Connecting safety culture to the educational mission

Ralph Stuart, CIH, CCHO

Chemical Hygiene Officer, Keene State College

Secretary, Division of Chemical Health and Safety, American Chemical Society

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My Lab Safety History

• I worked in environmental chemistry labs at **Cornell** and **UVM** for 5 years, then started the lab safety program at **UVM** in 1985

• In 2011, I went back to **Cornell** as Chemical Hygiene Officer for 3 years

• In 2014, I moved to **Keene State** to be the Environmental Safety Manager and Chemical Hygiene Officer
Modern Lab Safety

21st Century Science involves both Technical and Cultural Challenges

20th Century: Controls Based on Rules, guided by Chemical Intuition

21st Century: a Safety System based On Risk Assessment

Culture is rooted in the organization’s mission

Culture Change through Safety Education

Manage Hazards

Lab Safety iRAMP

- Lessons Learned
- Recognize Hazards
- Plan for emergencies / Protect the environment
- Assess Risks
- Manage Safety
- Documentation
- Improved Safety Culture

- More science
- New interdisciplinary sciences: nano, r/sNA, big science
- Discovery education
The Academic Mission

How does Lab Safety Connect to This Mission:
@ Keene State?
On other campuses?
What are the Academic Values around Safety?

1. Safety is everyone's responsibility. It operates at an institutional level. *(community service)*
2. Good science is safe science. *(research)*
3. Safety training and education are essential elements of research and education *(teaching)*
4. An improved culture of safety is necessary *(continuous improvement - not “compliance” or “zero incidents”)*
5. Diverse methods and flexible approaches are necessary *(institutionally-driven)*

MIT/Harvard example
Safety and the ACS Mission

• The ACS has over 150,000 members from academia, industry and government.
• Its structure is similar to academia:
  – **32 technical divisions** (analogous to departments),
  – **42 governance committees** (analogous to a Faculty Senate) and
  – **Staff** (analogous to administration) headquartered in Washington DC and Columbus, Ohio.
• It publishes 50+ academic journals, C&E News and Chemical Abstracts Services; it also has **advocacy** and **leadership** roles in the chemical enterprise.
## Recent Lab Incidents

<table>
<thead>
<tr>
<th>Event</th>
<th>Univ. of Minnesota 2014</th>
<th>Univ. of Hawaii 2016</th>
<th>Texas Tech 2016</th>
<th>Univ. of Bristol 2017</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unexpected Compound Exploded</td>
<td>Handling of flammable gas</td>
<td>Explosion of energetic compound</td>
<td>Inadvertent synthesis of TATP</td>
<td></td>
</tr>
<tr>
<td>Physical Result</td>
<td>Injury, Damage to lab, loss of science</td>
<td>Loss of arm, damage to lab</td>
<td>Superficial injuries</td>
<td>Hazmat response; disruption of work</td>
</tr>
<tr>
<td>Other Results</td>
<td>Medical costs</td>
<td>$70,000 fine; civil lawsuit against PI and institution</td>
<td>Medical costs</td>
<td>Student reported problem immediately and response ensued</td>
</tr>
<tr>
<td>Cause</td>
<td>Change of Chemicals -&gt; Inadequate Risk Assessment</td>
<td>Inadequate Risk Assessment -&gt; Improper Equipment; Failure to heed warning signs</td>
<td>Change in Process (skipped a step) -&gt; Inadequate Risk Assessment</td>
<td>Change in Process (change in order of chemical additions) -&gt; Inadequate Risk Assessment</td>
</tr>
</tbody>
</table>
The Goals of Lab Safety Cultural Education

- **Establish a Vision:** not zero incidents, but continuous improvement (aka zero unreported incidents)
- **Develop Safety Leadership and Empowerment skills:** bureaucratically known as roles and responsibilities
- **Share Lessons Learned:** both general tips and reminders as well as specific unexpected reactions
The Cultural Starting Point: The Cringe Factor

Chemical fire, explosions, toxicity

Biosafety; lasers, 3D printing

Radiation
The Safety Education Process

Fast Thinking: Cognitive Biases
- How do we react when we need to act fast?
- How do we decide when there’s not enough meaning in what we remember?
- What should we remember?
- How do we handle too much information?

Situational Awareness

Culture

Education and Training

Public Perception (the Cringe Factor)

Slow Thinking: Bloom’s Taxonomy
- Creating
- Evaluating / Analyzing
- Understanding / Applying
- Remembering

Sports Analogs
- Games
- Team Practice
- Individual Skill Development

Fans

Slow Thinking:
- How do we react when we need to act fast?
- How do we decide when there’s not enough meaning in what we remember?
- What should we remember?
- How do we handle too much information?
Technical Chemical Safety Resources

- NFPA 45 requirements for instructional and educational labs, 2015
- Safety in Academic Chemistry Laboratories, 8th edition, 2017
- Prudent Practices, 2011
- Identifying and Evaluating Hazards in Research Laboratories, 2016
- PubChem Laboratory Chemical Safety Summaries, 2016
- Pistoia Chemical Safety Library, 2017
Risk Assessment Resources

National Research Council, 2011

ACS, 2013 and 2016 (at the behest of the CSB)

IDENTIFYING AND EVALUATING HAZARDS IN RESEARCH LABORATORIES

* Laboratory Risk Assessment Methods Described by ACS 2013

Control Banding
Chemical Safety Levels (CSL) identifying facility requirements

Job Hazard Analysis
Identifies best practices for a process

What If
Identifies emergency scenarios and PPE needs

Standard Operating Procedures
Document management choices and supports training

Checklist
Guides oversight requirements
Other Technical Tools

National Library of Medicine’s Pubchem Laboratory Chemical Safety Summaries (2015)
• Modelled on LCSS format from Prudent Practices
• Safety information on about 103,000 chemicals
• Goes beyond SDS by including information on reactions between specific incompatible chemicals

Pistoia Alliance Chemical Safety Library (2017)
• Pre-competitive collaboration between pharma companies
Cultural Lab Safety Resources

High school

Undergraduate education labs
- Creating Safety Cultures in Academic Institutions from ACS, 2013
- Laboratory Safety Guidelines, ACS Committee on Professional Training, 2015

“Mentored” research labs
- A Guide to Implementing a Safety Culture in our Universities from the APLU, 2016
- ACS Safety Guidelines for the Chemistry Professional 2017

Research lab work
- Safe Science from the National Research Council, 2014
- ACS journals policy, 2016
A 2016 Cultural Initiative: ACS Publications Safety Policy

Ingredients for a Positive Safety Culture

ACS journals enact new safety policy
Authors to be required to address novel or significant hazards

By Jyllian Kemsley
**Spiral Learning Model for Lab Safety Competencies**

<table>
<thead>
<tr>
<th>Developmental stage</th>
<th>Knowledge</th>
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</thead>
<tbody>
<tr>
<td>Professional chemist</td>
<td>Identify and estimate significance of emerging risks</td>
</tr>
<tr>
<td>Graduate researcher</td>
<td>Develop procedures with risks in mind</td>
</tr>
<tr>
<td>Mentored researcher (CURE, REU, etc.)</td>
<td>Review procedure and locate information to identify hazards</td>
</tr>
<tr>
<td>Student</td>
<td>Based on prerequisite requirements</td>
</tr>
</tbody>
</table>

**Cultural Aspects**

- Accountable for group safety performance
- Oversee others’ safety practices
- Raise questions and concerns related to risk
- Respect Rules
Future Work

• Surveys of the Chemistry Community
  • needs for technical support
  • best practices in risk assessment
  • safety culture perceptions and education needs

• Maintaining Educational and Technical Support
  • Further development of guidance documents and ACS safety web site
  • RAMP templates and content in outreach materials
  • Outreach with these tools

• Matching cultural message to the appropriate media
  • Safety tools and templates
  • Case studies
  • Videos and social media
Ongoing ACS Lab Safety Culture Resources

  A blog covering chemical safety *events and lessons learned*. The lead writer is C&EN associate editor Dr. Jyllian Kemsley.

- **Committee on Chemical Safety**: [http://www.acs.org/safety](http://www.acs.org/safety)
  *Peer reviewed* documents from the CCS on a variety of both technical and educational topics

- **Division of Chemical Health and Safety**: [http://www.dchas.org](http://www.dchas.org)
  *Chemical safety research* (broadly construed) from DCHAS technical symposia and articles from the *Journal of Chemical Health and Safety*
Questions?

**Education and Training**

_Frazz_ by Jef Mallett

**Education is about adoption of concepts and training is about adaptation to them?**

**That works.**

**So coaching sessions are education and this is training.**

**I like it.**

**What are swim meets?**

**That's where I go to get schooled.**