31 "Inherently Safer" chemistry

32 Maintaining chemical inventories

33 American chemical disasters

34 Green Chemistry and safety practices

35 Approaching improved laboratory safety practices

36 ACS Safety Videos Update

37 Erratic behavior in the laboratory

Differences between Academic and Corporate Labs

The question: I'd like to know what the difference are between an academic lab, and a corporate lab are.Â I have only ever worked in academia.

Ralph's response: I asked this question during the webinar as well and got several very interesting responses from members of the audience who have worked in both settings. They agreed that there were differences that they primarily attributed to more focus on management training for people who work in non-academic environments.

They all noted that faculty are asked to address the many different aspects of the academic mission (teaching, research and service) with little or no training in any of these topics. There were two 2017 articles in C&EN that address this challenge pretty explicitly:

The challenges of moving between academia and industry

A year in the life of a new professor

I would be interested in further comments on this; feel free to e-mail me at rstuartcih@me.com

Connecting to central EHS offices

The Question:Â It's important to recognize that EHS offices actually know what they are doing.

Ralph's response: My experience is that EHS offices answer to a much broader audience than most chemists recognize. Within the constraints of their available resources, EHS offices address technical chemical safety issues from a viewpoint that emphasizes transferability, scalability and sustainability. These concerns may not apply directly to a specific research project and chemists often need more specific answers than the available hazard information can support. In my opinion, this situation points out the importance of a working partnership between EHS staff and lab staff to maintain a safe workplace for the scientific community as a whole.

Safety Training Resources

The Question: Do you provide Hazardous Materials and Chemical Hygiene Plan trainings for colleges? Not necessarily for all students but for lab staff. If yes, how much is the cost for you to come to a college?

Ralph's response: There are consultants within DCHAS which can provide this service. Contact me off line for help in locating these professionals.

Mixed use spaces and PPE

Do you have any recommendations for safety glasses use in a space that is mixed office and lab use? Do you think they should be mandatory at all times if youâ€™re at your desk in a lab?

Ralph's response: This is an interesting challenge accentuated by modern laboratory design; the programmers of building are often reluctant to give up any opportunity for more lab space and this can result in lab staff having desks in chemical work areas. In this context, the decision about when safety glasses are mandatory should be based on a risk assessment that includes not only chemical hazard concerns but the ergonomic impacts of wearing PPE when not working with chemicals.

ACS safety audit template

The Question: Does ACS provide a template or standard format for an internal safety audit? How often should it be performed?

Ralph's response: No, ACS does not provide an authoritative template for this work. It is possible to use Web search engines to locate a variety of templates that campuses around the use to build your own from, though.

Chemical Inventory Management

The Question: Not sure if this is appropriate, how do other universities pay for disposal and keep an accurate inventory as chemicals come into your system.

Ralph's response: These safety management support services vary significantly from institution to institution, depending on their local resources and regulatory history. A key challenge for both of these issues is the administrative overhead often requires support from central administration to maintain over time.

Safety Education support

Do you have any suggestions as to where I can find grants or funding sources for aiding in promoting safety in education labs?

Ralph's response: It depends on what the magnitude of the project you're considering is.

Sammyeâ€™s response: One possibility is to pursue an ACS Innovative Project Grant with a local section or a division. I participated in one this past year that a local section in my state obtained to provide professional development for teachers in the areas of Green Chemistry and Chemical Safety.

Spiral Learning and Safety Education

Two questions: Can you provide a typical example of spiral chemical safety education transfer in a typical university research lab?

Could you recommend some textbook with this spiral learning approach to safety in chemistry lab?

Ralph's response: An example was included in the webinar for flammable liquids. Other examples can be found in the textbook "Laboratory Safety for Chemistry Students" by Hill and Finster

Sammyeâ€™s response: There is some additional guidance on this in the article referenced at the end of the webinar Thursday, â€œChemical safety education for the 21st century â€” Fostering safety information competency in chemistsâ€•

Middle and High School Lab Safety

The Question: Are there resources that a middle school teacher could use to find a local person to help evaluate a labs risks and hazards.

Ralph's response: I would check with your local National Science Teacher's Association or American Chemical Society section for assistance in identifying such resources. Links to a list of ACS local sections can be found at this web site.

The Question: At some point I hope youâ€™ll address safety education and practices appropriate to primary and secondary schools, specifically for events such as Science Olympiad.

Ralph's response: The resource that Sammye mentioned is designed to address this use. It isÂ Safety Guidelines for Chemical Demonstrations from theÂ Division of Chemical EducationÂ can be found atÂ http://www.divched.org/committee/safety

Sammyeâ€™s response: About five years ago or so, the ACS created the American Association of Chemistry Teachers (AACT) to assist K-12 educators. Teachers can join AACT for a reduced membership rate to view all materials, but the safety information is available here.

ACS Safety Resources

Are the ACS Safety Resources identified in this presentation available to non-ACS members? Also, what hazard assessments has ACS conducted that are available for viewing?

Ralph's response: Yes, all of the resources discussed are available for download by anyone at http://www.acs.org/safety

The ACS does not have generic hazard assessments publicly available, because these should be specific to the circumstances of each laboratory. However, many ACS scholarly journals present hazard information for specific processes they describe that would be very helpful in developing a specific hazard assessment for your lab's work.

Sammyeâ€™s response: Several years ago, Leah McEwen (Cornell) and I published a ACS Book Symposium chapter on using risk assessment to teach chemical safety and chemical information literacy. That chapter has some general guidance and is available to read at the Cornell eCommons Digital Library.

There are also examples for the various tools in Identifying and Evaluating Hazards in Research Laboratories.

What do you mean by "community"?

Does "community" refer to general public or other personnel within same lab or other labs in the vicinity?

Ralph's response:Â Good question. I mean "All of the above." when I talk about "community". In my experience, there is a growing appreciation and concern by labmates, people in the same building and the public at large that a chemical hazard is not limited to the person working with the chemical. A fire in a laboratory can result in the disruption of science thoughout the building for weeks.

Class Labs and Safety

The Question: For the vast majority of students lab is a necessary evil and all they care about is what can I do to get in and out as fast as possible, how does this approach address this?

Ralph's response:Â My experience is that this attitude is partially driven by fear of the unknown hazards in the lab.Â By including risk assessment in the planning to be done before the lab session, the students are less likely to spend speed through their lab work and thus spend time in lab reworking their chemistry to get the data they need.

Sammyeâ€™s response: Even a simple prelab assignment such as looking up the GHS information on the chemicals that will be used for the day can spark great conversions. You may even learn something!

Have you seen the MoDRN how to read an SDS lessons?

https://modrn.yale.edu/sites/default/files/files/How%20to%20Read%20an%20SDS%20for%20Biology%20Classrooms.pdf

Ralph's response: I hadn't see this before. Thanks for pointing it out.

Sammyeâ€™s response: This one is new to me as well and this is a subject that interests me very much. At some point, I realized that telling a student to â€œRead the SDSâ€• prior to working with a chemical was not useful if the student did not have the required competencies to understand the information. A large portion of the paper referenced in the webinar, â€œChemical safety education for the 21st century â€” Fostering safety information competency in chemistsâ€• is spent describing the competencies needed to read a SDS and some methodologies for teaching them.

Chemical Storage Practices

The Suggestion: Look up "Chemical Reactivity Worksheet" to check compatibility for storing chemicals. It helps to see what may react with what.

Sammyeâ€™s response: One of my favorite sites is NOAAs other site, â€œComputer-Aided Management of Emergency Operationsâ€• or CAMEOÂ®.Â I can take students here and show them how they can mix chemicals or chemical families â€œin silicoâ€• to predict if there will be a reaction. They can download and print the report which can be placed in lab notebooks or lab reports. I love to start by asking, â€œCan nitric acid and ethanol be placed in the same waste container?â€•

EHS offices and 21st Century Safety

Question: Is it your experience that university safety and health offices are ready for 21st-century safety approaches, moving beyond rules. Are EHS offices leading or following, from the ACS safety perspective?

Ralph's response:Â My experience as a EHS professional is that this can vary depending on the both individual and the institution involved. Institutions with a history of significant legal interactions around EHS issues may be more reluctant to delegate the leadership and empowerment responsibilities to support a generative safety culture.

It is also true that many EHS professionals have seen situations which make it difficult for them to delegate these responsibilities. However, many of us look at the growing size of the lab safety job and realize that our current level of resources requires an effective partnership between laboratory leadership and the institutional administration as described in Safe Sciences from the National Academy of Sciences.

Safety Experience as a Professional Credential

The Question: How about positioning safety experience as a competitive advantage when applying for jobs?

Ralph's response: This is a good point, which is often overlooked in a chemist's education. I know of many students who report that they got a job because they were able to demonstrate good safety awareness as part of the job interview process.

Sammyeâ€™s response: I also have ancedotal evidence that students well educated in chemical safety concepts will shine in the workplace or interviews. Even things as simple as knowing what the acronyms GHS or JHA stand for will make an impression!

Student PPE Oversight

The Question: How do you get students to understand that safety precautions in teaching labs? There are less risky so it is hard to establish the important of wearing Personal Protective Equipment.

Ralph's response: One challenge in this situation is identifying and explaining the reason for wearing PPE, since there are multiple potential reasons - to control the spread of chemical contamination, to be prepared for unexpected events, or to enhance enclothed cognition. Another important element here is the ergonomic challenge presented by much lab PPE, particularly ill-fitting or inappropriate PPE. A third element is the need for easy oversight of the PPE practices in the lab, which is why there is a desire to have a single standard for PPE use lab in spite of the challenges wearing gloves, googles, etc. can present to individual students. All of these factors must be balanced in establishing PPE expectations in the lab setting.

Sammyeâ€™s response: Obtaining PPE compliance in teaching labs is an area that I have the least chronic problems with these days. If you recall from the webinar, we spoke of moving towards risk-based safety for 21st Century education. It was also stated that while rules address lower order levels in Bloomâ€™s taxonomy, these lower levels are necessary. If your instructors and TAs will be consistent in reinforcing the PPE requirements your department has set and you have the support of your Chair, the students will respond. I rarely must send a student home because they do not have full coverage between their pants and the top of their shoes more than once! It is my opinion that, at least at the introductory level, we are not just â€œenforcing rulesâ€• for the sake of the rule, but to establish a mindset in the student. As students progress, we can start teaching them how to make informed decisions about what PPE is appropriate for the work they are doing (spiral).

Once students get to the research lab, hopefully they have formed good habits, but the PI must lead by example or students will fall backwards unless they have truly been empowered to â€œdo the right thingâ€•. For me, it always helps to realize that this is what I do when nobody is looking.

Chemical Labelling

The Question: Â Is everyone using the GHS labels or are people still using HMIS labels?

Sammyeâ€™s response: I am not sure if you are asking about manufacturer labels or secondary labels? Distributers and manufacturers are required to provide GHS information on the chemical products they distribute or make. Additional labeling information such as NFPA and HMIS is allowed so long as it does not contradict the required GHS label elements. There are some exceptions to this such as pesticides which fall under EPA labeling regulations.

Coverage of the OSHA Lab Standard

The Question: Industrial quality control labs (and others) donâ€™t fit the definition of a laboratory for management under the lab safety standard. They must operate under Hazcom.

Ralph's response: I'm not sure if that's true. As I understand it, OSHA's definition of laboratory is based on the amounts of chemicals used rather than where they are used. Their definition of laboratory reads:

Laboratory use of hazardous chemicals means handling or use of such chemicals in which all of the following conditions are met:

(i) Chemical manipulations are carried out on a "laboratory scale;"

(ii) Multiple chemical procedures or chemicals are used;

(iii) The procedures involved are not part of a production process, nor in any way simulate a production process; and

(iv) "Protective laboratory practices and equipment" are available and in common use to minimize the potential for employee exposure to hazardous chemicals.

I think that this presents an interesting challenge in some research departments, where physicists, biologists, engineers or other scientists may not recognize that their work is considered chemistry by OSHA.

Safety Training Practices

The Question: In a small undergraduate academic environment, how often should safety training sessions or refreshers be provided to professors/staff? What are some tips to ensure safety compliance in an academic setting, even when the risks seem minimal?

Implementing Safety in Academia

The Question: I spent a long time in industry before coming to a research 1 university to teach and do research. My primary concern is the inadequate safety culture in the academic setting. It isn't about a lack of rules, and it isn't (in my case anyway) a result of the PI lacking safety focus and energy. The issue is a lack of practical tools to enforce the safety culture at the university. I'd love to hear ideas about how to improve.

Ralph's response: This is a topic of ongoing discussion in many professional organizations. One set of tools is described in a recent document from theÂ Association of Public and Land-grant Universities Task Force on Laboratory Safety. Their report can be found here.

Sammyeâ€™s response: One way that I have been trying to shift this is by attempting to get safety performance as a measured component of tenure and promotion â€“ so far I have not made headway, but I think it worth pursuing by those who are in the position at universities to lead this type of effort.

Getting involved in DCHAS

How does one get more involved in the efforts of the Division of Chemistry and Safety?

Ralph's response: Check out this web page or contact me at membership@dchas.org and I can help you identify the opportunity that best suits your interests.

Academic interest in safety

Knowing that lab safety is a concern, have you identified an interest in the academia world?

Sammyeâ€™s response:Â Yes. In my department, I have noticed tangible benefits of having an embedded safety professional that is faculty. As indicated with the â€œStoryboardingâ€• example, researchers seek me out for advice, to report near-misses, provide extra guidance for students when needed. They know my purpose is to educate. I have â€œinfiltratedâ€• many classes to teach risk assessment and that has had the added benefit that faculty are learning it!

Safety Communication

The Question: Â My career has been in industry and I have found that the safety specialists vary dramatically from people who want to learn the goal of the chemist to others that just quote rules randomly. How can I improve safety through thoughtful communication?

Another question:Â I've learned the hard way that in the area of safety communication it doesn't matter how right you are, how smart you are, or how educated or qualified you are, all that matters is whether your audience trusts you. Chemists have lost the trust of the public - how can they go about restoring it?

Sammyeâ€™s response: One exercise that I like to do now initially came from a student question. One day I was walking through an introductory lab (not mine) setting up for the next section as part of my stockroom duties and I saw a student take some food out of their book bag.Â The student was done with lab and on their way out, but I still reminded them that there should be no food in lab.

The student said, â€œWhy canâ€™t you eat in lab?â€• and at first, I thought they were kidding. However, the student was completely serious. My first response was to tell the student that that was actually a really good question (as opposed to laughing and saying how can you not know that?). It made me realize that often, students do not know where these rules come from. Though it seems obvious to all of us all the ways things can go wrong it is not obvious to them. I took the time to explain about chemical transfer and how easily it can happen with out one knowing where chemicals are in use and give some examples of bad events that had occurred.

The point being â€“ take all opportunities to explain to people what best practices are and why they are important. Donâ€™t assume that answers are obvious.

User Friendly Safety Tools

The Question: The ACS safety resources are all excellent. However, the attention span of the intended audience is nowhere close to time needed to absorb this information. How do you see addressing this problem?

Sammyeâ€™s response: This is a great observation, and one that the CCS Taskforce writing Identifying and Evaluating Hazards in Research Laboratories struggled with. Knowing that it is not possible with any one publication to create a document that can teach someone to be an EHS professional, we focused on creating a resource that explained the types of tools available for risk assessment and recommended that those interested in implementing the tools should assemble a â€œteamâ€• â€“ including their EHS professionals. With a team, some of the burden of having to figure the whole process out on their own is alleviated. Also, see the answer to the next question!

Hazard Assessment Tools Usability

The question: Two general comments on the hazard assessment tools ACS is promoting:

- First, as a safety professional, I think these are incredibly helpful and a great resource.

- I am very concerned, though, that they will be overwhelming for those who aren't familiar with the concepts. As a result, I am hesitant to refer our researchers to these as a resource but am rather working to 'distill' them into simpler form.

Sammyeâ€™s response: This is a very valid concern, especially if one thinks about K-12 teachers. In 2015, the National Fire Protection Association (NFPA) released the updated â€œNFPA 45 - Standard on Fire Protection for Laboratories Using Chemicalsâ€•.Â Chapter 12, which deals with flammable materials in educational laboratories (those that are K-12), specifically states that instructors must be knowledgeable about fire emergencies, PPE use, emergency planning, and hazard assessment. Ralph and I prepared a simplified tool for this audience (or anyone learning really) based on asking and answering five questions â€“ â€œFive Key Questions for Safe Research and Demosâ€•

Are there specific chemical or physical reactivity hazards associated with the use of the chemicals involved?

Does this experiment require the use of a fume hood or other local ventilation system?

What Personal Protective Â or other safety equipment is appropriate for the chemicals and processes in this demo?

Are unusual emergency response protocols necessary for work involving this demonstration?

What waste disposal protocols are required to dispose of the created or leftover solutions?

"Inherently Safer" chemistry

What about addressing the issue of "Inherently Safer" chemistry in the experimental process. It becomes a tremendous mindset as chemists/chemical engineers move forward through all facets of a career in research.

Ralph's response: In my mind, based on the definition in Wikipedia, "Inherently Safer" chemistry is similar to Green Chemistry, but more focused on the overall process, whereas Green Chemistry focuses on choosing alternative chemicals for the process. In this way, these two approaches can work hand-in-hand to improve the safety of chemistry in general.

Sammyeâ€™s response: I think that this would be a great addition to any education program but is especially necessary for those who will be going into fields working with the high process hazards. Learning the basics of risk assessment would need to be an early part of the spiral for these students.

Maintaining chemical inventories

Ralph's response: This is an ongoing challenge for most chemistry laboratories and laboratory institutions because of the rapid turnover of both chemicals and people involved. Software is available that can assist with this challenge, but human resources and administrative infrastructure are the key to making these systems work. One software platform that is designed to work at the institutional level is UNH CEMS.Â Quartzy is used by individual laboratories, but I'm not clear how well it scales across multiple laboratory departments.

Sammyeâ€™ response: As Ralph has stated, this will always be a moving target and very susceptible to â€œgarbage in, garbage outâ€•. At my institution we use a purchased web-based system. While it is not perfect (none of them are), I am satisfied with the performance. As with everything, some faculty are more receptive than others to investing the time to learn the system and use it (you can lead a horse to waterâ€¦). Our system is used in conjunction with a barcode printer and MSDS Online.

American chemical disasters

Ralph's response: There is a long history of chemical disasters, both in the USA and globally, and which is the worst probably depends on how close you are to a particular event. Wikipedia has an interesting list that is helpful in browsing a selection of such events.

Sammyeâ€™s response: One very good website for learning about chemical and other industrial incidents is the U.S. Chemical Safety and Hazard Investigation Board. Their investigation case studies and videos are very through and I often use them in my Chemical Safety course to teach students about latent and active causes of incidents.Â In addition to Ralphâ€™s observation that the perception of the event severity is influenced by how close you are to it or the aftermath (injured loved one), the other factors to consider are the numbers of lives lost, the severity of property loss ($$ amount), and/or environmental damage.

As far as world disasters, I think that most still consider the Bhopal, India event the worst chemical disaster in terms of life lost and continuing impact on the local population.

Â

Green Chemistry and safety practices

Question: I missed the very start of the webinar but are you using green chemistry practices to help fully integrate safety practices?

Ralph's response: The connection between Green Chemistry and lab safety was discussed in a webinar I participated in last year. Check out Â Creating a 21st Century Chemical Research Laboratory: Hazard Assessments and Fundamentals

Approaching improved laboratory safety practices

The original question: All chemists want to stay safe, and most of them are truly experts in the chemistry itself. However, anticipating abnormal hazards and forward thinking "safety culture" seems to be a challenge for long-time chemists who were trained decades ago. As an ES&H professional, do you have any advice for meeting resistance in improving safe practices.

Ralph's response:Â Thanks for pointing this out.Â My biggest successes are working as an EHS professional with laboratories have been when I have focused on continuous improvement of safety practices over time and connecting safe practices to successful science. I have seen too many situations when irreplaceable samples or data are lost in lab fires or other accidents, so the science suffers. In my experience, chemists who are leaders in safety tend to have had that experience personally or close-up. Discussing this aspect of the safety program can be a powerful motivator.

Sammyeâ€™s response: I would just add that we do sometimes have to recognize our limitations as well. Like Ralph, I strive for continual improvement. I learned to recognize that a small improvement (better secondary container labeling for example) is still improvement.Â I may not be able to convince this scientist to completely rethink their practices, but every improvement is a win.

ACS Safety Videos Update

The Question: Any possibility of a newer video or online video resource for undergraduate safety training?

Ralph's response: Yes, the ACS is actively pursuing this in a variety of formats for different audiences. It's not clear when a video itself will be published, as it will reflect the new information available in the Guidelines document and SACL, but we hope that it will be available in an year or two.

Erratic behavior in the laboratory

The Question: Any suggestions for dealing with someone showing erratic behavior in the laboratory?

Ralph's response: As discussed during the webinar, this is a tricky issue. It is probably best dealt with on a one-on-one basis, which means that the instructor of a class lab should ask for assistance from other campus resources (e.g. the department chair, student assistance offices or campus safety) in addressing this concern so that the instructor can focus on teaching the rest of the class.

Sammyeâ€™s response: When this question was posed to me during the webinar Q & A, I was thinking â€œfacultyâ€•. For students, we have very well-defined protocols for this. Check your office of student affairs and/or Code of Student Conduct. In North Carolina it is unlawful for students to be disruptive in class â€“ or any â€œlearning environmentâ€•. Â Our campus police may be called if needed. Your state may have similar laws.

An audience member added: Our university has a general site for all such cases as the abnormal behavior that at the same time, the info goes to the Department Head. If itâ€™s a student, the VP of students will be in formed. If itâ€™s a staff, it goes to HR