A Task Force was convened in October 2013 under the auspices of the University Committee on Health and Safety and the Office of the Vice Provost and Dean of Research to review and evaluate Stanford's research laboratory safety culture and, as appropriate, identify findings and provide recommendations for continued advancement of a robust laboratory safety culture at Stanford (see Appendix A for the charge). The Task Force gathered information and input from primary stakeholders involved in the day-to-day research laboratory work, the faculty-principal investigators (PIs), bench researchers (research associates/assistants, post-docs, grad students, undergraduate students) and university, school and departmental environmental, health and safety staff who support research laboratory safety. This report provides findings and recommendations the Task Force believes will contribute to further development and advancement of a strong, positive laboratory safety culture at Stanford University.

As part of its deliberations, the Task Force developed a common set of safety culture attributes (principles, characteristics and traits) that support a strong, positive laboratory safety culture across the broad range of academic research laboratory activities (see Appendix B for the definition and analysis of safety culture). These attributes describe patterns of interaction, group dynamics, communications and behaviors that appropriately emphasize safety in research laboratories, particularly in "goal conflict" situations (e.g., research production vs. safety, research schedule vs. safety, and cost of the effort vs. safety). Attributes are identified at a sufficiently high level of detail to ensure that they apply across the range of research activities and myriad relationships that exist among, between and within individuals and groups engaged in and supporting laboratory research at Stanford.

The attributes of a strong, positive laboratory safety culture fall within the following general categories which are explained in detail later within this report.

Executive Summary

1. Laboratory research group organizational dynamics
2. Working behavior within the laboratory
3. Communication about safety in the laboratory
4. Environmental Health & Safety programs
5. Institutional and organizational attitudes about laboratory safety

The Task Force has identified these attributes as a set of best practices to be applied within and embraced by the academic research laboratory community at Stanford. The information and input garnered from Task Force outreach, online input, interviews and in the results of a Stanford Laboratory Safety Culture Survey are aligned along these laboratory safety culture best practices and summarized in the findings and recommendations below (see Appendices C and D for results). Full detail and background is included in the Task Force detailed report below.

Summary of Findings and Comments

The discovery process undertaken by the Task Force produced a large amount of data and information, and the development of a common set of safety culture attributes. Appendix E defines and describes the attributes of a positive laboratory safety culture. There are many additional findings along with very detailed and important, often enlightening, comments from stakeholders in the main body of this report and we encourage all to read the full report. The Task Force has developed many recommendations, but recognizes that implementation of these recommendations will require the collective commitment of members of the Stanford research community to develop and implement action plans to integrate these best practices for laboratory safety culture advancement into the academic research programs and day-

to-day bench research work at Stanford (see Appendix F for a description of Stanford's commitment to safety).

Thus, an initial over-arching recommendation is to have the Dean of Research Office and EH&S, in consultation with the University Committee on Health and Safety and other stakeholder representative groups, lead an effort to develop strategy and implement plans incorporating these findings and recommendations, and set priorities and measurable goals to enable changes that advance Stanford's culture of safety to the level of excellence expected in all Stanford activities. This undoubtedly will require significant resources and action plans with multi-year and ongoing initiatives, but will be a necessary first step in the follow-up process.

Laboratory research group organizational dynamics

A number of research groups at Stanford maintain a safety-conscious research environment, but this is not universally true.

Stanford research groups do not function within a single laboratory safety culture; safety culture is local and varies group-by-group, laboratory-by-laboratory, and building-by-building. Laboratory safety must be embraced as a core element in the responsible conduct of research, which is central to the academic research mission at Stanford.

Faculty-principal investigators (PIs) set the tone for safety for the laboratory group; bench researchers look to and take their lead from PIs regarding prioritization for safety within the laboratory. Many PIs, especially senior faculty, are not regularly in their laboratories and they often no longer do bench research. So PIs can't practically be the day-to-day enforcer of laboratory safety practices. That is often left to the laboratory researchers' own responsibility, or to a PI designate such as a laboratory manager. But PIs can and must provide the base expectations, procedures and accountability for safety in the laboratory by all laboratory researchers.

The majority of academic researchers are students and post-doctoral fellows who are relatively young and still completing their educational development under the faculty/PI advisor. As such, these individuals are dependent on the PI for their development and advancement and there is concern over their future if their view varies from their PI. New PIs and postdoctoral fellows represent particularly vulnerable groups as they often have little or no laboratory management training and are under intense pressure to produce research outcomes. New PIs are not systematically trained on how to start or manage a laboratory, or how to build safe practices into their research programs.

Based on the survey results, important differences of opinions and perceptions regarding safety within Stanford research laboratories exist between PIs and bench researchers in laboratories. Nearly 30% of researchers disagreed with the statement "In our lab, safety is the highest priority" compared to <5% of PIs.

PIs often assign responsibility for safety to others in the research group from a laboratory manager to a new graduate student; outcomes are variable depending on clarity and PI support of the laboratory safety coordinator role. Sometimes serious mistakes in the laboratory are made, but there are no tangible consequences for researcher or PI. As a result, there are variations in disciplinary practices among research groups. There are no penalties for unsafe practices in some laboratories while others have revoked laboratory membership arguing "the science can't be trusted if safety is compromised." This raises the need for establishment of clear expectations and responsibilities within research laboratory participants.

Working behavior within the laboratory

Turnover of researchers (post-docs, grad students) at universities is very high, much higher than in industry. 60-80% of laboratory researchers change over a four to five year period.

New procedures and experiments are devised continually by laboratory researchers and it is rare that PIs are aware of every procedure carried out in their laboratories.

Risk assessment and hazard analysis of experimental procedures are not always conducted in academic laboratory research. More than 20% of researchers in the survey do not agree with the statement that they review risks and safety procedures prior to starting new research procedures.

In some laboratories, compliance with regulations and the wearing of personal protective equipment (PPE) is seen as integral to safety; in other laboratories, there is wide variation regarding use of appropriate PPE.

Particular groups are especially at-risk, including 'volunteer' high school and undergraduate students, short-term undergraduate researchers, visiting scholars, rotating graduate students, and scientists from other laboratories working for short periods to learn techniques or to perform specific experiments. Also vulnerable are non-scientific staff members who enter laboratories, custodial and service support workers, and non-Stanford vendors.

Newer, open laboratories create safety challenges with the placement of researchers' desk areas adjacent to or within operational laboratory spaces, as well as lack of good communication within laboratory groups or across different laboratory groups in open laboratories. All researchers (post-docs, grad and undergrad students) in Stanford laboratories are here to continue and advance their education and training; however, they may not have the necessary expertise and knowledge to identify or fully understand the hazards and risks associated with advanced laboratory research. A strong, proactive laboratory safety culture will aid in the development of the necessary knowledge and skills to work safely in the laboratory, and better prepare Stanford researchers for their ensuing professional careers.

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Stanford PIs and laboratory researchers noted in the information provided that risk assessment and hazard analysis are important elements of the experimental design and review process for hazardous laboratory procedures. Effective training, guidance, assistance and periodic review of these practices will be needed.

Stanford needs to develop, implement and enforce a policy that new laboratory researchers cannot initiate research unless they have undergone a safety orientation, including a local research laboratory onboarding process that includes the laboratory PI's clear expectations, requirements and accountability regarding working safely within the research laboratories. The PI must ensure that these policies are communicated to and reinforced with all incoming researchers in their research groups.

For short-term transient scientists and/or untrained personnel, school and departmental mechanisms must be developed to assure such researchers are properly trained and approved to work in research

laboratories on campus, and that volunteers in laboratories are not allowed, except through specifically designated school approved and supported programs.

Every research group must have a designated laboratory safety coordinator (preferably a relatively senior and experienced researcher if possible). The PI must provide a clear role, responsibility and commensurate authority to the laboratory safety coordinator.

EH&S and University Safety Partners (USPs) must develop or enhance programs for support of, and regular interaction with, laboratory safety coordinators.

EH&S, with input from PIs, USPs, and laboratory safety coordinators, must develop and institute a revised institutional Personal Protective Equipment (PPE) program that includes research and laboratory-specific risk-based requirements.

Regarding the at-risk groups: the inexperience of a group may be in part due to high turnover

Communication about safety within the laboratory

Poor communication about safety within and among all research stakeholders is a major underlying component of the safety comments observed or received by the Task Force. Clear, open and regular communication about safety within the laboratory is a critical component of a strong laboratory safety culture and should be an integral part of the research safety culture.

Laboratory safety coordinators and departmental safety contacts play an important role in communicating about and driving safety culture within the laboratory. There are examples of many excellent laboratory safety programs in place at Stanford, and these need to be captured and shared with other research groups. Ongoing education is important to developing the laboratory safety skills and knowledge for academic researchers. Online and classroom training is important to this effort but, based on this Task Force review, hands- on training in the laboratory by an experienced mentor is the most effective way to learn and retain laboratory safety information.

It was noted that the presence of health and safety professional staff in laboratories and at laboratory meetings may help identify safety problems before injuries occur, and may also improve communication between bench scientists and health and safety staff. PIs need to provide regular opportunity for and facilitate open communication and dialogue regarding safety with laboratory researchers. Safety communications must be a regular part of ALL laboratory group meetings.

What is our most common problem? (Chemistry)

Incident and near miss reports can be a valuable tool for experiential learning about laboratory safety. However, the data indicates such items not regularly reported, reviewed or disseminated at Stanford.

NEAR MISS – New Report Form online submission and PDF to print and hand in.

Research Lab/Other EH&S Reporting – "Near Miss" Who? Who else was there? Who else does this - researchers or other groups? Who is your supervisor? What happened? What else could have happened? Your comments: Other comments: Other ideas or reminders: Where did this happen? Where else could this happen? When did this happen? When else could this happen? Why did this happen? Why else could it happen? How else could this occur? How can it be prevented? How else can this be done safely?

EH&S needs to coordinate the identification of best practices in laboratory safety and create a mechanism whereby these best practices can be communicated, shared and implemented into the health and safety programs of laboratory research units. Individual departments and research groups must be encouraged to communicate best practices independent of any efforts of EH&S.

Outreach programs for PIs and all scientists must be developed and implemented. Training vehicles such as actor or simulation-based training and hands-on training on specific techniques are examples of effective training modules that could be developed.

Resources need to be provided to enable regular personal contact between health and safety staff and bench scientists.

EH&S must develop a process for non-punitive incident and near miss reporting as an integral component of Stanford's laboratory safety culture and safety information management program.

Environmental Health & Safety programs

The EH&S website is in dire need of major updating and rebuilding. It was noted that the website is the repository of laboratory safety information and resources for the research laboratories and must be easily and readily accessible as well as cogent and current.

EH&S personnel must be able to better understand complex research processes and work collaboratively with laboratory researchers on Standard Operating Procedures (SOPs) for research experiments.

Some research groups at Stanford indicated they have experienced positive interactions and mutually supportive relationships between EH&S staff and researchers. These labs are noted to often have lab managers or researchers more involved in safety within the lab.

EH&S conducts regular safety audits but there is sometimes a lack of integrated and collaborative follow-up. Appropriately designed and conducted laboratory safety reviews can be a major leading indicator of potential incidents in a robust safety culture program.

EH&S and research laboratories will require financial and personnel resources to support, enhance and promote advancement of the culture of laboratory safety.

What is missing from our safety inspections?

Institutional and organizational attitudes about laboratory safety

Roles and responsibilities are not always clear to those in research laboratories. The relative roles and responsibilities of faculty/PIs, those working in the research labs and EH&S personnel should be clearly promoted.

Research laboratory safety begins with laboratory facility planning and design for safety. New open laboratory designs place researcher work desks immediately adjacent to bench tops where research with potentially hazardous materials is being conducted. Simple facility and building items such as washing machines for laboratory coats, showers, better-designed emergency wash stations, and hand-less door opening devices are examples of measures suggested by bench researchers during our outreach.

Funding for safety equipment and requirements within the laboratory remain a continuing struggle for many. Everything is monetized, but laboratory operations need some core resources focused on safety support.

In crowded laboratories safety is often more compromised, there are more accidental chemical and reagents spills and incidents; crowded hoods can cause researchers to perform their experiments in unapproved and undesignated areas.

Stanford's excellence in research ought to include a similar excellence in its laboratory safety culture.

Safety is an identified priority and a core value of Stanford University as evidenced in the University Health and Safety Policy (Appendix F). Periodic reinforcement by the University President, Provost, Deans, Chairs and other institutional leaders is needed to promote safety as a core value.

Safety culture does not begin and end at the laboratory door. To some extent a safety culture begins with practices outside laboratories – bike safety, helmets, stopping at crosswalks. If it is appropriate, beneficial and feasible to hand out bike helmets, why not laboratory coats and goggles?

Changing culture is not going to be easy, nor will it happen rapidly. *Eye protection plateau?*

Reference

Task Force for Advancing the Culture of Laboratory Safety at Stanford University. Advancing Safety Culture in the University Library. 2014. 7 June 2016 <http://web.stanford.edu/dept/EHS/cgi-bin/lsctf/sites/default/files/Stanford_Task_Force_Report.pdf>.