AMERICAN INSTITUTE OF CHEMICAL ENGINEERS

CENTER FOR CHEMICAL PROCESS SAFETY

SACHE News

Safety and Chemical Engineering Education - Spring 2000

Status of SACHE

J. F. Louvar, Chair
CCPS Undergraduate Education Committee

SACHE Membership

In 1999 we had 111 university members in SACHE. This is a record.

We understand that some universities are joining SACHE to help them with their ABET audits. Great! As you know, our objective is to develop products that will help universities add an element of safety to their curriculum. Our products are quite diverse; you should be able to choose the products that are especially helpful to your specific programs.

2000 Workshop

Our year 2000 Workshop is scheduled for September 17-20. This is a specially designed workshop for university faculty. It will give the attendees a fundamental understanding of "Chemical Process Safety" as practiced within industry. It will additionally give these professors a package of information that they can immediately use in their university courses. Plant and laboratory tours are a part of this program.

Based on our previous successes and based on the detailed work in progress, this workshop will be a significant experience for all participants. Anyone interested in attending this workshop should contact Dr. Crowl (crowl@mtu.edu.)

2000 Workshop Sponsors

Industry is also pleased with this workshop concept. We already have three companies that are sponsors, and the list of sponsors is growing. So far we have:

- Dow Chemical Company
- Rohm and Haas
- BASF Corporation

A special thanks to our sponsors!

2000 Products

The products scheduled for 2000 include:

- Free CCPS book
- Safety Course (AIChE) for half price
- Video - Explosions (Welker)
- Problem Set on Mass Transfer (Willey)
- NIOSH Pocket Guide to Hazardous Chemicals (CD-ROM)
- Design for Overpressure and Underpressure Protection (Grossel and Louvar)
- Video on Piper Alpha (Willey)
- Faculty Workshop (Crowl and Wehman)

SACHE Essay Award

Students have an opportunity to write an essay on safety and win $500. We will have two $500 awards every year. Details will be published in the Fall 2000 edition of SACHE News.

SACHE Breakfast at AIChE National Meeting

Each department chair (or SACHE interface) should plan to send one or two of your faculty to our SACHE breakfast on November 14 morning during the Los Angeles Annual AIChE Meeting (7:00 a.m. to 8:30 a.m.). At this meeting, we will discuss the status of CCPS and SACHE, and acquire your ideas and suggestions concerning SACHE and our products.

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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.

SACHE News is published two times annually by the Undergraduate Education Committee of the AIChE Center for Chemical Process Safety.

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.

Undergraduate Education Committee

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New SACHE Modules

NIOSH POCKET GUIDE TO CHEMICAL HAZARDS and Other Databases

John M. Yacher

The "NIOSH Pocket Guide to Chemical Hazards and Other Databases" on CD-ROM will be part of the 2000 SACHE Renewal Package. The National Institute for Occupational Safety and Health (NIOSH) offers easy access to the following databases on this CD-ROM:

1. *Immediately Dangerous to Life and Health Concentrations (IDLHs)*
2. *International Chemical Safety Cards (WHO/ IPCS/ILO)*
3. *NIOSH Manual of Analytical Methods (NMAM)*
4. *NIOSH Pocket Guide to Chemical Hazards (NPG)*
5. *Recommendations for Chemical Protective Clothing*
6. *Specific Medical Tests Published for OSHA Regulated Substances*
7. *Toxicologic Review of Selected Chemicals*
8. *1996 North American Emergency Response Guidebook (U.S. Department of Transportation)*

Also included on this CD is the NIOSH Certified Equipment List as of March 31, 1999.

Students in Unit Operations Laboratory or Design Courses can look up the materials they will be handling using this CD-ROM. They can report any or all of the following information:

1. Compare the IDLH values for each chemical they will use with the exposure limit data (NIOSH RELs, recommended exposure limits; OSHA PELs, permissible exposure limits; and ACGIH TLVs, threshold limit values) found in the Pocket Guide to Chemical Hazards and the International Chemical Safety Cards.
2. What are the long term and short term exposure risks?
3. What protective clothing is recommended?
4. Is there a frost bite hazard?
5. What are the fire and explosion hazards?
6. What reactions might occur with other chemicals/ incompatibilities?
7. What are the environmental hazards?
8. What are the first-aid procedures?
9. What emergency response procedures are required?
   a. Evacuation
   b. Fire fighting
   c. Spill or leak control
   d. First-aid
   e. Protective clothing
   f. Environmental protection

An advantage of accessing the files on the CD is that an Internet connection is not needed and the software applications required for this CD are the same as those commonly used for internal access. If an Internet connection is available, these and other databases and documents can be accessed on the NIOSH website (http://www.cdc.gov/niosh) and the Department of Transportation website (http://www.hazmat.dot.gov).

Mass Transfer Problem Set

Ronald J. Willey

This problem set was developed during the winter of 1999 with the assistance of chemical engineering graduate students at Northeastern University. Three texts in mass transfer were used for guidance: *Transport Processes and Unit Operations, 3rd Edition* by Christie J. Geankoplis, *Transport Phenomena*, by R. Byron Bird, Warren E. Stewart, and Edwin H. Lightfoot, and *Separation Process Principles*, by J. D. Seader, and Ernest J. Henley. Problems are primarily arranged following Geankoplis' book. The first 5 problems are easy to solve and simply require finding the appropriate equation in Geankoplis (or similar mass transfer textbook). As the problem numbers increase, the problems become more time consuming.

The main resources for the health, safety, and loss prevention information are the textbooks by Daniel A. Crowl and Joseph F. Louvar, *Chemical Process Safety: Fundamentals with Applications,* Prentice Hall 1990 and the more recent Louvar and Louvar, *Health and Environmental Risk Analysis*, Prentice Hall 1998. Equations necessary for process safety calculations are included within each problem statement so students do not have to purchase these books.

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EDITORS NOTE: The following essay is the second of two winning entries in the 1999 SACHE Student Essay Contest. The first essay by Lucas Osborn, Texas A&M University, was published in the October, 1999, issue of *SACHE News*. Each student received a $500 award and a certificate.

Safety Relevance in Undergraduate Education

Aimee Golder
University of Missouri, Rolla

The study of industrial safety in the undergraduate curriculum should be looked upon as one of the most important aspects of an engineer's education. Industrial accidents often occur because special attention was not paid to safety procedures or equipment was not designed to withstand or prevent the accident. Since 1970, the Occupational Health and Safety Administration (OSHA) has been the government's "watchdog" for enforcing strict safety guidelines in all workplaces with threats of severe fines, penalties, or even shutdown of the facilities. Even with these threats, not all of today's industrial companies comply with OSHA standards, yet the cost to comply with OSHA standards is less than the cost of the plant, equipment, and human losses. Recently, OSHA has delivered stiff fines of $7-8 million dollars to the Union Carbide Corporation's Seadrift, Texas plant; Citco's Lake Charles, Louisiana refinery; and the Dayton Tire Company's Oklahoma City plant[1]. These fines not only affect the fined companies profits, but also serve as a warning to other companies, which encourages them all to keep up a good safety program or correct their current safety deficiencies.

However, fines and penalties are not the only result of not observing safety procedures and designs. Plant explosions or fires can lead to monetary losses in billions of dollars, human losses, and a tarnished public image. In February of 1998, an explosion at York International Corp. in Pennsylvania killed one worker, injured dozens of others, and emitted a large plume of vapor into the environment. Pieces of metal were thrown for 12 blocks, and the explosion was heard 25 miles away. The source of this explosion is unknown, but a vapor had apparently been leaking into the air before the explosion. This vapor was not seen, but it reportedly burned the noses and throats of people near the building[2]. In February of 1999, five people were killed and many others injured at Concept Sciences, Inc. in Allentown, Pennsylvania. A chemical explosion occurred while workers were making hydroxylamine used to etch computer semiconductors. Investigators believe that the explosion was due to "the improper mixing of chemical inside the building." Hydroxylamine can also become volatile if it gets too hot or too dry[3]. Another employee was killed and 45 hurt when an explosion occurred at the Tampa Electric Co. (TECO) power plant in Florida. This blast occurred during a routine maintenance test of a generator[4]. The most recent event comes from Chevron's San Francisco Bay refinery. This explosion occurred on March 25, 1999 and is still being investigated.

These four examples are only representative of the many industrial explosions that occur each year. However, losses due to explosions are not the only result of improper safety precautions. Years after these accidents occur, they are not forgotten by the public or the companies. For example, the accident that occurred at Pennsylvania's Three Mile Island nuclear power plant is still in the news after 20 years. Scientists and physicians are finding new cases of cancer and leukemia linked to this nuclear meltdown. Last year alone, Pennsylvania residents filed more than 2,000 damage claims linked to the disaster. More evidence has been uncovered to show that the size of the radiation releases may have been greater than originally thought[5].

In a related event, the Chernobyl accident of 1986 is still a concern to those living in the Ukrain. In April 1996, a brush fire in the deserted villages surrounding the Chernobyl disaster site was reported to have spread leftover radiation particles into the air. Greenpeace stated that the fire was momentarily intense enough to put radiation into high levels of the atmosphere, which increases the chances of it escaping past the 18-mile exclusionary zone around the plant[6].

From these accident cases, it is easy to see the importance of safety education to everyone from plant employees to upper management. In addition, OSHA is working on changes to the Occupational Safety and Health Act to increase safety standards and penalties for non-compliance. The new proposal would include companies of 11 or more employees and require employee participation in safety training and programs. Most likely engineers will lead these activities, adding incentive to train engineers more rigorously in safety operations and design. Also, engineers need to have an intimate understanding of the OSHA regulations to design equipment and mange and supervise employees in the workplace. Even though an engineer may not work within

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Safety Relevance

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the confines of the plant, they still need to be taught about the hazards they may encounter and the danger of becoming complacent as they become more experienced. Engineers must realize that people don't always follow directions, any job can be done wrong by someone, people are not immune to accidents, and people do not always use common sense[1]. Therefore, if engineers begin thinking about safety in their formal education, it will become a lifelong habit.

However, implementing safety programs into engineering curriculum is not as simple as adding an extra course onto the already extensive four to five year engineering programs. Annette McKay Rossignol and N. Bruce Hanes, both university professors, have studied several methods of introducing safety into the university curriculum[7]. Rossignol and Hanes have proposed three modes of introducing industrial health and safety courses. One proposal is to develop a required undergraduate course for all engineering disciplines. However, this mode was abandoned because it is not possible to get all 19 departments of the Accreditation Board for Engineering and Technology (ABET) to agree to this requirement. This is mostly because engineering school deans claim that it takes the average student "4.5 years to 4.8 years to complete the normal four-year curriculum." So, unless ABET extends the length of accredited undergraduate programs, it is difficult to amend the curriculum to include a safety course.

The second option proposed by Rossignol and Hanes is to develop a safety elective course available to undergraduates. This method has been implemented at Pennsylvania State University and Purdue University. Although this option is viable to ABET, it only reaches a small fraction of all engineering students. But, it designates a starting place to expose some of the new engineers.

The third option is to integrate safety and health material into existing classes, where it will reach all students. While this method does not give the detailed study into safety that industry craves, it does satisfy ABET and most professors. This method was integrated into the coursework at Tufts University, and the success of the program was evaluated from a survey of the five participating faculty and 301 students. The evaluation showed that students felt that safety was an important issue in engineering practice and that safety education should be included in the undergraduate education. Both faculty and students felt the occupational safety and health material raised awareness about safety issues. However, the professors unanimously agreed that there is a lack of good safety engineering course material available. Implementing this option, students were exposed to the safety and health engineering topics that provide a good solid knowledge base. In addition, through this exposure some students may decide to further study the field of safety and become industrial hygienists, which is a job in high demand.

In addition, the Safety and Chemical Engineering Education (SACHE) committee of AIChE's Center for Chemical Process Safety (CCPS) has made it their mission to assist universities in adding process safety courses to their undergraduate curriculum. Their work includes providing funds to universities to pay for faculty and safety engineering materials and developing teaching aids that provide "a) the fundamentals, b) good illustrations, and c) text to assist the professor in developing effective educational exercises[8]."

Since safety is obviously important and can be easily implemented into current engineering coursework, one question remains. Why isn't safety an integral part of every engineer's curriculum? From my perspective as a senior engineering student enrolled in a safety course, I feel like it has been a very important part of my education. Now that I have taken all the required theory and design courses and understand how to engineer $50 million dollar plants, I understand why it is vital to protect the equipment and most importantly, the employees. Why would a company build a multi-million dollar facility, only to see it burn to the ground a few years later? Of course, no company wants to see that happen. Also, if I can decrease or eliminate my employer's chance of having an explosion, accident, or risk of OSHA fines and penalties, I am a valuable employee worthy of getting a raise or a promotion, and, more importantly, in keeping my job. As engineers, it is our job to see the "unforeseen" problems that could arise and protect our plants and employees. We will be the ones held responsible when a plant does not operate correctly. So, if we are going to be held responsible for accidents, shouldn't we know what we are being held responsible for and how to safeguard against it?

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Call for Papers
35th Annual Loss Prevention Symposium
AIChE 2001 Spring National Meeting
Houston, Texas
April 22-26, 2001

Overview of the Symposium

The Loss Prevention Symposium, organized by the American Institute of Chemical Engineers Safety and Health Division, Group 11A, has been held annually since 1967. The objective of the symposium is to promote safety in the chemical process and allied industries by providing a forum for practitioners from industry, academia, and government to share experiences, technological advances, and new ideas.

Original, unpublished material is preferred. Authors are encouraged to submit an Abstract. Accepted papers will be published in the Symposium Proceedings and may also be chosen for publication in the Division journal, Process Safety Progress. The 35th Symposium will consist of six sessions of five to six papers each. The session topics are described below.

1. **Fire, Explosion and Reactivity Hazards** – The analysis, prevention and mitigation of fire and explosion hazards continue to be important issues to the Loss Prevention community. We invite papers that identify, analyze or offer design guidance on fire, explosion, and reactivity hazards.

Chair: Erdem A. Ural
Fenwal Safety Systems
90 Brook Street
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508 429-2990 (FAX)
erdem@world.std.com

Vice-Chair: William A. Thornberg
HSB Industrial Risk Insurers
85 Woodland Street
Hartford, CT 06102-5010
860 520-6090
860 520-6135 (FAX)
william.thornberg@industrialrisk.com

2. **Protection for Special Occupancies** – Loss prevention and fire protection technology is changing to provide protection for new technologies such as semi-conductor manufacturing, cryogenic environments, ultra clean environments, biotechnology, and electronic installations such as computer and telecommunications facilities. Protection for traditional facilities such as flammable liquid bulk storage and warehousing also continues to evolve. Papers that address loss prevention in special occupancies are invited.

Chair: Robert P. Benedetti
National Fire Protection Association
One Batterymarch Park
Quincy, MA 02269-9101
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617 984-7110 (FAX)
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Vice-Chair: Stanley S. Grossel
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3. **Safety Application of Advanced Preventive Maintenance and Inspection Techniques** – This session invites papers on a variety of subject areas including: optimization of safety critical inspection and test programs, risk based inspection, reliability centered maintenance, designing equipment for reliability and testability, implementation of ISA S84.01, and methods used to determine appropriate safety integrity levels.

Chair: Scott W. Ostrowski
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ormsbyrw@apci.com

4. **Providing and Maintaining Integrity of Process Control Software** – This session will focus on software safety rather than computer hardware safety issues. We invite papers discussing techniques for ensuring the safety of software systems, management of software change, procedures for testing and de-bugging control and safety software, understanding software issues in Process Hazard Analysis, human factors in software systems, safety and control software security, and case studies of incidents or near misses caused by software errors or problems.

Chair: Walter L. Frank
EQE International
Broom Street – Unit 3
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Vice-Chair: Daniel A. Crowl
Michigan Technological University 1504 North
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Houghton, MI 44931
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906 487-3213
crowl@mtu.edu

5. **Advanced Applications for Loss Prevention Systems** – Process facilities are being operated with ever smaller staffing levels, with some plants in the near future likely to be run entirely without full-time personnel. This session shares concepts and experiences for meeting the very real loss prevention challenges where the human element is intentionally minimized. Issues include remote system operation, real-time abnormal situation detection and response, significantly higher levels of containment and control reliability, resource sharing and mutual aid, and practical limits of outsourcing.

Chair: Robert W. Johnson
Unwin Company
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Vice-Chair: Gary C. Phillips
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6. **Case Histories and Lessons Learned** – Reviews of Process Safety Incidents and near misses provide valuable learning opportunities. Papers detailing incidents, near misses and lessons learned are requested.

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To Present a Paper - Please contact the appropriate session chair and submit a typed abstract of 150-200 words by June 1, 2000. Include the names, addresses, telephone numbers and affiliations of the authors with the abstract. Electronic submissions by e-mail or computer disk are encouraged. Contact the session chair for the preferred electronic file format for diskettes. Session chairs will select papers to be presented and contact the authors by July 1, 2000. Authors of selected papers will need to complete a Proposal to Present (PTP) on the AIChE Worldwide web site by August 1, 2000. Contact the session chair to make other arrangements if you are unable to submit an electronic PTP. Final manuscripts for publication in the Symposium Proceedings are due to the session chairs by November 6, 2000.

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Mass Transfer

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Problem statements are set up for easy copying and distribution to students. They will take 1 to 3 days to be completed by undergraduate students as homework. Occasionally, faculty seek novel problems for Ph.D. qualifier exams. Feel free to use any of these problems. Competent graduate students will be able to provide reasonable solutions within an hour. Solutions are included; however, as with any new text book, these may not be the optimal solutions. Feel free to send corrections and improvements to Willey@neu.edu.

SACHE Web Page

SACHE has a page on the AIChE web site (www.aiche.org). Look for announcemts and information at www.aiche.org/sache/.

A Case for Pre-Startup Safety Reviews

Author Unknown

We've all done it. Had an accident because we failed to think before we acted. The following article is not meant to poke fun at safety, but to point out that most accidents are avoidable, if we think before we act. In the following letter, a bricklayer wrote:

I am a bricklayer by trade. On the day of the accident, I was working alone on the roof of a new six-story building. When I completed my work, I discovered that I had about 500 pounds of bricks left over. Rather than carry the bricks down by hand, I decided to lower them in a barrel using a pulley which, fortunately, was attached to the side of the building at the sixth floor. Securing the rope at ground level, I went up on the roof, swung the barrel out and loaded the bricks into it. Then I went back to the ground and untied the rope, holding it tightly to insure a slow decent of the 500 pounds of bricks. You will note in block number 11 of the accident reporting form that I weigh 135 pounds. Due to my surprise at being jerked off the ground so suddenly, I lost my presence of mind and forgot to let go of the rope. Needless to say, I proceeded at a rather rapid rate up the side of the building. In the vicinity of the third floor, I met the barrel coming down. This explains the fractured skull and broken collarbone. Slowed only slightly, I continued my rapid ascent, not stopping until the fingers of my right hand were two-knuckles deep into the pulley. Fortunately, by that time, I had regained my presence of mind and was able to hold tightly to the rope in spite of my pain.

Approximately at the same time, however, the barrel of bricks hit the ground . . . and the bottom fell out of the barrel. Devoid of the weight of the bricks, the barrel now weighed approximately 50 pounds. I refer you again to my weight in block number 11. As you might imagine, I began a rapid descent down the side of the building. In the vicinity of the third floor, I met the barrel coming up. This accounts for the two fractured ankles and the laceration of my legs and lower body. The encounter with the barrel slowed me enough to lessen my injuries when I fell onto the pile of bricks, and fortunately only three vertebrae were cracked. I am sorry to report, however, that as I lay there on the bricks - in pain, unable to stand, and watching the empty barrel six stories above me - I again lost my presence of mind . . . I LET GO OF THE ROPE.