The Laboratory Standard Syllabus for Academic Safety Programs

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Introduction

In most schools and colleges, there is a general appreciation that safety is important. However, it is at least as common for there to be no significant safety program certainly no Safety course; and probably little, if any, specific treatment of Safety as a subject in any course. Reasons given are many and diverse Theres just not enough time.; Weve never had a serious accident.; Recent budget cuts make it impossible to even think of any new programs.; We have no Safety expert on the staff.

Well, this paper will not offer rebuttals to these common excuses. Rather, well try to suggest a path that might lead to a reasonably complete safety program in a relatively short period of time and at minimal expense. Along that path, the development of a Chemical Hygiene Plan (CHP), there will be many pieces that can be used to add Safety to the curriculum, even if a full safety program, or a Safety course does not materialize.

When inserting material into any curriculum, there will always be very strong resistance. Although academicians are usually portrayed as being quite liberal, they are certainly extra conservative when it comes to guarding the Program as though it was received via some supernatural process.

So, if we are to have some hope of influencing many institutions, we must appeal, in a very rational and unemotional way, to one or more generally recognized authorities. For better or worse, in this paper well use some rather traditional authorities - experts and the government.

We will discuss the development of the OSHA Laboratory Standard[1] as a model regulation, and one that is performance based; that is, it places the responsibility on individual organizations. The Lab Standard charges each organization with one or more qualifying laboratories, to produce a comprehensive set of guidelines (the Chemical Hygiene Plan (CHP)) on how to best minimize the occupational exposure of employees to hazardous chemicals at that facility.

The Lab Standard was developed subsequent to the first publication of Prudent Practices[2] and it relies heavily on the guidance found in that landmark document. Thus, it should be the goal of all academic laboratories to develop an appropriate CHP. However, that can not be accomplished in a few weeks, or months when done as an overload by folks already teaching a full load. Nevertheless, each step along the way toward a full CHP will produce an integral part of the organizations safety program, and will provide material suitable for classroom/laboratory use in teaching safety. It may even be beneficial to plan on working piece by piece. Then, as a new piece of the puzzle we call a CHP is developed, it gets student tested and probably amended, before becoming part ot he CHP.

Hopefully, organizations with an existing CHP will also find material of use in evaluating and improving their CHP.

Another value of this paper may be to provide instructors with a good overall understanding of the Lab Standard. With this understanding, it should be easy to find pieces of the CHP requirement that apply directly to current lab situations. Relatively simple revisions of current lab directions and policies should then be possible. Implementing these changes should be assisted by reference to the Lab Standard regulation and to Prudent Practices as authorities. Each time, we should, as scientists, be sure we understand the underlying scientific (and/or legal!) principle involved. Then the safety

rule will become an application of another scientific principle in the curriculum. The farther we can get from demonstrating Safety as a set of Dos and Donts, and move toward safety as an application of scientific principles, the easier it will be to get students to accept these ideas, and colleagues to accept the increasing emphasis on safety. Predictably, well also notice a concomitant increased level of satisfaction of the employers who hire our students for lab based jobs.

Background

In the1970s, the country was focused growing expectations for health and safety in the workplace, protection of the environment in general, and concern for the problems associated with hazardous waste in particular. Love Canal was a major rallying point. An entire neighborhood in upstate New York, had been built on ground previously used as an industrial burial ground for waste chemicals. Emissions from that waste were seeping into the homes and causing unusual illnesses. Ultimately, much of the neighborhood was evacuated and abandoned.

To meet the cry to do something about situations like Love Canal which were being discovered throughout the country, Congress had recently passed the Resource Conservation and Recovery Act (RCRA)[3] designed to provide a Cradle to Grave system for the management of hazardous waste from all sources.

Although laboratories were thought to produce one percent or less of the nations hazardous waste, many laboratories academic, government, and industrial were having substantial problems in understanding and complying with these complex regulations.[4] With the support of the National Institutes of Health, the National Science Foundation, the Environmental Protection Agency, the Alfred P. Sloan Foundation, the American Chemical Society, and the Chemical Manufacturers Association, the National Research Council assembled a Blue Ribbon panel of widely acknowledged experts to develop a set of recommended procedures for the safe handling and disposal of hazardous substances in laboratories to use in establishing a Cradle to Grave system for the management of hazardous waste from laboratories. Thus, following the great success of the first Prudent Practices, another Prudent Practices was issued.[5]

Both books were received remarkably well throughout academia, government and industry. They were the true seeds of a new Culture of Laboratory Safety that was elaborated in the 1995 Prudent Practices[6] That edition was also well received and sold well, and is now available on-line[7]

The Laboratory Standard

What is the Laboratory Standard ? The Lab Standard is the short name for the OSHA[8] Regulation, first published in the Federal Register as 29CFR1910.1450[9]
on 31 January 1990, under the full title Occupational Exposures to Hazardous Chemicals in Laboratories: Final Rule.

The Supplementary Information section of this issuance, contains the history of the deliberations and public hearings that led to the Lab Standard. From reading over those twenty six pages, it becomes clear that Prudent Practices greatly influenced the regulation. Likewise, the Appendix of the same issuance that gives guidance on what would constitute a satisfactory Chemical Hygiene Plan, frequent quotations from Prudent Practices are made and it is included in the lengthy list of references (now quite out of date).

The Laboratory Standard was developed as an employee protection. Then why should we consider using it for our students, most of whom are not employees of the laboratory?

To answer that in the context of Prudent Practices, we should ask, ***Now, what would a Prudent Person do in this situation?*** Should our students be provided with any less protection from hazardous chemicals in the laboratory just because the regulation does not specifically refer to them? In the event of a disabling accident, would we like to address a jury with a defense that says, Yes, we knew that the chemicals were hazardous. We have provided suitable

training and other protection for all of our employees. However, the injured was a student, not an employee, and therefore not covered by the Lab Standard. Ill bet you get uncomfortable and a bit queasy just reading that, right?

For the sake of argument, lets presume weve made at least a decent argument for using the Lab Standard as a model for our CHP and ultimately for our Safety Program. Lets take a look at the components of the Standard, and suggest academically important points along the way. Hopefully, you will see many other things that will be adaptable to things taught in your current curriculum. Maybe youll even make a few changes over this academic year to incorporate some safety principles gleaned from the Lab Standard.

By the way, one of the tenets of the Lab Standard is that covered employees must receive as a part of their training, a coverage of the Lab Standard itself!
The section that was added to subpart Z part 1910 of 29 CFR to constitute the Lab Standard **1910.1450 Occupational Exposure to Hazardous Chemicals in Laboratories**, is outlined below. While much of this is legalistic regulatory talk, it does provide a good overview of both the things that are fundamental to laboratory safety, and important to developing a common culture of professional safety, and of course important to obeying the law.

(a) **Scope and Applications** the Lab Standard is designed to cover all employers engaged in laboratory use of hazardous chemicals as defined below. Exempt are laboratories that use chemicals in such a way as to present no potential for employees exposure such as medical office labs that use only contained test strips and kits. Why this exclusion? Would too many people be covered? Are those excluded subject to similar hazards as those working in regular wet labs? How could we change our labs to come closer to the presumed safer situation in these excluded labs? Would that be a step forward, or backward in the culture of chemistry?

(b) **Definitions** Clear definitions of more than thirty key terms used in the Lab Standard are given. Many in a format suitable for instructional use and as an introduction to further elaboration.

(c) **Permissible Exposure Limits (PELs)** For OSHA regulated substances for which a PEL exists[10], employee exposure must be kept below the PEL. These measures of safety provide excellent opportunities for instruction. If a pint bottle of chloroform is spilled in the laboratory, is it likely that the PEL will be exceeded? How was that value determined? Animals, why not humans? Im going to use 1,1,1-trichloroethane, can I use the PEL for chloroform to measure the maximum exposure to this close relative of chloroform? Why not?

(d) **Employee Exposure Determination** The employer must monitor whenever theres reason to believe that a PEL or an action level may have been exceeded; and affected employees must be informed of the monitoring results. How might we conduct monitoring for a gas like vinyl chloride? How large a sample must be taken? How many samples from which areas of the room? What techniques are most appropriate for measuring vinyl chloride? After reading the MSDS and perhaps the OSHA Standard for Vinyl Chloride, would you be comfortable working with it? Can your exposure to this material be satisfactorily minimized with equipment available to you? What are the signs of overexposure?

(e) **Chemical Hygiene Plan** This is probably the most novel requirement of the Lab Standard. As a performance based standard it was left to the employer to determine how best to minimize employee exposure to hazardous chemicals in the laboratory. This employer developed plan has to be written, and available at all times to affected employees. It would also be one of the major things an OSHA Inspector would look for when visiting a laboratory. Gee, maybe our lab really should have a set of published rules of behavior, and I should use them for more then punishment. Maybe I can teach several scientific concepts using these rules as the vehicle. If the students realize the rationale for safety rules, theyll probably respect them much more regularly.

(f) Employee Information and Training To regularize the transmission of appropriate safety information, this information and training component is required in every CHP. Employees must receive training based on

the CHP at the time of initial employment, and at such intervals thereafter as determined by the employer. Common usage has developed that this training should be done semi-annually, or at least annually. The training must also include the contents of the Lab Standard. If this is a requirement of all lab employees, how can we do any less for our students, the employees of tomorrow? Will students take lab rules more seriously after reading the Lab Standard? Why? Why not?

(g) Medical Consultation and Medical Examinations Access to appropriate medical examinations and monitoring is mandated under certain clearly set conditions. Are these adequate for protection of an employee in a commercial lab? What should we do for students? Perhaps, the reason for carefully scrutinizing the lab conditions, the chemicals used there, and the experiments performed there is now more apparent? Should we redesign the lab? Thats almost a definite YES! but may not be practical. ***Now, what would a Prudent Person do in this situation?*** Given that we are now a bit more knowledgeable of both the conditions in our lab, and of the pertinent regulation (the Lab Standard) how do we react? Do we review our current experiments and replace the most noxious materials used with chemicals posing a lesser hazard, but sufficient to demonstrate the same scientific objective of the experiment? Have we carefully described just what the Objective of each experiment really is? Does that objective justify the hazard posed?

(h) Hazard Identification Through labels and Material Safety Data Sheets (MSDS), the hazards posed by any substances in the lab must be clearly described, and the lab worker must be trained in how to read and understand the same. For any chemistry lab, it would seem to be a pertinent objective to insure that the students understand the hazards posed. If this can be accomplished by the student looking it up so much the better! Best might be to have a critical discussion of the experiment after the students have searched out the information and now must decide how to proceed, based on the facts!

(i) Use of Respirators This simply describes the requirement that if respirators are required, then it is the responsibility of the employer to provide them along with appropriate training and monitoring of use. Should we all use respirators to better safeguard against the hazards of volatile compounds? Isnt more protection better protection? After a short description of what a respirator is, and perhaps passing one around, wouldnt a typical enlightened student discussion be interesting to observe? Dont you believe that a e issues involved?

(j) Recordkeeping Records of monitoring of employee exposure and medical examinations must be maintained. Who does this protect? How does it provide anyone any protection?

(k) Dates After promulgation in the Federal Register on January 31, 1990[11], the Lab Standard became effective on May 1, 1990, and required that an employer developed Chemical Hygiene Plan CHP) be implemented by January 31, 1991

(l) Appendices These contained material derived from Prudent Practices, organized to provide some guidance in the preparation of a Chemical Hygiene Plan. This material is non-mandatory. Many pertinent references to the safety literature are also included, but are now generally outdated.

By now, you have a taste of what is in the Lab Standard. Perhaps you can see how it is compatible with many of the things we already do. Hopefully, it also suggests some new things that we might consider doing. Perhaps everything in our instructional and research labs is not entirely perfect. Maybe we could reduce a few hazards here and there? Maybe in that process we would teach our students a few good ways to look at lab safety. Maybe they would be in the habit of asking, ***Now, what would a Prudent Person do in this situation?***

Appendix A National Research Council Recommendations Concerning Chemical Hygiene in Laboratories (*Non-mandatory*)

These Principles are easy to understand, and in themselves provide most of the big picture of laboratory safety. Extending them to particular specific lab situations again provides teachable moments . When treated imaginatively, they will help the student to think critically about situations that are truly real life! For the sake of brevity, I will just list most of them.

A. General Principles

1. Minimize all chemical exposures due to the wide variety of chemicals handled in a laboratory and the lack of adequate knowledge of the health effects of most, it is only prudent to minimize all chemical exposure. Rather than develop distinct handling procedures for each of the many chemicals, it is more practical to design general precautions for handling chemicals. As a cardinal rule, skin contact with any laboratory chemical is to be avoided.

2. Avoid underestimation of risk it is prudent to consider all compounds (and mixtures) of unknown toxicity to be toxic. Special precautions should be employed when dealing with substances that are known to present special hazards

3. Provide adequate ventilation
4. Institute a Chemical Hygiene Program
5. Observe the PELs and TLVs

B. Responsibilities

1. Chief Executive Officer The buck must stop somewhere. On a typical campus it does NOT stop at the level of the Professor,nor at the Department Chair. Rather, it is the CEO (President, Chancellor) who legally has this responsibility for safety.
   Time spent with this individual by a smooth talking and OSHA knowledgeable faculty member could have surprisingly beneficial effects on the department. Plan such a visit carefully, but do I!
2. Supervisor of Administrative Unit
3. Chemical Hygiene Officer Someone needs to be so designated. It really needs to be an active member of the department, broadly knowledgeable of the activities of the department
4. Laboratory Supervisor
5. Project Director
6. Laboratory Worker Students paid for lab work are employees and can fall under the Lab Standard!

C. The Laboratory Facility

1. Design
2. Maintenance
3. Usage
4. Ventilation

D. *Components of the Chemical Hygiene Plan* [12]

1. Basic Rules and Procedures
2. Chemical Procurement, Distribution, and Storage
3. Environmental Monitoring
4. Housekeeping, Maintenance and Inspections
5. Medical Program
6. Personal Protective Apparel and Equipment
7. Records
8. Signs and Labels
9. Spills and Accidents
10. Training and Information

11. Waste Disposal

D. General Procedures for Working with Chemicals

1. General Rules for all Laboratory Work with Chemicals
2. Allergens and Embryotoxins
3. Chemicals of Moderate Chronic or High Acute Toxicity
4. Chemicals of High Chronic Toxicity
5. Animal Work with Chemicals of High Chronic Toxicity

E. Safety Recommendations

F. Material Safety Data Sheets

Useful suggestions on how to develop each and every point above in your CHP, are found in the Appendix to the Standard. However, guidance is also available by examining current CHPs of facilities like yours. There are several books on the subject. In the twenty first century, I believe we might also consider doing a GOOGLE (or equivalent) Search on Chemical Hygiene Plan.

I hope this helps to set the mood for what I believe will be a lively On-line Conference. I hope youll check in frequently and participate in the discussion of many of the papers.

We should also send hearty and sincere thanks to Don Rosenthal at Clarkson, and to Brian Tissue at Va Tech for their creative, and untiring work in providing us the wherewithal of holding open for a like this. ***Thanks BRIAN and DON!!***

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[1] 29CFR1910.1450 refers to volume 29 of the Code of Federal Regulations. Volume 29 covers the regulations promulgated by the Department of Labor.

[2] Prudent Practices for Disposal of Chemicals from Laboratories, National Research Council, National Academy Press, Washington, DC 1983

[3] http://www.epa.gov/epaoswer/general/k02027.pdf

[4] Prudent Practices for Handling Hazardous Chemicals in Laboratories, National Research Council, National Academy Press, Washington, DC 1981

[5] Prudent Practices for Disposal of Chemicals from Laboratories, National Research Council, National Academy Press, Washington, DC 1983

[6] Prudent Practices in the Laboratory Handling and Disposal of Chemicals, National Research Council, National Academy Press, Washington, DC 1983

[7] http://books.nap.edu/books/0309052297/html/index.html

[8] Occupational Safety and Health Administration of the US Department of Labor

[9] 29CFR1910.1450 refers to volume 29 of the Code of Federal Regulations. Volume 29 covers the regulations promulgated by the Department of Labor.

[10] 29CFR1910 Subpart Z

[11] Federal Register, Vol. 55, No. 21, Wednesday, January 31, 1990, 3300-3335.

[12] Developing a Chemical Hygiene Plan, Jay A. Young, Warren K. Kingsley, George H. Wahl, Jr., American Chemical Society, Washington, DC, 1990.