in the Workshop, including 23 ChE faculty from universities all across the U.S. plus Canada and Denmark, and two graduate students from West Virginia University.

The focus of this Workshop was on three areas related to process safety: Chemical Reactivity Hazards, Process Hazards Analysis, and Emergency Relief Systems. The program involved lectures, demonstrations, plant tours, hands-on exercises and discussion sessions. A kickoff address by Sam Mannan of Texas A&M on "Federal Guidelines and Safety Education" started the program, which also featured the films "Look Back in Time", "Piper Alpha", and "Reactive Materials".

The Chemical Reactivity program included talks on evaluation and characterization of the reactivity of materials, a Case Study of a Nitroaniline Reactor Runaway by Ron Willey, as well as a laboratory tour and demonstration of the use of various instruments and the type of data obtainable from each. A presentation by John Edgar of Sedgwick James on the influence of the quality of the process safety program on insurance coverage and rates helped put it all in perspective.

The program on PHAs included an overview by John Marshall of Dow on the various techniques for evaluating process hazards, as well as detailed presentations on the use of the Dow Fire and Explosion Index and Chemical Exposure Index for screening and ranking the hazards of various processes. This was followed by a hands-on workshop, in which the participants worked in groups on an application to a polymer plant. Also included were a discussion of the use of the F&EI to establish plant siting and layout criteria, followed by another hands-on exercise by the participants, and a presentation by each of the groups of their results. This part of the program also included presentations by Art Dowell of Rhom & Haas on "Layer of Protection Analysis" and "Inherently Safer Processes."

Plant tours at Dow included both Light Hydrocarbon #7 and #8 and the Toluene Diisocyanate plants. The LHC tours provided a vivid demonstration of the application of process safety principles to both plant siting and emergency relief, and the TDI plant provided an excellent example of methods that must be used to contain and control extremely toxic chemicals.

The final day of the program was conducted at Anderson Greenwood Crosby in Stafford, Texas, who is a leading manufacturer of relief valves in this country. The program focused on the design and application of emergency relief systems, with an overview by Ron Darby of design principles and the use of data on runaway reactions to size relief valves for reactors. This was followed by a presentation by Alan West of AGCO on the design, operation and application of relief valves, a presentation by Dean Miller of Fike on rupture disks, and a presentation by Roy Sanders of PPG showing a number of case studies involving accidents resulting from improper relief design. A tour of the manufacturing facilities of AGCO included demonstrations of the flow capacity testing of the relief valves and their calibration.

All the participants reported having benefitted greatly from their experience at the workshop. There was a substantial "overflow" in applicants for this workshop, beyond the limit of 25, so if you are interested in participating in the one next year at BASF in Wyandotte please get your name "in the pot" early to ensure a place.

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### Student Essay Award

The popular SACHE essay contest for undergraduate chemical engineering students will return in 2000. Prepare a 1500 word maximum essay on one of the following topics or equivalent:

- Safety in the unit operations laboratory.
- Integration of safety into undergraduate education.
- 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?

Send your essay entries to:

Dr. J. F. Louvar  
BASF Corporation  
1419 Biddle Avenue  
Wyandotte, MI 48192-3736

Deadline: June 1, 2000

The two winning essays will each receive \$500!

Two honorable mention awards will also be made.

EDITORS NOTE: The following essay is the first of two winning entries in the 1999 SACHE Student Essay Contest. The second essay by Aimee Golder, University of Missouri, Rolla, will be published in the Spring, 2000, issue of *SACHE News*. Each student will receive a \$500 award and a certificate

## Process Safety in Education

LUCAS OSBORN

Texas A&M University

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 in the playground: at times annoying yet unavoidable. Safety in the chemical industry has matured greatly since it was first forced into management's calculations 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 the "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 task second nature. Safety should be incorporated as early as the students' freshman 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

*Continued on page 7*

## New SACHE Modules

### **CD-ROM Proceedings of the 1998 Process Plant Safety Symposium**

Ron Darby

This CD contains the Proceedings of the 1998 Process Plant Safety Symposium, held on October 26-27, 1998, in Houston, Texas, and sponsored by the South Texas Section of the AIChE. This 2-day meeting included 27 sessions and 110 papers covering a wide variety of areas in Process Safety Engineering and Process Safety Management. Some of the technical sessions included Reactive Chemical Hazards, Emergency Relief Systems, Blast Modeling, Consequence Analysis, Process Safety in the Chemical Engineering Curriculum, and Research Issues in Process Safety. The CD is packaged in a 3-ring binder, which includes the program listing with titles and authors of all the presentations, a list of authors/presenters, background information, and instructions for accessing, searching, and printing from the CD.

### **Explosion Venting Research**

W. Howard and J. Louvar

SACHE member universities should receive this module as part of the fall package. This module will contain a video and a CD-ROM; both will contain the same presentation but in different formats.

This module will emphasize the importance of research in this area of safety by:

- Describing the specific research that was conducted to develop the methodology for sizing explosion vents.
- Emphasizing that this research can be relatively inexpensive if it is planned and executed appropriately.

Additionally, this video includes pictures and movies of actual explosions that clearly demonstrate the consequences of explosions. A viewing of this video will give the student, engineer, and professor an awareness of the importance of "the design" of explosion vents. Mistakes could be fatal.

### **An Introduction to Reactive and Explosive Materials**

Produced by Hazards Productions, Inc. of Sparta, NJ

SACHE package prepared by Ronald J. Willey

This video tape runs for about 20 minutes. Although filmed in 1988, its message is timeless: what precautions must be made when working with explosive and reactive chemicals. The video tape is ideal for a kinetics course where runaway reactions is a topic. After all, explosions are very fast reactions. There are several other places in the curriculum where the video can be used such as freshman introductory courses, senior design courses, unit operations laboratory courses, and thermodynamics (these reactions reach equilibrium very quickly!).

It is a very easy SACHE product to use. Simply arrange for a VCR playback machine and a television monitor. Place the tape in the machine. Press play. The message, however, is not so simple. The information that students gain in 20 minutes cannot be covered in any more efficient manner. They will be impacted after viewing this video. They will learn and remember the difference between detonation and deflagration. They will learn about peroxide formation, and about the hazards involved in dealing with peroxide materials. They will be reminded about sodium, an often underestimated element by many who are unaware of its reactivity. If you have any questions or comments, feel free to contact Ron Willey by email using [willey@neu.edu](mailto:willey@neu.edu)

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### ***Process Safety Progress on the Internet***

The Safety & Health Division of AIChE has developed a database of all articles in *Process Safety Progress* and placed it on the Division Web Page (<http://www.chem.mtu.edu/org/aiches&h/publications.html>). The database was originally created in ProCite Version 2.4 and converted to Microsoft Access 7.0 format. Soon the contents will be available in Adobe Acrobat format. If the option for searching PDF files is selected when installing Adobe Acrobat Reader, the database can be searched for keywords. Note: Volumes 1 through 11 were published as *Plant/Operations Progress*.

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## **SACHE News Shared with Chemistry Departments**

Jach Wehman

The first word in chemical engineering creates a descriptive bond with chemistry that must not be ignored. Much of the work by SACHE to improve the understanding of and appreciation for chemical industry safety in the chemical engineering education process is directly applicable to those teaching and studying in the field of chemistry. In fact, the chemist during the development of the basic reactions frequently directs the fundamental process safety of concern to the chemical engineer. The successful spirit of close cooperation between the practicing chemist and the chemical engineer which yields safer work environments throughout industry should begin in the university community. This is a win-win opportunity for improvement.

Beginning with this issue, a copy of the *SACHE News* will be sent to the chair of the chemistry department at our member universities, in addition to the chemical engineering faculty. We hope that the information contained in *SACHE News*, as well as the valuable SACHE safety education products, will be widely shared throughout both chemistry and chemical engineering departments to foster a mutual interest in safety.

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## **Chemical Reactivity Worksheet**

The Computer-Aided Management of Emergency Operations (CAMEO) Team at the Office of Response and Restoration, National Ocean Service, NOAA, and the Chemical Emergency Prevention and Preparedness Office of the EPA have developed a *Chemical Reactivity Worksheet* that can be used to check the reactivity substances or mixtures of substances. The worksheet contains a database of over 4,000 hazardous chemicals and includes information on the reactivity of a chemical with air, water, or other materials. The worksheet allows the user to "virtually mix" chemicals to explore the potential hazards of accidental mixing. Additional information and a copy of the program can be downloaded from <http://response.restoration.noaa.gov/chemaids/react.html> or <http://www.epa.gov/ceppo/cameo/react.htm>.

The CAMEO program is an integrated set of software modules designed to help first responders and emergency planners plan for and respond to chemical accidents. Other

## **SACHE Workshop 2000 - A Working Safety Symposium**

Jack Wehman

The next SACHE safety workshop will help chemical engineering faculty and graduate students to learn about the advanced application of safety principles in the chemical process industries. These workshops, held over the past four years in the early summer, have provided a forum for combining safety technical theory with practical examples from working facilities using lectures and plant tours.

Workshop 2000 will enhance the proven success of the lecture and tour approach by working through an engineering assignment for a new polyether manufacturing facility dealing with the business considerations, scope development, problem definitions, solution approaches and issue explanations. Considering the polyether technology, the Workshop 2000 participants will have exposure to issues of reactivity, relief systems, thermodynamic characterization, toxicology, emergency response, heat transfer, process safety management (PSM) and many other critical safety elements.

The Workshop 2000 participants will have the opportunity to work with experts in plant design and simulation, learn through interacting with each other as well as seeing actual operating polyether facilities and research support labs. The combination of these activities will be an excellent hands-on experience and provide classroom materials for the chemical engineering student studying at the university.

This new 3½ day safety workshop will be hosted by BASF in Wyandotte, Michigan, and will be held 17-20 September 2000. Further details can be obtained through the co-chairs, Dan Crowl, Michigan Technological University ([crowl@mtu.edu](mailto:crowl@mtu.edu)) or Jack Wehman BASF Corporation ([wehmanj@basf.com](mailto:wehmanj@basf.com)).

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elements of the program contain a chemical database to provide guidance for fire fighting, physical properties, health hazards, and first aid. An air dispersion model and a mapping module to display the footprint of a dispersion cloud on an electronic map of the local area are also included. Ordering information can be found at <http://response.restoration.noaa.gov/cameo/cameo.html> or <http://www.epa.gov/ceppo/cameo/react.htm>.

## Process Safety in Education

*Continued from page 4*

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 the 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 students, the professors, and the industry leaders. Much like the "fire triangle" requires all three sides for combustion, this "safety triangle" requires all three sides for success.

**SACHE RECEPTION  
1999 AIChE ANNUAL MEETING  
Tuesday, November 2, 1999  
4:30 PM to 6:30 PM**

Check meetings listings for location.

You are invited to join us at this reception to learn what SACHE has been doing and has on tap for 2000.

This is your opportunity to tell us how you are using our materials, what new products you would like to see, and what formats you would like us to use in the future.

This is also an opportunity to network with other SACHE users.

SACHE member university representatives and universities interested in learning more about SACHE are welcome to join us.

*Owen Kubias, CCPS Liasson*

## SACHE Speakers Bureau

Several members of the Undergraduate Education Committee, Center for Chemical Process Safety, are available to make presentations on a variety of safety topics to classes, student chapters, and local sections. Groups interested in hosting one of the following speakers should contact them directly:

Bob Bethea  
Department of Chemical Engineering  
Texas Tech. University  
P.O. Box 43121  
Lubbock, TX 79409-3121  
806 742-3553

Topics: Process Safety in the Unit Operations Laboratory, Introduction to HAZOP, Infamous Accidents, Use of SACHE Products in Chemical Engineering Courses

Ron Darby  
Department of Chemical Engineering  
Texas A&M University  
College Station, TX 77843-3122  
409 845-3301

Topics: Designing Relief Devices, other topics

Stan Grossel  
Process Safety & Design  
41 Sussex Road  
Clifton, NJ 07012  
973 779-8579

Topics: Process Design for Safety

Charles Sheppard  
Chemical Engineering Department  
University of Tulsa  
600 South College  
Tulsa, OK 74104-3189  
918 631-2644

Topics: Nitroaniline Explosion, Seveso, Flixboro, Pasadena

J. Reed Welker  
University of Arkansas  
Department of Chemical Engineering  
3203 Bell Engineering Center  
Fayetteville, AR 72701  
501 575-6691

Topics: Toxicology, Fires, Explosions

**1999 SACHE MEMBERS**

Arizona State University  
Auburn University  
Brigham Young University  
Brown University  
Bucknell University  
Cal Poly State University Foundation  
Carnegie Mellon University  
Case Western Reserve University  
Clarkson University  
Clemson University  
Colorado School of Mines  
Colorado State University  
Cornell University  
Drexel University  
FAMU-FSU College of Engineering  
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Hampton University  
Illinois Institute of Technology  
Indian Institute of Technology Kanpur  
Indiana University of Pennsylvania  
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Johns Hopkins University  
Kansas State University  
Lafayette College  
Lamar University  
Lehigh University  
Louisiana State University  
Louisiana Tech University  
Manhattan College  
Marshall University  
Massachusetts Institute of Technology  
McNeese State University  
Michigan State University  
Michigan Technological Univ.  
Mississippi State University  
NC Agricultural & Tech. State U.  
New Jersey Institute of Technology  
North Carolina State University  
Northeastern University  
Ohio State University  
Ohio University  
Oklahoma State University  
Oregon State University  
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University of Missouri, Columbia  
University of Missouri, Rolla  
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West Virginia Inst. of Technology  
West Virginia University  
Widener University  
Yale University