Online Chemistry Course (OLCC)

Chemical Safety: Protecting Ourselves And Our Environment

Paper: 5

Discussion: October 3 - October 9, 2004

Title: *Laboratory Hardware and You: The Interface*

Author: John E. Pingel

Affiliation: University of Illinois at Urbana-Champaign, Urbana IL

Posted: 10/16/2004

Website: http://science.widener.edu/svb/olcc_safety/index.html

Laboratory Hardware and You: The Interface
John E. Pingel
University of Illinois

I chose to write about the interface, or interaction between us, as the equipment user, and the laboratory equipment because the interaction is not addressed specifically as a topic in the texts that are assigned reading, but needs to be discussed. Equipment, for the purpose of this paper, will be defined very broadly as most things related to laboratory work in the lab outside of chemicals. Some of the elements of this paper have a larger scope of application; that is they apply to more than just the equipment in a laboratory. Because of this, some might be discussed in other papers also, but all are interconnected and applicable to equipment, so are included here.

The degree to which we remain safe in our interaction with equipment can be impacted by limitations and tendencies we have, some of which I will discuss in this paper. I'll also write about equipment limitations, equipment interaction with the lab environment and with us, and provide some additional insight and discussion on a few of the vignettes in *Prudent Practices in the Laboratory*.

First, I'd like to talk about some of our human physical limitations that can compete with our intent to use or operate equipment safely or interfere with our ability to make wise decisions regarding work with equipment.

Tiredness or hunger can distract us, allowing us to be exposed directly to the temperatures, pressures, physical hazards, etc. that come with the equipment we are interacting with. We know that prudent practice is to not eat or drink while in a lab, and we wouldn't normally sleep in a lab, but there may be times when it may be tempting to do so. It is important for us to plan ahead so that we are not hungry or tired when we are working, or we can plan to take a break outside of the lab to eat or rest, or start work again the next day.

Taking drugs, including but not limited to medications and alcohol, can make working with lab equipment (or chemicals) inadvisable. Labels on medications may provide warnings, but it's important for us not to rely on labels alone to tell us if we will be able to work safely. I can remember reading labels on cold medications that said not to operate "heavy equipment" while taking them, and I can remember thinking, “Well, I'm not going to be operating a bulldozer or a steamroller today”, as "heavy equipment " is often referred to in this context.

Much later, I was at a civilian police academy class where a judge talked about the differences between “driving while intoxicated”, which is usually thought of as being connected to alcohol, and being “under the influence”, which can be applied to prescription or non-prescription drugs or anything else that we take into our bodies that impacts our reasoning or judgement. I hadn't before noticed the distinction between the two legal terms, and the fact that there were also serious legal consequences associated with "being under the influence" led me to think through the potential impact of drugs other than alcohol. The judge also referred to cars as "heavy equipment", a connection I hadn't made before. Being "under the influence" can equally affect the safe operation of any equipment including lab equipment, not just "heavy equipment".

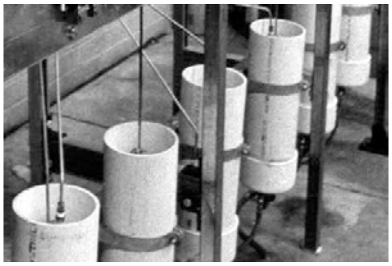
Outside of our physical condition are thought processes that can interfere with safe operation of equipment. As different individuals, and sometimes depending on the circumstances, we vary in our willingness to voluntarily take on risks and

expose ourselves to hazards. Lab examples might include our deciding to work with a chipped beaker (shown, and not safe practice) or our willingness to take potentially unwise shortcuts in established procedures. We need to develop an awareness of our tendency to take on risk and curb what we do so that we do not expose ourselves to potential harm.

Impatience can very quickly make any situation unsafe. A good example of how impatience can impact safety in varying degrees in life would be how closely we follow other vehicles on the freeway. Some of us choose to follow closer than others, and the distance that each has determined "safe" may be less if the driver becomes impatient. The distance could change from "safe" on a fairly open

road, to "safe enough" in heavy traffic, to "get out of my way!", if behind someone driving slowly in the left lane, at which time safety may become seriously compromised in favor of our belief that it’s our right to travel fast, or whatever other belief we have that drives our impatience. It is important to be patient in a lab; by the nature of the work, laboratory work often takes time.

Somewhat different from purely taking risks or being impatient, is that working with lab equipment can become repetitive or overly familiar, which can lead to our easing off on the prudent behavior we started out with when first working with the equipment. Repetitive work does not need to mean performing a task in repeated successions, rather it may mean performing a task twice in one week, if the same or a similar task is performed over a longer period of time. "Easing off" on necessary prudent behavior is what happened to me in the "Imploding Dewar" vignette on page 131 in *Prudent Practices*. I was the researcher who set up the dry ice traps and had the Dewar implode. The Dewars were like wide-mouth thermoses, maybe about 16" tall by 8" in diameter, with glass vacuum liners. I repeated this task most mornings, and as I'd never had trouble with a Dewar imploding before, as I look back on it, I was increasingly less respectful of the hazards and structural limitations of the Dewars until one broke. The photo shows some of the traps after they were changed to PVC pipe traps to avoid the implosion issues.



There is also a tendency for us, particularly when we are younger, to think we are invincible, that nothing is going to hurt us. This way of thinking, though incorrect, follows from the fact that we've made it this far through life, most of us without serious permanent injury, and is upheld by the relative lack of awareness we have of injuries others have suffered with equipment. The concept of invincibility doesn't only apply to males, but it is a significant enough problem that the phrase, "young male invincibility syndrome" is a recognized term. It shows itself in attitudes like people not wanting to wear eye protection. In the vignette "Ampoule Explosion in a Refrigerator" on page 113 of *Prudent Practices*, the researcher also wasn't wearing any eye protection at the time of the explosion, and was very fortunate (lucky is a more accurate term) that she didn't lose an eye. The photo shows the door where the explosion occurred.

Our safe behavior, either while with others or by ourselves, can also be greatly impacted by our tendency to allow ourselves to be controlled by peer pressure and perceived personal image. We have expectations of ourselves that may be counterproductive towards working safely. An example might be as simple as not wanting to ask for help when we really need it, or may be subtler or more complicated, but may have serious consequences. Our safety should be more important than what others think about us.

Next, let's talk about the equipment side of the interface. It is important to also consider the equipment we are using, the hazards associated with the equipment and the environment in which the equipment is being used. Equipment can involve inherent hazards that we are normally aware of, such as temperature, pressure, etc., but there is more to consider.

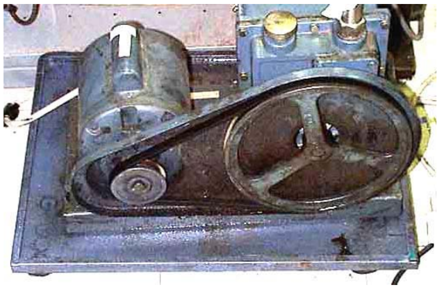
While we know it is critical to the safe use of equipment for us to know how to use the equipment, most of us tend not to want to read directions or procedures. We may find that instructions from manufacturers are written to be understood at lower grade levels or conversely may be difficult to understand because of the use of words or concepts that we are not familiar with. Additionally, the manufacturer may also mix in text to protect the company from legal action against the company. The assumption should always be that laboratory procedures are written a particular way for a particular reason. Understanding this all, we can make a conscientious decision to look at the directions and procedures, with the intent of learning what we don't already understand. If we still don't understand the directions after reading them, it is ok to explain to someone that we don't understand the directions and would like to be shown how to do something. Words, sometimes even with pictures and diagrams, cannot replace being shown a technique or other action.

Bill Nye has used a phrase that has wonderful insight into equipment design: "Good engineering invites right use"[1]. It would follow that equipment could be engineered such that we will want to use it safely. Equipment, however, often is not engineered with safety as a principal priority in design. Cost, appearance, manufacturing ease, material limitations, functionality and various other tradeoffs often take priority in the manufacturing of a product. Likewise, equipment is not always manufactured to optimize ergonomic considerations, and if not, then additional procedures that address those concerns may need to be developed and followed. In the photo is a vacuum desiccator. It is the policy in our chemistry department that vacuum glassware be shielded to provide implosion protection. This desiccator will not be used for vacuum work, so does not need to be shielded, but is labeled accordingly.

Somewhat separate in thinking from the knowledge of how to operate equipment, is the knowledge of how equipment may malfunction. Things may not happen the way we expect. Proper maintenance of equipment is often crucial to the safe use of the equipment, and this is where the term "preventative maintenance" comes from. It means performing maintenance on equipment before the equipment has a chance to malfunction. Routine inspections of lab equipment can help in determining the need for repairs, and required maintenance needs to be intentionally scheduled. Found in an inspection of equipment, the tubing in the photo, which was on a piece of high pressure equipment, had been worn to the point of near rupture.

Maintenance must be done correctly. The photo shows that a researcher had repaired a frayed

cord with electrical tape instead of getting the cord replaced, which would have been the right repair. If you are unsure of how a repair should be handled, contact the manufacturer of the equipment.



Often for safety reasons, equipment needs to be used in its complete form. The belt guard has been removed from this vacuum pump, which has left it in an unsafe condition. It should be assumed that every part of a piece of equipment is there for a reason.

I mentioned structural limitations before and should say at this point that using equipment for purposes for which it was not intended also can cause unintended consequences. Equipment is usually designed for a specific purpose, and not designed such that it can be used for a different purpose. Tools and tape come to mind as having specific and limited uses, but lab equipment often also has only specific application. Tube fittings (shown) and valves are a couple examples of equipment that is designed for specific applications. Use of any equipment should be limited to its intent.

Beyond the intended use of the equipment is the environment in which it is used. A laboratory chemical hood, for example, may isolate and exhaust vapors from chemicals used in the hood very well under ideal conditions in a test lab. If that same hood is put into a location where there is competitive airflow, such as near a fresh air diffuser that blows air down across the face of the hood, the effectiveness of the containment of the hood can be highly compromised. When setting up any equipment, whether for permanent or temporary use, ask yourself if the environment it is being placed in is as intended by the manufacturer or if hazards are being created by the location of the equipment.

Much of what has been discussed in this paper is intended to convince the reader to be proactive in cultivating and developing an awareness of issues and concerns of working with equipment. Understanding our limitations, assessing and controlling our potentially negatively impacting tendencies, reading directions, following well-thought-out procedures, familiarizing ourselves with the intent of use and limitations of design of the equipment are all important to working safely with equipment. It is likely that the reader can add insight from personal experience to what has already been said, or come up with additional elements of the interface. Please feel free to do so in the discussion of this paper.

Reference

1. Bill Nye, University of Illinois Engineering Open House, March 8, 2002