SAFE SCIENCE

Actions for Principal Investigators and Department Chairs

Interest in promoting safety in academic research laboratories has grown in recent years, following high-profile incidents in which researchers were injured or killed. Many colleges and universities want to go beyond complying with regulations to fostering a safety culture: affirming a constant, institution-wide commitment to safety and integrating safety as an essential element in the daily work of researchers.

A report from the National Research Council, *Safe Science: Promoting a Culture of Safety in Academic Chemical Research,* identifies steps that everyone involved in research and other activities using chemicals—from researchers to principal investigators to university leadership—should take to create and promote this approach to safety.

As principal investigators, you have enormous influence over the culture in the laboratories, which you lead. In many ways, you set the tone for the standard of safety that will be implemented. The principal investigator and the entire institution are responsible for promoting safety and providing the resources and training needed to work safely. Day-to-day actions and practices that lead to safe laboratories demand that you, as PIs, encourage participation, commitment, and leadership among your research team (or group), whose safety is at stake.

ELEMENTS OF A STRONG LABORATORY SAFETY CULTURE

An ideal laboratory safety culture ensures that anyone who enters a laboratory, from inexperienced students to senior investigators, understands that they are entering an environment that requires special precautions. They are aware of the hazards posed by the materials they and others in the lab are working with, and they are prepared to take immediate and appropriate measures to protect themselves and their co-workers, especially in the case of unexpected events. At a minimum, laboratory safety includes:

- awareness of the physical and chemical properties and health hazards of laboratory reagents and equipment being used, gained by conducting hazard analysis,
- availability and use of proper apparatus and infrastructure needed to carry out the procedure safely,
- knowledge of and ability to execute any additional special practices necessary to reduce risks,
- use of proper personal protective equipment,
- access to a well-organized workspace that facilitates unrestricted movement about the laboratory and appropriate segregation of materials and processes, and
- familiarity with emergency procedures, including the use of safety showers, fire extinguishers, and eye stations.

A strong, positive safety culture encourages all laboratory workers to place the highest priority on these practices. It is not enough to provide safe equipment, systems, and procedures if the culture of the organization does not encourage and support working safely.

One of the barriers to the development of safety culture in academic laboratories is the attitude that safety practices inhibit research productivity. But the occurrence of a serious incident in a laboratory, in addition to being a tragedy in itself, stops research and is certainly a dramatic impact on research progress, as anyone who has experienced or witnessed such an incident can attest.

It is part of the academic culture for researchers to work long hours, late at night, and often alone. These practices may reflect a pressure to produce results, influenced by power dynamics that are antithetical to the advancement of a strong safety culture. No amount of productivity justifies carrying out hazardous procedures alone and with inadequate sleep.

Safety is a core element of responsible research, not an impediment to it. Good science is safe science, fostering a productive and secure work environment. Like publishing papers and acquiring grants, conducting research safely is key to the success of a research group, and it must be held in high academic esteem.

ACTIONS FOR PRINCIPAL INVESTIGATORS

Academic research faculty play primary roles in laboratory safety and in developing and maintaining an effective safety culture within their research groups. Principal investigators should take the following steps to promote this kind of culture:

Encourage open and ongoing dialog about safety. Graduate students and other research staff are dependent, financially and educationally, upon principal investigators' grants and research projects. This sense of dependence may inhibit them from raising safety concerns because of fear that the principal investigator will feel that they are less focused on

productivity. In addition, the risk of losing peer collegiality or approval might make co-workers reluctant to confront fellow students who are not following good safety practices. Principal investigators should take active steps to counter these dynamics and foster a culture where safety is discussed regularly and where students can raise concerns without fear of retaliation. For example, some departments regularly begin each laboratory meeting or faculty meeting with a "safety moment" when any safety-related issues or concerns can be discussed, and these are widely viewed as successful. Further engagement with Environmental Health and Safety, to help develop these safety moments, would encourage even greater collaboration.

Serve as a role model by exhibiting good safety behavior.
If principal investigators enter the lab to talk to students without proper attire and personal protective equipment, this sends a message that those higher up on the laboratory hierarchy routinely engage in unsafe behavior, which may inhibit those lower in the hierarchy from raising safety concerns. Principal investigators should wear long pants, closed-toe shoes, and personal protective equipment whenever they go into the lab, even just to talk to a student who is working. Failure to dress properly sends the wrong message and reinforces the impression that safety is not a high priority for the principal investigator and the group.

Empower researchers to assume leadership roles in establishing safety practices within research groups and for entire departments.
In general, the laboratories with the best safety culture are those where the individuals working at the bench are actively involved in establishing safety culture and safety practices—a finding consistent with much of what has been learned from experts on safety culture in other industries. Departments and principal investigators should empower students and postdocs to assume leadership roles in establishing safe practices within research groups and also for entire departments. A department safety committee driven by graduate students and postdocs, along with faculty involvement, can be a powerful platform for promoting safety culture.

Ensure that a hazard analysis is conducted prior to conducting any experimental procedure.
Hazard analysis is a process to assess risks and to ensure that those risks are mitigated or eliminated before initiating any laboratory work. Many types of hazard analysis exist, and particular types may be suitable to certain situations; regardless of the approach used, it is important for researchers to assess the hazards in any experiment before it is undertaken. The principal investigator and all researchers involved in an experiment should incorporate hazard analysis into lab notebooks prior to an experiment and into thesis and dissertation proposals. If a procedure yields unexpected results, the hazard analysis should be revisited.

Insist that everyone who works in the lab receives proper safety training.
Most lab researchers in academia are still in the training phase of their professional development, and students arrive at laboratories with widely varying—and sometimes very little—knowledge of safe practices. Department chairs and principal investigators should ensure that everyone who works in the lab receives comprehensive, lab-specific safety training. Requiring researchers and other lab workers to complete safety training before they are issued laboratory keys or passwords is a simple way to ensure that researchers have been properly trained. Because a large proportion of research workers in U.S. laboratories are from other countries, principal investigators should also ensure that cultural or language barriers do not impede either training or ongoing discussion of safety issues.

Complement initial basic safety training with ongoing actions and activities to encourage safety and promote a strong, positive safety culture in the research lab.
This step will ensure that collective experience and knowledge about safety are integrated with actual lab work, practiced, and maintained. Among these activities should be—

- **Walkthroughs and unannounced inspections.** These should be carried out regularly to assure that personal protective equipment is being used, hazard analysis has been conducted, etc. These should be non-punitive, at least at the outset, since the inspections are intended to promote safety culture, not produce "gotcha" rule violations. Including researchers' peers—probably from other laboratories—in inspection teams promotes the right kind of discussion.

- *Coaching and mentoring.* One strength of scientific research—a strong apprenticeship ethic where more experienced researchers mentor younger scientists in doing research—should be leveraged to enable new researchers to receive hands-on training in safety practice from more-experienced researchers.

- **Reporting system.** A reporting system should be established that aims to reduce the potential for incidents by giving researchers a place to report near misses and injuries, share lessons learned, propose ideas, and give feedback to the department. A near miss is an undesirable or unexpected event that could have resulted in an injury or property damage had the timing, space, or sequence of events happened under slightly different conditions. It also represents a learning opportunity for sharing experiences with others. Allowing anonymous reporting of near misses may increase the likelihood that they will be reported.

To develop a strong safety culture, it is crucial that principal investigators establish a nonthreatening atmosphere for free expression of safety concerns or questions. For example, if near-miss reporting is to make an impact, the identity of the person involved and the person who reported it should not matter. Instead, the focus should be on addressing the threat of the danger and eliminating it as quickly as possible. A positive safety culture supports the free exchange of safety information and assigns greater importance to solving problems than to placing blame.

Be aware that stress can undermine safety culture and performance.
Given the highly competitive nature of academic research, researchers and principal investigators often feel stress from striving to meet deadlines, make reports, obtain funding, and achieve milestones in completing one's degree. The level of stress can distract researchers from disciplined safety practices and may overwhelm an individual's capacity to function safely in the laboratory. Most universities have counseling and stress management resources to which individuals may be directed if they are in need of help. Principal investigators should not hesitate to use these resources or to direct researchers to them.

ACTIONS FOR DEPARTMENT CHAIRS
Department chairs in chemistry and other research-oriented disciplines are uniquely positioned to take additional actions to advance safety culture.

Build and facilitate a partnership with environmental health and safety (EHS) personnel.
Currently, lack of understanding of the role and authority of EHS personnel sometimes leads to negative attitudes toward EHS among faculty and researchers. In some campus cultures, EHS personnel are viewed as obstacles to research productivity instead of partners in achieving a safe lab culture. Shifting to a more cooperative dynamic will require engagement from principal investigators and departments.

Department chairs are in the best position to provide mechanisms for creating a robust safety collaboration between researchers, principal investigators, and EHS personnel. However, EHS assistance can enhance the responsibility for safety of researchers and faculty, who may be in the best position to identify and mitigate hazards specific to their research projects.

Contribute to and use cross-institution information on near misses.
Establishing an anonymous reporting system for incidents and near misses in laboratories across universities and colleges will help institutions and laboratories learn from one another's experiences. Department chairs should work with university leadership to incorporate the use of this system into their safety planning—both by encouraging their principal investigators and researchers to contribute to it and by using data collected on near misses across universities to enhance their own institution's safety practices.

Incorporate efforts to foster a strong, positive safety culture as an element in the criteria for promotion, tenure, and salary decisions for faculty.
The core missions of academic institutions—teaching, research, and service—establish the key criteria used to make decisions about faculty tenure, rank, salary, and awards. Faculty members align their efforts with these criteria. Department chairs should work with more senior members of their institutions and with faculty governance to add the establishment and promotion of laboratory safety as an important element of faculty evaluation and advancement. Doing so will allow faculty members to align their work on safety to institutional expectations. This change will also allow institutions to recognize the substantial work required to identify the hazards associated with research, mitigate their risks, sustain a group culture of safe practices, and train and educate a constantly changing group of junior researchers.

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