An Approach to Strengthening Compliance with ABET Safety Criteria

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Motivation

- Every semester it seems like there is a major chemical process safety incident reported that ends up in our classes as a teachable moment
  - Spring 2015 – ExxonMobil Refinery Explosion – 2 injuries
  - Fall 2014 – DuPont LaPorte Facility Toxic Chemical Release – 4 deaths, 1 injury
  - Spring 2014 – Freedom Industries Chemical Release Charleston WV – contaminated water supply
  - Summer/Fall 2013 – Williams Olefin Plant Fire Geismer, LA – $9M property damage
  - Spring 2013 – West Fertilizer Explosion and Fire – 14 deaths, 100's injuries
  - …
- In 2012 ABET program criteria for Chemical Engineering changed to include
  - "The curriculum must include the engineering application of these basic sciences to the design, analysis, and control of chemical, physical, and/or biological processes, <u>including the hazards associated with these processes.</u>"
  - Note that this is not a required Student Outcome (a-k)

Approach and Challenges to Safety in the Curriculum

- Multiple approaches with many opportunities available
- Stand alone courses (credit hour requirements)
- Integration within existing curriculum:
  - Laboratories (Personal and Occupational Safety, Safety Instrumented Systems)
  - Reaction Engineering (Chemical Storage Safety, Runaway Reactions)
  - Controls (Fault Trees, Failure Modes, Fail Safe)
  - Design (Process Hazards Analysis and everything else)
- Faculty expertise

University of Illinois Approach
- Fully integrate through curriculum

- Freshmen project – Formal instruction
  - Incidence sequence and thinking about safety
  - Deliverable: poster session to seniors (Expand)
    - Example: Each group of 3 students is assigned a recent (within ~10 years) chemical safety incident from completed final reports by the Chemical Safety Board (~50-60 groups) – Poster Session where seniors view posters and offer feedback
- Sophomore & Junior projects – No instruction
  - Deliverables: 4 course based design projects – safety section
    - Example: Reaction Engineering (Junior) – Required safety component based on project eg: Release calculations; waste treatment design; runaway temperature & available HTXR area calculations; batch reactor procedure analysis

University of Illinois Approach
- Fully integrate through curriculum

- Senior – Unit Operations – Formal instruction
  - Personal, lab, equipment safety
  - Deliverable: Test performance
- Senior – Process Design – Formal instruction and Self-taught
  - Process Hazard Analysis methods HAZOP in detail
  - Required to show SAChE competency among group (9 modules among 4 students)
  - Deliverables: Environmental, Health, and Safety section of final report
    - Required to complete 2 PHA's – on reactor and column
    - One HAZOP (formally covered in class)
    - One non-HAZOP (student chosen and self taught)

The Ohio State University
- Across three upper level courses - Learning Objectives

- Junior/Senior Unit Operations
  - Be familiar with safety issues important in the chemical industry, including laboratory safety protocols, materials safety data sheets, and proper handling, storage and disposal of chemicals
  - Become familiar with basic principles of emergency vents
- Senior Design 1 – closed ended problems
  - Familiarization with Process Safety (Covers PHA's and LOPA – no project, smaller assignments)
- Senior Design 2 – open ended projects
  - Be familiar with process safety issues involved in the laboratory environment and chemical process design.

OSU Content from Senior Design 2

- SACHE Modules
  - All students must complete the following 5 modules
    - Safety in the Process Industries
    - Dust Explosion Control
    - Risk Assessment
    - Runaway Reactions
    - Chemical Reactivity Hazards
- OSU Environmental Health & Safety (EHS) Modules – 5 required
  - Lab and personal safety – PPE, chemical spill cleanup, compressed gas, lab standards
- Safety and risk analysis on open ended project

Accreditation Comments

- One size does not fit all programs
  - ABET knows this
  - We should have students apply engineering principles to the hazards associated with processes
    - Not necessarily test their knowledge of the subject
- Both programs went through accreditation recently with no program shortcomings at the exit statement
  - The Ohio State University Fall 2011 reaccreditation visit resulted in verbal appreciation for addressing the safety criteria prior to implementation
  - University of Illinois Fall 2013 reaccreditation visit was smooth

Addressing Further Challenges

- Faculty expertise is not easy to develop
  - Use advisory boards
  - Use university resources – R1 schools likely have a laboratory safety course
  - Use Safety and Chemical Engineering Education (SAChE) http://www.sache.org/
  - Send faculty to the AIChE-CCPS-SAChE Faculty Workshop
    - Ron Willey R.Willey@neu.edu