



Stanford
University

Advancing Safety Culture in the University Laboratory

A report of the Task Force for Advancing
the Culture of Laboratory Safety
at Stanford University



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APPROVALS

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Advancing Safety Culture in the University Laboratory publication was developed by the Task Force for Advancing the Culture of Laboratory Safety at Stanford University. Please direct all questions and comments to EH&S (650) 723-0448 <http://ehs.stanford.edu>.

Task Force Members

Co-Chairs

Bruce Clemens

Professor in the School of Engineering (Materials Science and Engineering) and Professor of Photon Science at SLAC and, by courtesy, of Applied Physics, and Chairman of the University Committee on Health & Safety

Robert Waymouth

Professor in Chemistry and Professor, by courtesy, of Chemical Engineering

P.J. Utz

Professor of Medicine (Immunology and Rheumatology) and Program Director for the Medical School Training Program (MSTP) and Stanford Institutes of Medical Research (SIMR) Summer High School Research Program



Members

Anthony Appleton

Recent Postdoctoral Research Fellow in Chemical Engineering at Stanford; currently Adjunct Chemistry Faculty member at Ohlone College

Persis Drell

Professor of Particle Physics and Astrophysics and of Physics and former Director of SLAC National Accelerator Laboratory

Mary Dougherty

EH&S Industrial Hygienist and University Chemical Hygiene Officer

Curtis Frank

Senior Associate Dean, School of Engineering and Sr. Professor in Engineering (Chemical Engineering) and Professor, by courtesy, of Materials Science and Engineering and Chemistry

Larry Gibbs

Associate Vice Provost, Environmental Health and Safety (EH&S)

Linda Heneghan

Facilities Manager, Institute for Stem Cell Biology and Regenerative Medicine

Loan Nguyen

Life Sciences Research Assistant, Department of Biology

David Silberman

Director, Health & Safety Programs, School of Medicine; University Safety Partner Representative

Nickolas van Buuren

Postdoctoral Research Fellow, Microbiology and Immunology

Jessica Vargas

Ph.D. Student in Chemistry and Member, University Committee on Health & Safety

A culture of excellence pervades the research and teaching activities at Stanford and the university aspires to a similar culture of excellence for laboratory safety in its research and learning environments. A Task Force was convened in October 2013 by the University Committee on Health and Safety to proactively engage in thoughtful, creative and scholarly discussions regarding laboratory safety to better inform the university research laboratory community of the current status of laboratory safety culture at Stanford and identify opportunities for its continued advancement.

Although there are many diverse aspects involved in organizational safety culture, the Task Force's initial effort focused in three specific areas identified as core elements critical to supporting and advancing safety culture in academic research laboratories: the frontline research groups conducting work at the bench top (research associates/assistants; post-doctoral fellows; graduate students; and undergraduates in research laboratories); faculty/principal investigators (PIs) and departments or schools with academic research laboratory activity; and, institutional organizations that provide direct safety support for research safety activities at Stanford, including the Dean of Research Office, the Department of Environmental Health and Safety (EH&S) and University Safety Partners (USP).

This review finds that Stanford has many base characteristics and elements of a good laboratory safety culture active and in place, but these are not consistently or universally applied throughout the research laboratory community. There is substantial room for improvement and this report includes findings, comments and recommendations to support continued advancement toward a stronger, positive and more active laboratory safety culture at Stanford.

The Task Force believes that the advancement of a stronger, more positive laboratory safety culture is a critical element to the continued development and sustainability of the academic laboratory research programs at Stanford and recommends the President and university academic leaders support the subsequent actions required to enable these recommendations.

Many of the Task Force findings reflect some of the findings and recommendations identified in the recently released National Research Council Report: *Safe Science: Promoting a Culture of Safety in Academic Chemical Research*.¹ The NRC Report provides

encouragement and motivation for academic research institutions to undertake their own self assessment, which Stanford has done with this effort.

The Stanford Task Force followed a similar process as the NRC committee to gather information and data and focused on evaluating the status of the safety culture within Stanford research laboratories. The Task Force also developed important new tools for use in this review that will be available to other institutions after publication. These include a laboratory safety culture survey instrument, a set of Lab Safe Culture Attributes prescribing best practices, and a process for institutions to conduct a self-assessment.

One of the most important findings of the Task Force is the clear recognition that managing and nurturing a healthy and robust laboratory safety culture in an organization where approximately 60-80% of the laboratory bench research community changes every four to five years requires an ongoing commitment, from the President and the entire university research laboratory community. The young men and women who work in Stanford research laboratories and help to promote and sustain the academic research enterprise deserve to have a fully rounded professional education that, in addition to developing excellent scientific research prowess, includes acquiring a value for a strong, proactive laboratory safety culture. As these young researchers move forward in their professional careers, Stanford must provide them with the tools and breadth of learning to best prepare them for their future success, including the prioritization for safety within the research laboratory. Faculty-PIs are central to maintaining a culture of research excellence and are also critical to establishing, encouraging and sustaining a vibrant safety culture within their laboratories. Given the regular change in laboratory group membership identified previously, PIs provide the single point of constancy over time within Stanford's research laboratories. There remains an ongoing challenge and much work to be done to act on these recommendations and also to develop incentives, tools and information to engage and support faculty-PIs, researchers, laboratory managers and others who constitute the core stakeholders in advancement of the research laboratory safety culture at Stanford.

¹ National Research Council. *Safe Science: Promoting a Culture of Safety in Academic Chemical Research*. The National Academies Press, Washington, DC 2014

Stanford University is a world leader in education and teaching, research and discovery, student athletics, and development of programs and initiatives that benefit millions of people. As Chairs of this Task Force, we believe that Stanford must also be a leader in the area of laboratory safety culture. We would like to emphasize four key points in our introduction to this Task Force Report.

First, it is critical to note that the Task Force was not commissioned as a response to a serious laboratory accident on campus, nor because there are grave concerns about current status of laboratory safety at Stanford. The faculty-led University Committee on Health and Safety, in collaboration with the Dean of Research, commissioned the Task Force to assess the current culture of laboratory safety at Stanford, to make recommendations for improving the laboratory safety culture, and to identify attributes that will achieve excellence at Stanford in this area parallel to that which it achieves in its other endeavors. The goal of this review is to instill in our research trainees a value for safety in the laboratory and make Stanford laboratories a safer place and a model for other institutions.

Second, we envision that this Task Force Report is just the start of an intensive, longitudinal effort to further develop a positive culture of health and safety throughout campus. While our current efforts are focused on laboratory safety, Stanford is already leading broader culture change on campus in areas such as student and faculty diversity; healthy lifestyles (e.g., the popular BeWell Program); environmental sustainability; and other safety programs such as the highly effective School of Medicine's bike helmet distribution program. This report will serve as a starting point for change over the coming years. Best practices will be developed, innovative training plans created, and deficits in the current laboratory safety culture will be studied further and improved. A stated goal of the Task Force is to develop a laboratory culture in which safety is instilled into the mindset of all our scientists from the day they arrive on campus – and that they take this mindset with them to the next stages of their career. In short, we hope to create a culture where our scientists don't think about safety as a compliance issue or a set of guidelines distinct from their research activities, but as a fundamental value imbedded in everything they do.

Third, we acknowledge that change will not happen immediately, nor will it happen spontaneously or without some resistance or conflict. Improving our safety culture will take buy-in at all levels – students, fellows, staff,

faculty, administration and university leadership. New educational programs will need to be developed. Monitoring systems will need to be implemented. Some existing research facilities may need to be retrofitted to meet the demands of newer, cutting edge research. Planned new facilities will need to have additional safety elements included in building design. Many scientists, particularly senior faculty, may need to be reminded of the importance and value of safety within their research program. Culture change may be difficult in some laboratories and it will take time. It will also require a commitment by the University administration to provide leadership, incentives, and resources to ensure that Stanford remains at the forefront of scientific research and laboratory safety.

Finally, the Task Force Chairs must acknowledge the incredible hard work and diligence of the many people who have contributed to the research underlying this report, and their efforts at drafting the report and beginning to implement change. Particular thanks goes to Larry Gibbs, who has driven us all, on a very tight timeline, and kept us on track. His vision and dedication was evident throughout; the members of our Task Force for their insights and dedication, particularly for their herculean efforts in reviewing and summarizing the comments and input received from the research community; Denise Hofer of the Dean of Research Office and EH&S staff for their efforts in supporting this endeavor; Erik Vinkhuyzen and Mike Kuniasky of Palo Alto Research Center (PARC) for generating and analyzing large amounts of high quality survey data; and the hundreds of Stanford scientists who participated in town hall meetings, online comments, face-to-face meeting, surveys, and other activities.

Significant effort by many stakeholders and contributors has gone into providing and gathering the data and information for this review and preparation of the subsequent recommendations. We urge everyone involved with academic research laboratories at Stanford to read the full report and consider the positive impacts of a stronger, more proactive laboratory safety culture to our research community and the entire campus.

Task Force Co-chairs,

Bruce Clemens, Ph.D.

Robert Waymouth, Ph.D.

P.J. Utz, M.D.

Executive Summary



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.

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

Findings	Comments
<ul style="list-style-type: none"> • 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, building by building. • 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. • 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. • 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. 	<ul style="list-style-type: none"> • 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. • 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. • 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. • 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

Findings	Comments
<ul style="list-style-type: none"> • 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. 	<ul style="list-style-type: none"> • 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. • 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.² • 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.

² See also NRC Report p.77

Communication about safety within the laboratory

Findings	Comments
<ul style="list-style-type: none"> 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. 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. 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. 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. 	<ul style="list-style-type: none"> 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. 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. 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. 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

Findings	Comments
<ul style="list-style-type: none"> 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.³ 	<ul style="list-style-type: none"> 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.

Institutional and organizational attitudes about laboratory safety

Findings	Comments
<ul style="list-style-type: none"> 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. 	<ul style="list-style-type: none"> 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.⁴ 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.

³ See also NRC Report p.76

⁴ See also NRC Report p.74

Recommendations

Below is a high level summary of the many recommendations contained in this report. Recommendations were coalesced into four major themes for this summary: Research Laboratory Group Leadership, Institutional Policy, Environmental Health and Safety and Technology Solutions, followed by further explanation of the context of the recommendation. There is more detail in the body of the report on these and a number of other recommendations, but this summary conveys the essence of needed institutional actions and follow up to this report.

Research Laboratory Group Leadership and Initiatives

#1 PIs are the single most important element for developing and sustaining a strong, proactive laboratory safety culture and must clearly communicate and reinforce to everyone within their groups that safety within their research laboratory is a top priority and define roles, responsibilities, authority and accountability for safety within their laboratory.

PIs need to institute policy that new laboratory researchers cannot initiate laboratory research activities unless they have undergone a laboratory specific safety orientation that includes communication of clear expectations, requirements and accountability regarding working safely within research laboratories. The PI needs to ensure that these policies and expectations are communicated to and reinforced with all incoming researchers in their research groups.

#2 Every research group needs to designate a laboratory safety coordinator (preferably a senior and experienced researcher if possible). The PI must provide a clear statement of the role, responsibility and authority of the laboratory safety coordinator to all laboratory personnel.

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

#3 PIs need to provide regular opportunity for and facilitate open communication and dialogue regarding safety with and among laboratory researchers.

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. PIs need to provide regular opportunity for and facilitate open communication and dialogue regarding safety with laboratory researchers.

Institutional Policies/Initiatives

#4 Stanford leadership, at every level, must promote a strong, positive research laboratory safety culture as a core element in the responsible conduct of research.

Critical elements of such a program include actively strengthening safety, including research laboratory safety, as a core value of the institution and demonstrating ongoing commitment for programs and infrastructure to support laboratory safety and reinforcing these values with policy when appropriate. Part of this outreach includes clearly identifying and promoting the roles, responsibilities, authority and accountability for safety of faculty, staff, researchers and students as identified in the University Health & Safety Policy and other applicable safety regulations, policies and programs. The recent NRC Report includes this recommendation as a finding.⁵

For short-term transient researchers and untrained laboratory personnel, mechanisms will need to be developed to assure such researchers are properly trained and certified to work in research laboratories at Stanford, and that volunteers in laboratories are not allowed, except through specifically designated school approved and supported programs.

#5 Building and research laboratory design at Stanford must be reviewed

⁵ National Research Council. *Safe Science: Promoting a Culture of Safety in Academic Chemical Research*. The National Academies Press, Washington, DC 2014

and updated to better accommodate new and emerging best practices for safety of personnel within research spaces.

Although safety code is included, good safety design practices must also be a priority in laboratory design and not removed in the budget “value engineering” processes of project design and management. For example, the current design model of including desk spaces within or immediately adjacent to research bench space is no longer considered good practice for safety of the researchers.

#6 Need for centralized funding support for comprehensive, campus-wide safety related mandates.

Funding for safety equipment and requirements within the laboratory remain a continuing struggle for many laboratories. Everything is monetized, but laboratory operations need some core resources focused on safety support. For example, there is a need for core central funding for personal protective equipment (PPE), safety equipment and safety requirements applicable to all laboratories.

Environmental Health & Safety (EH&S)

#7 Coordinate the identification of best practices in laboratory safety and create a mechanism whereby such practices can be communicated, shared and implemented into the health and safety programs of laboratory research units.

Develop and incorporate non-punitive (and optionally, anonymous) incident and near miss reporting as an integral component of Stanford's laboratory safety culture and safety information management program. Encourage individual departments and research laboratory groups to communicate best practices and lessons learned independent of any efforts of EH&S. EH&S, with input from PIs, USPs, and laboratory safety coordinators, needs to develop and institute a revised institutional personal protective equipment (PPE) program with laboratory-specific risk-based requirements.

Develop and implement research laboratory safety program awareness education and information for

current and incoming PIs. Include training vehicles such as actor or simulation-based training and hands-on training on specific techniques as examples of effective training modules that could be developed.

#8 Implement a proactive and consultative laboratory safety review program that includes laboratory personnel collaboration and provides feedback and recommendations for laboratory safety improvements and continued development of the laboratory safety culture.

In collaboration with USPs, local safety coordinators and laboratory researchers, EH&S needs to develop tools and support systems that aid in continued advancement of a strong, proactive laboratory safety culture program.

Technology Solutions for Health and Safety Support of Laboratory Research

#9 Identify, develop and apply existing or new technology solutions to streamline and provide for better communication and readily make available laboratory health and safety information and data to laboratory researchers.

PIs and laboratory researchers must incorporate risk assessment and hazard analysis into the experimental design of hazardous laboratory procedures and ensure that they are specific and appropriate to the laboratory and research topic area. Develop technology solutions such as integration of electronic laboratory notebooks (ELNs) and hazard information data and risk assessment applications. Silicon Valley is tech central, and Stanford ought to be at the forefront of applications that integrate and streamline research and laboratory safety support tools into modern technology.

#10 Redesign and reconstruct the EH&S website in a new paradigm that provides access to needed health and safety information by developing a new safety information support system that is

useful, easily accessible and searchable on all platforms by Stanford laboratory researchers and other constituencies.

Summary

Stanford is a world leader in scientific research. This culture of excellence is not as evident in the habits and behaviors that define Stanford's Laboratory Safety Culture. The recommendations in this report are not necessarily a prescription of how to do it, but a reflection of what can be done to advance the culture of laboratory safety at Stanford.

There remains ongoing challenges and much work to be done to realize actualization of these recommendations and also to develop incentives, tools and information to engage and support faculty-PIs, laboratory researchers, laboratory managers and others who constitute the core stakeholders in advancement of the research laboratory safety culture at Stanford. A most important finding of the Task Force was that managing and nurturing a healthy and robust laboratory safety culture in an organization where approximately 60-80% of the laboratory bench research community changes every

four to five years requires ongoing commitment by the entire research community.

Faculty-PIs, who are central to maintaining a culture of research excellence, are also critical to establishing, encouraging and sustaining a vibrant laboratory safety culture, which requires that Stanford invest appropriate resources. PIs provide the basic constancy to the regular change and turnover of researchers within Stanford's academic laboratories. However, just as critical is the need for institutional support from department chairs, deans, and the President and Provost. A proactive and strong laboratory safety culture requires the ongoing support and focus of the academic line management of the institution.

An overarching goal is to ensure those individuals who develop and hone their scientific research skills within Stanford's academic research laboratories leave this university with the understanding that safety is a primary and core value in Stanford's research laboratory activities and that these individuals will embrace and promote those safety culture values throughout their professional careers. To realize this outcome will require the focused support of those engaged in the leadership, management, oversight, support and operation of research laboratories at Stanford.



for Advancing the Culture of Laboratory Safety at Stanford

Overview

The unique flat management structure in academic research organizations can create challenges for establishing and maintaining an effective and responsive culture of safety throughout university research laboratories. A culture of excellence pervades the research and teaching activities at Stanford and the university aspires to a similar culture of excellence for laboratory safety in its research activities. This Task Force was convened to proactively pursue and engage in thoughtful, creative and scholarly discussions about laboratory safety to better inform the university research laboratory community regarding laboratory safety culture at Stanford.

Over the past five years, a number of serious and tragic accidents involving laboratory researchers occurred at other academic institutions' research laboratories and have resulted in governmental, professional and corporate organizations questioning the adequacy of the safety culture in American academic research laboratories.^{6,7,8} The Stanford University Committee on Health & Safety (UCHS), a standing faculty committee that reports to the President of the University, in reviewing these incidents and subsequent recommendations of governmental and professional associations, initiated a review of Stanford's laboratory safety culture. In early 2013, the Associate Vice Provost for EH&S engaged Dr. Emmett Barkley, former Director for Laboratory Safety with the Howard Hughes Medical Institute, to conduct a preliminary review and evaluation of Stanford's academic research laboratory safety culture. A brief on-site review was conducted and included interviews with representatives of Stanford research management, principal investigators, bench researchers and safety support organizations. The ensuing report highlighted significant strengths in many of the organizational safety culture elements supporting

laboratory safety, but also, identified areas for further review and follow up by Stanford. These included:

Discussions with members of the research community revealed that those in leadership positions hold a favorable view of Stanford's safety culture while those more involved in the day-to-day research are less cognizant of Stanford's framework in support of safety, and hold a lesser view of the current safety culture. Interest and enthusiasm in working together to advance and sustain a safety-conscious work environment, however, was unequivocal.

Principal Investigators should serve a leadership role in creating and sustaining a safe and compliant research environment. It is important that scientists (faculty-PIs) fully support Stanford's commitment to a culture of safe science and continuously motivate students and staff towards safe laboratory practices.

An internal Task Force charged with reviewing the laboratory safety programs and making recommendations to further advance a culture of safe science would emphasize Stanford's commitment to support a safe research environment, and be useful in identifying areas where EH&S services could improve. [See Appendix A]

The UCHS subsequently convened the Task Force for Advancing the Culture of Laboratory Safety at Stanford University 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. The Task Force was not convened in response to any crisis in laboratory safety at Stanford, but to be proactive and engage in thoughtful, creative and scholarly interaction and discourse about laboratory safety. Task Force membership consisted of representation from a broad spectrum of the research academic leadership and the laboratory research and support communities and was co-chaired by three faculty members.

Objectives and Goals of the Task Force Review

The scope of the Task Force review, as defined in the Task Force background and scope document, [Appendix A] is to meet with key principals, participant representatives and stakeholders involved in research laboratory operations to solicit input, information and perspectives on safety culture or safety program status and needs, and to receive suggestions for improvement and advancement of the research laboratory safety

⁶ American Chemical Society, *Creating Safety Cultures in Academic Institutions*. Washington, D.C.: American Chemical Society, 2012, <http://www.acs.org/content/dam/acsorg/about/governance/committees/chemicalsafety/academic-safety-culture-report-final-v2.pdf> (accessed May 15, 2014).

⁷ U.S. Chemical Safety and Hazard Investigation Board (CSB), "Texas Tech University: Laboratory Explosion," *Case Study*, 2010, http://www.csb.gov/assets/1/19/CSB_Study_TTU_.pdf#page=1&zoom=auto,0,800 (accessed May 15, 2014).

⁸ National Research Council. *Safe Science: Promoting a Culture of Safety in Academic Chemical Research*. The National Academies Press, Washington, DC 2014

culture at Stanford. Although there are many diverse aspects involved in organizational safety cultures, the Task Force's initial effort focused in three specific organizational areas identified as critical and core elements to developing and sustaining a robust research laboratory safety culture:

- The frontline research groups conducting the day-to-day work at the bench top (laboratory managers, research associates/assistants; post-doctoral fellows; graduate students; and undergraduates in research laboratories);
- Faculty-Principal Investigators (PIs) who serve in a supervisory role and are responsible for primary, front-line leadership and management of research laboratories and activities; and,
- Campus organizations that provide direct safety support for research activities at Stanford, including Environmental Health and Safety (EH&S), University Safety Partners (USPs) and others providing support to the laboratories.

With this organizational area as a focus for review the following general Task Force objectives were identified:

1. Review and evaluate the existing state/perception of safety climate/safety culture in academic research laboratories at Stanford through solicitation and gathering of information, perspectives on laboratory safety, and input from the various stakeholders in laboratory research at Stanford.
2. Identify best practices of a sound, proactive laboratory safety culture within the three critical functional areas that most closely touch the day-to-day research laboratory environment:
 - a. Within the research laboratory and amongst the research group (PIs, Post-docs, grad students, undergraduate students);
 - b. Within the departmental and schools management systems; and,
 - c. Within EH&S programs and support functions.
3. Identify the roles, responsibilities, authorities and accountabilities within and among each of these functional areas.
4. Identify additional program needs, support functions, new tools and/or other issues for advancing laboratory safety culture in each of the areas identified above.
5. Recommend approaches and programs to address the identified needs/gaps.

Through the Task Force process activities and action plan described below these objectives have been fully realized or initiated for follow-up as part of this review.

Task Force Activity

Perspectives on Laboratory Safety Culture

The Task Force met as a group seven times over the course of this review activity. Task Force members reviewed various background reports by government and professional organizations identifying concerns and providing recommendations about laboratory safety culture in academic research organizations.^{9, 10} The Task Force also reviewed documents that provided background and information about the personnel dynamics and best practices in organizational safety cultures,¹¹ and the challenges associated with implementation of rules and requirements within academic laboratory research environments.¹² The Task Force also heard presentations from local faculty and safety professionals about their related research and experiences in advancing safety culture changes in other settings such as hospital patient care activities and within a Department of Energy science center laboratory. One Task Force member also recently served on a National Academy of Sciences committee that was conducting a similar review of academic research safety culture.¹³

Copies of two presentations given to the Task Force about safety culture are included in Appendix B.

One of the major learnings taken from the discussions around "safety culture" involves the understanding that there is often no singular, unique safety culture regardless of the work environment. As depicted in Figure 1, organizational safety cultures can be viewed along a spectrum where the specific safety culture of an internal work group is dependent upon a number of core attributes or characteristics within the group.

⁹ U.S. Chemical Safety and Hazard Investigation Board (CSB), "Texas Tech University: Laboratory Explosion," Case Study, 2010, http://www.csb.gov/assets/1/19/CSB_Study_TTU_.pdf#page=1&zoom=auto,0.800 (accessed May 15, 2014).

¹⁰ American Chemical Society, *Creating Safety Cultures in Academic Institutions*. Washington, D.C.: American Chemical Society, 2012, <http://www.acs.org/content/dam/acsorg/about/governance/committees/chemicalsafety/academic-safety-culture-report-final-v2.pdf> (accessed May 15, 2014).

¹¹ Aerosafe Risk Management, *Overview of best practice in Organizational & Safety Culture*, Offshore Helicopter Safety Inquiry-Newfoundland and Labrador, Canada, May 2010.

¹² Huising, R. and Silbey, S., "Constructing Consequences for Noncompliance: The Case of Academic Laboratories" *The ANNALS of the American Academy of Political and Social Science*, 2013, 649: 157, <http://ann.sagepub.com/content/649/1/157> (accessed May 15, 2014).

¹³ National Research Council. *Safe Science: Promoting a Culture of Safety in Academic Chemical Research*. The National Academies Press, Washington, DC 2014

Hudson defines various possible stages of an organization's safety culture spectrum.¹⁴ These five stages, illustrated in Figure 1 include:

1. Pathological

The organization cares less about safety than about not being caught;

2. Reactive

The organization looks for fixes to accidents and incidents after they happen;

3. Calculative

The organization has systems in place to manage hazards; however the system is applied mechanically. Staff and management follow the procedures but do not necessarily believe those procedures are critically important to their jobs or the operation;

4. Proactive

The organization has systems in place to manage hazards and staff and management have begun to acquire beliefs that safety is genuinely worthwhile; and,

5. Generative

Safety behavior is fully integrated into everything the organization does. The value system associated with safety and safe working is fully internalized as beliefs, almost to the point of invisibility.

These five stages provide a model for evaluating the maturity of an organization's overall safety culture.

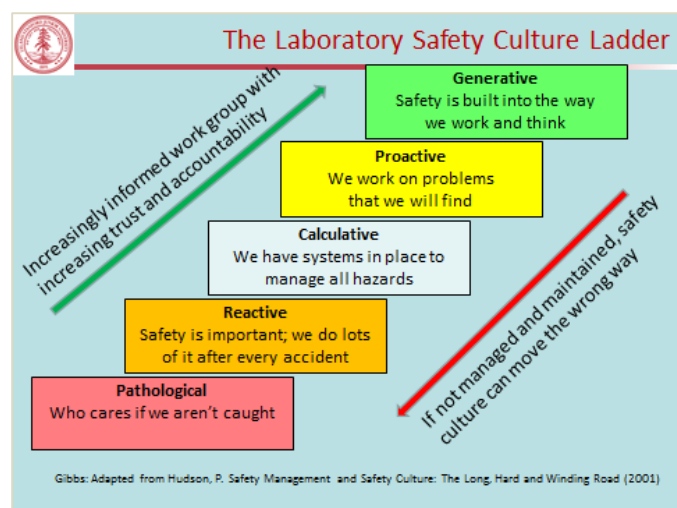


Figure 1. Safety Culture-Spectrum Ladder

A large organization often will have a variety of safety cultures within differing parts of the organization, depending upon the leadership and behavioral dynamics of the various local work groups. This is especially true for academic research laboratory organizations due to the operational characteristics of academic research laboratories and the autonomy embedded in individual research laboratory groups.

The goal for most organizations and sub groups of the organization is to be able to identify and understand the attributes and characteristics of a strong, positive safety culture and incorporate those attributes into an organizational program, with focus at the local working units. In organizations with strong vertical organizational management systems, safety culture advancement can be moved through strong leadership and management promotion with a focus on safety culture as a core value in corporate goals and strong performance management.¹⁵ Academic research institutions, on the other hand, are relatively flat and dispersed governance organizations. As such, even with strong central leadership directive, the development of laboratory safety culture is most influenced within the local research laboratory groups, led locally by the faculty-principal investigator.¹⁶ Other university entities, such as departments, schools and university support systems may attempt to influence this local culture, but the underlying basis of an individual research group's safety culture is highly dependent on the leadership of and within the group. This level of autonomy locally is a unique organizational characteristic that separates academic research organizations from industrial or governmental research laboratory operations, and greatly localizes safety culture development for the laboratory group. Thus, advancement of overall laboratory safety culture within such horizontal organizations must rely on consistent leadership at this core group level, especially by the principal investigator, to develop a strong, positive laboratory safety culture for the group. When there is great diversity among research groups, as exists in academic research, it is understandable that there will also be a diverse and variable set of safety cultures that will range from less effective (pathological or reactive) to more advanced and robust (proactive or generative). The challenge, then, is to help support and advance those groups with a less effective safety culture to one that is stronger and more proactive. This is the challenge faced by most academic research organizations, including Stanford.

Task Force Plan of Action

¹⁵ Duhigg, Charles, *The Power of Habit*, Random House 2012

¹⁶ Huising, R. and Silbey, S., "Constructing Consequences for Noncompliance: The Case of Academic Laboratories" *The ANNALS of the American Academy of Political and Social Science*, 2013, 649: 157, <http://ann.sagepub.com/content/649/1/157> (accessed May 15, 2014).

¹⁴ Hudson, P. *Safety Culture: Theory and Practice*, Paper presented at the RTO HFM Workshop on "The Human Factor in System Reliability – Is Human Performance Predictable?" held in Siena, Italy, 1-2 December 1999, and published in RTO MP-032.

After reviewing background information and documents, and gaining a better perspective of organizational safety culture and related issues, the Task Force set out a plan of action to solicit input from primary stakeholders into the review and evaluation process. The Task Force noted that such direct input and information was critical to a better understanding of some of the cultural issues that might underlie any concerns or perspectives about laboratory safety culture at Stanford, while emphasizing that the overarching goal is to identify means to continue the advancement of the laboratory safety culture at Stanford.

The Task Force agreed upon multiple approaches to information gathering including open town hall style meetings, online submittals via a Task Force website, development and use of a laboratory safety culture survey and in-depth ethnographic interviews with a number of PIs and researchers.

Task Force Outcomes

Research Laboratory Safety Culture

Stanford is known for its excellence in academic research. This is due to the significant autonomy and focus of its faculty and researchers on discovery of new knowledge. This same autonomy and creativity that leads to amazing new discoveries and scientific breakthroughs can create challenges for assuring the application of a robust safety culture in the same laboratories conducting this cutting edge research. The challenge is to facilitate an environment and research laboratory group culture that supports and embraces integration of safety into the day-to-day research activities within the laboratory. The findings and recommendations herein are generally aligned along the stated goals and objectives of the Task Force described previously. As with many similar activities a number of issues were presented outside the specific goals, but the Task Force believes the attendant findings and recommendations are intrinsically important to advancing laboratory safety at Stanford. Such items are addressed at the end of this section.

GOAL 1: Review and evaluate the existing state/perception of safety culture in academic research laboratories

The Task Force used multiple means and methods to gather information and input including campus-wide open call town hall style meetings, use of a Task Force website for online information submittal and gathering, and development and deployment of a Laboratory Safety Culture Survey for faculty-principal investigators and laboratory bench researchers. Information gained from the combination of these sources, in addition to

background and experiences of the Task Force members themselves, was used in developing its findings and recommendations, which are detailed in other areas of this document.

Stakeholder outreach: meetings

Eight open stakeholder meetings with bench researchers, EH&S and safety partner staff, and faculty-principal investigators were held during late fall and winter quarter. These meetings, led by Task Force faculty co-chairs, were attended by over 200 research and safety support personnel, were interactive and productive with many issues raised and discussed.

Data and information gathered through these meetings was collected and itemized. This data and information was subsequently reviewed and analyzed by a Task Force subgroup. Throughout the course of these meetings a number of common themes emerged relative to laboratory safety culture and these are reflected in the findings in this document.

Task Force Website

A Task Force web page was created to provide information on Task Force activities and also to provide an opportunity for community input or feedback on the subject matter. Information was able to be submitted anonymously through this vehicle. Feedback was prompted through a set of general questions for response:

- What is the current state of safety habits and practices in your work or study environment?
- How safely do you believe you and/or others around you carry out your/their daily research activities?
- What practices or habits could be improved to enhance safety in everyday laboratory research activities?
- Institutionally, how could Stanford respond to modify its policies, procedures, or support to enhance safety?

As with the town hall meeting, information received from the online submittal was logged and reviewed by the Task Force subgroup to identify common issues and themes derived from the comments.

A set of best practices, called “laboratory safety culture attributes,” was developed and are representative of a strong, positive laboratory safety culture at Stanford. The information and comments received by the Task Force were then tabulated into the following general laboratory safety culture attribute areas.

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

Some comments or data may have applied to more than one of the attributes and thus were so assigned. A total of 383 comments or data inputs were identified and assigned. Almost all of the information and input consisted of negative reflections on a particular issue. This approach provided the Task Force with the ability to better delineate the specific types of safety culture issues that are of most concern to those working in Stanford laboratories. Figure 2 is a distribution of comments from town hall meetings and the website across the respective best practices areas. The results indicate that the focus of concerns about laboratory safety culture are split along two organizational lines; between behavioral dynamics and interactions within the individual research laboratory groups, represented by the first three attributes, and concerns about EH&S and other organizational support elements, including building design, central resource support, etc.

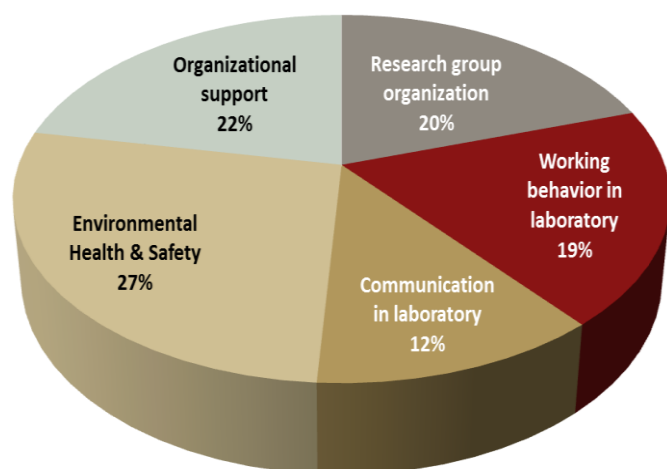


Figure 2. Distribution of Comments by Laboratory Safety Culture Attribute

These results point to a need to clarify how these attributes of a strong, positive safety culture can be further strengthened and advanced within the academic research laboratories at Stanford.

A great majority of the comments received point to the fact that there is opportunity for further advancing the safety culture within research laboratories. Also, based

on comments by individuals who attended the open town hall meetings, laboratory researchers would welcome more focus and attention on enhancing the overall safety culture within their laboratory research groups, beginning with more attention to safety culture in the laboratory by the principal investigators and others.

Laboratory Safety Culture Survey

A Stanford Laboratory Safety Culture Survey instrument was developed by Palo Alto Research Center (PARC) researchers in collaboration with the Stanford Task Force [Appendices D-4/5]. The goal of this laboratory safety culture survey is to:

- Track any change in the laboratory safety culture status over time by running the survey periodically;
- Map results of the survey responses to the above attributes to identify areas for continued emphasis; and,
- Aid in the development of technologies and tools to promote continued advancement of these attributes within the laboratory work groups and individuals.

The survey methodology involved a stratified random sample of opt-in responses to targeted email and newsletter invitations. Separate surveys were developed for principal investigators and laboratory bench researchers. Responses were received from 97 principal investigators (estimated to represent about 14% of wet laboratory research PIs) and 364 bench researchers (estimated to represent about 10% of all wet laboratory researchers). The sample margin of error for the survey is PI: $\pm 9\%$ for the principal investigator survey and $\pm 5\%$ for laboratory bench researcher survey at 95% confidence level. The percentage of respondents to the survey was split along the following schools: ~40% from the School of Medicine; ~30% from Humanities and Sciences; ~20% from Engineering; ~8% from Earth Science and ~5% from the Independent Laboratories. A full description of survey results is included in Appendix D.

The laboratory safety culture survey results compared the perceptions of laboratory safety culture by Principal Investigators with that of the laboratory bench researchers responding to the survey. General summary findings of the survey results include:

- Overall, people in Stanford research laboratories believe that they work safely and that their environment is relatively safe. This broad optimism is probably an accurate representation of people's feelings towards safety: Stanford is a pretty positive place.
- Principal Investigators score a little more positive and often with statistical significance on the overall

survey. This could be a concern because PIs may underestimate some safety issues. However, some questions were phrased differently for researchers and PIs, which could account for some of the difference as well. PIs may also be reporting what they believe is expected of them.

- People took the survey seriously, and varied their scores appropriately.

There were a number of survey questions where significant differences in responses between laboratory researchers and PIs were evident. Examples include:

- Approximately 5-10% of researchers feel that their workplace is not safe and their PIs are not concerned about safety. Although it's difficult to know exactly the proportion because of the margin of error, and its part of a standard distribution of opinion, it's still significant since it does not match PIs own views of safety in their laboratories.
- Researchers indicate that PIs do not always hear about all of the new procedures conducted by researchers.
- A significant minority of researchers disagree with PIs that all safety issues are discussed.
- A proportionally small, but significant number of researchers say there is pressure to finish a project even though safety may be compromised.
- Nearly 30% of researchers did not agree with the statement "In our lab, safety is the highest priority" compared to <5% of PIs.
- 50% of researchers do not believe safety related incidents in laboratories elsewhere on campus are communicated to them with a causal analysis.
- Hands-on training is considered most useful. Many people did not get classroom training. Many consider online training useless, especially researchers.
- A significant minority (~15%) of researchers do not agree that their responsibilities for safety had been clearly communicated, whereas nearly all PIs believe people in their laboratories know their responsibilities when it comes to safety.
- A significant minority of researchers believe that their laboratory does not adequately instruct new researchers on safety procedures, as does a small number of PIs.

Positive findings from the survey include:

- Researchers and PIs generally agree that people in laboratories feel comfortable refusing tasks they believe to be unsafe, with a small minority of researchers disagreeing.
- Both researchers and PIs strongly believe that researchers are comfortable calling each other on unsafe behavior.
- Everyone believes researchers are comfortable asking for help learning proper safety procedures.

Ethnography Review of Laboratory Safety Culture

In addition to developing and analyzing the survey, PARC researchers were engaged by Stanford to conduct ethnographic studies within campus research laboratories to gain a better understanding of how local research and safety cultures are established and reinforced in the day-to-day research work within the laboratories. This work involved the reviewer detailed interviewing of members of the laboratory groups to observe and learn how the groups and members interact relative to laboratory safety. These findings are based on 41 interviews with a variety of laboratory researchers, mostly grad students and post-docs, but also some laboratory managers and PIs. The written report of findings is located in Appendix D-3.

A summary of the findings from the ethnographic review include the following:

- Stanford is not a unified culture; there is not 'one' safety culture; safety culture is local and varies group by group, laboratory by laboratory, building by building;
- Principal Investigators set the tone for safety for the laboratory group; researchers look to PIs to set the tone;
- Laboratories with designated laboratory managers can drive the safety culture much more than a PI. PIs without a laboratory manager often assign junior researchers responsibility for laboratory safety without specific delegation of role and responsibility or appropriate authority or accountability;
- Sometimes serious mistakes in laboratories are made, but there are no tangible consequences for researcher or PI—this sends the wrong message according to some; some laboratories have let grad students go that have done something unsafe, arguing that if you can't be safe the science can't be trusted either;
- Infrastructure and building design affect laboratory safety;

- Access to good laboratory safety information is challenging;
- Personal Protective Equipment (PPE) is worn when necessary; few places have strict rules such as always wear a laboratory coat and glasses; hence PPE is largely left to people's own judgment; and,
- EH&S is viewed as not enforcing safety very strongly.

More detail on the full set of remarks is available in Appendix D-3. The review of the current status of laboratory safety culture conducted by the Task Force involved considerable outreach and provided the stakeholder community with opportunity for engagement on numerous levels. The outreach process was thorough and resulted in considerable input with a significant amount of data and information that was reviewed and categorized by the Task Force, as explained above. This data and information form the basis of the Task Force findings and recommendations below.

GOAL 2: Identify best practices of a sound, proactive laboratory safety culture

Identify best practices of a sound, proactive laboratory safety culture within the three critical functional areas that most closely touch the research laboratory environment within the:

1. Research laboratory and amongst the research group (PI, Post-docs, grad students);
2. Departmental and schools management systems; and,
3. EH&S programs and support functions.

After reviewing the safety culture literature and information taken from interactions with bench researchers and laboratory safety support staff, a set of "laboratory safety culture attributes" supporting a strong, positive laboratory safety culture was developed. These can serve as the basis of a set of best practices for those most closely involved with the day-to-day laboratory activities [Appendix E]. It is important to have a common set of safety culture attributes (principles, characteristics and traits) that describe a strong, positive safety culture across the broad range of research laboratory activities. These attributes describe patterns of interaction, group dynamics, communications and behaviors that appropriately emphasize safety, particularly in "goal conflict" situations (e.g., research production vs. safety, research schedule vs. safety, and cost of the effort vs. safety). Attributes are kept at a sufficiently high level of detail to ensure that they apply

across the range of research activities and myriad types of relationships [horizontal relationships (i.e., peer to peer researchers, individual researchers within laboratory group, researchers to safety representatives, etc.) and vertical relationships (researcher to faculty-PI/laboratory manager, researcher to EH&S, faculty-PI to Department Chair, and faculty-PI/laboratory manager to EH&S)] that exist among persons and groups engaged in academic research laboratory activities. The following represent the attributes of a strong, positive academic research laboratory safety culture:

Research group organizational dynamics

- a. Faculty-PI/laboratory manager and research group members maintain a safety conscious research work environment in which personnel feel free to raise safety concerns without fear of retaliation.¹⁷
- b. Faculty-PI/laboratory manager and laboratory research personnel demonstrate ownership for safety in their day-to-day research activities.
- c. Decision-making reflects that safety is a priority over research production and is compatible with good research science.
- d. Processes for planning and controlling research activities and tasks ensure that individual faculty-PIs, researchers, and other laboratory personnel communicate, coordinate, and execute their research work in a manner that supports safety.
- e. Faculty-PI/laboratory manager ensures that the personnel, equipment, tools, procedures, and other resources needed to ensure safety in the academic research laboratory are available.
- f. Faculty-PI/laboratory manager understands the risks of the research being conducted, are interested and actively involved in the laboratory safety program and integrate safety into the laboratory research culture.

Working behavior within the laboratory

- a. Laboratory members are considerate of others working in the laboratory and maintain a laboratory environment where safety and laboratory housekeeping are very important.
- b. Laboratory members openly discuss laboratory safety concerns and prioritization regularly.
- c. Laboratory members identify and manage their own safety environment and are receptive and

¹⁷ See also NRC Report p.76

responsive to queries and suggestions about laboratory safety from their laboratory colleagues.

- d. Laboratory members conduct their research using protocols and procedures consistent with best safety practices in the laboratory.
- e. Faculty-PI/laboratory manager evaluates the laboratory safety status themselves and know what to change, if needed, and how to manage the change to enhance safety in the laboratory.

Communication about safety within the laboratory

- a. The laboratory group ensures that issues potentially impacting safety are identified and appropriately communicated commensurate with their risks and potential consequences.
- b. The laboratory supports a continuous learning environment in which opportunities to improve safety are sought, communicated and implemented.
- c. The feedback loop on identified safety issues (bottom-up and top down) is closed (addressed) at the faculty-PI/laboratory management level.
- d. Safety discussions become part of regular laboratory meetings; near-misses within the laboratory are consistently reported in a timely manner and safety information is requested by laboratory members to prevent future mishaps through understanding HOW and WHY laboratory near misses and accidents happen.

Environmental Health & Safety program

- a. EH&S provides easily accessible laboratory safety information.
- b. EH&S staff promotes laboratory safety improvement while trying to reduce the inconvenience to laboratory members.
- c. EH&S staff is involved in the early stages of laboratory and experimental design and provides technical consultation and safety support.
- d. EH&S supports adaptation and localization of safety procedures by laboratory members so long as they meet the intent of the safety requirements.

- e. EH&S communicates lessons learned from incidents and near-misses so others may improve safety practices (unless egregious actions, ongoing investigations or litigation preclude the sharing of details).

Organizational attitudes about laboratory safety

- a. Roles, responsibilities, and authorities for safety in academic research laboratories are clearly defined and reinforced.
- b. The organization's decisions ensure that safety in academic research is maintained as a priority and supported.
- c. The organization ensures that the facilities, infrastructure, programs and other resources needed to ensure safety in academic research conducted at the institution are available.
- d. Management acknowledges and rewards exemplar laboratory safety experiences and promotes as examples to other laboratories.

These laboratory safety culture attributes will form the basis for subsequent evaluation of findings from the review as well as help guide development of tools and aids for laboratory groups in promoting and adopting these best practices into their daily discussions, work and research practices within the laboratories and within the respective research laboratory groups.

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“Safety is a core value at Stanford and the University is committed to continued advancement of an institutional safety culture with strong programs of personal safety, accident and injury prevention, wellness promotion, and compliance with applicable environmental and health & safety laws and regulations”

During the course of this review, responses of individuals who have reviewed the best practice attributes, principal investigators, laboratory bench researchers and safety support staff have been very positive that these represent guidelines and practices that are, indeed, appropriate and achievable in the advancement of a robust laboratory safety culture. The challenge arises from many laboratory groups, including the principal investigator, not utilizing many or any of the recognized good practices of a good laboratory safety culture. Promotion of and support for more laboratory research groups to use the above as guidance for laboratory safety within their groups will be a major outcome of this review.

GOAL 3: Identify roles, responsibilities, authorities and accountabilities for laboratory safety

Clarity around relative roles and responsibilities for strong safety management in laboratory research is an ongoing discussion within many organizations. The [*Health & Safety Policy at Stanford: Principles, Practices and Procedures*](#) was updated last by the University Committee on Health and Safety and approved by the President in October, 2012. (Appendix F) In the opening statement, the policy conveys the institution's commitment to safety.

Table 1 from the *Health & Safety Policy* document clearly delineates the respective roles and responsibilities for safety and health of those throughout the organization, both for individuals who work in laboratories, as well as for supervisors, including faculty who operate research laboratories. The Task Force activities clearly embrace this institutional commitment to continued advancement of the laboratory safety culture at Stanford. Roles and responsibilities for safety throughout the organization and within research laboratories themselves are defined within the institutional health and safety policy. What is not as clear is how well faculty-principal investigators and others in the research laboratories understand and participate in fulfilling these responsibilities.

In addition to the roles and responsibilities described in the University Policy on Health & Safety, the Task Force developed attributes of a strong, positive laboratory safety culture, identified in the prior section, can also

contribute to clarification and identification of roles, responsibilities and authorities within the laboratory.

One of the findings from the Task Force outreach and review is that there is lack of clarity over roles, responsibilities, authorities and accountability by many of the different sectors involved within the research laboratories as well as those supporting research safety from principal investigators to bench researchers, Environmental Health & Safety, department chairs and upward through the system hierarchy.

Another main finding is that individuals in laboratories look primarily to the faculty-principal investigator of their individual research groups for leadership on safety within the laboratories for their group. If the faculty / Principal Investigator is engaged in and focuses on safety as core and intrinsic to the conduct of good research, most individuals within those research groups follow that leadership direction and counsel. If the faculty / Principal Investigator is focused on research production as a priority, and safety is seldom discussed or is not visibly supported, then the message received by the researchers in the group is that safety is not a priority or not a priority over research production, and the risk of safety incidents and accidents within the group can be elevated.

One major difference in opinion between PIs and researchers identified from the survey is that a significant minority (~15%) of researchers do not agree that their responsibilities for safety had been clearly communicated, whereas nearly all PIs believe they had clearly communicated such responsibilities.

Clearly, more needs to be done to clarify the respective roles and responsibilities, both institutionally and within research laboratory groups.

Table 1.

Principles, Policies, and Procedures: Roles and Responsibilities from the Health & Safety Policy at Stanford.

(Appendix F)

Role	Responsibilities
Managers	<p>University managers, academic and administrative, are responsible for ensuring that:</p> <ul style="list-style-type: none"> • Individuals under their management have the authority to implement appropriate health and safety policies, practices and programs; • Areas under their management have adequate resources for health and safety programs, practices, and equipment; and, • Areas under their management are in compliance with Stanford University health and safety policies, practices and programs.
Supervisors	<p>University supervisors, including faculty supervisors and Principal Investigators (PIs), are responsible for protecting the health and safety of employees, students and visitors working under their direction or supervision. This responsibility entails:</p> <ul style="list-style-type: none"> • Being current with and implementing Stanford University health and safety policies, practices and programs; • Ensuring that workplaces, including laboratories, and equipment are safe and well maintained; • Ensuring that workplaces or laboratories are in compliance with Stanford policies, programs and practices, and, • Ensuring that employees, students and visitors under their supervision or within their work areas have been provided with appropriate safety training and information, and adhere to established safety practices and requirements.
Faculty, Staff, and Students	<p>Faculty, staff and students are responsible for:</p> <ul style="list-style-type: none"> • Keeping themselves informed of conditions affecting their health and safety; • Participating in safety training programs as required by Stanford policy and their supervisors and instructors; and, • Adhering to health and safety practices in their workplace, classroom, laboratory and student campus residences; advising of or reporting to supervisors, instructors or EH&S potentially unsafe practices or serious hazards in the workplace, classroom or laboratory.
EH&S	<p>Environmental Health & Safety (EH&S) is responsible for:</p> <ul style="list-style-type: none"> • Reviewing legislation, recommending policies, and monitoring compliance with environmental and health and safety statutes and regulations and University health and safety policies and programs; • Developing institutional safety and compliance programs and assisting schools, departments, faculty, and managers with implementation; • Providing guidance and technical assistance to supervisors and managers in the schools, departments, and other work units in identifying, evaluating, and correcting health and safety hazards; • Developing programs for the safe use of hazardous radiological, biological, and chemical substances and lasers; • Providing training materials, assistance, and programs in safe work practices; • Providing guidance on effective emergency management and business continuity programs, and providing emergency response services for incidents involving hazardous materials; • Providing fire prevention, inspection, engineering and systems maintenance services; and, • Hazardous waste management and disposal services. <p><i>While EH&S is responsible for developing and recommending relevant health and safety policies, institutional policy approval rests with other University authorities, (e.g., President, Provost, Vice Provost and Dean of Research, Faculty Senate, University Cabinet, University Committee on Health & Safety, Committee on Research, Administrative Panels for Research Oversight, etc.) depending on the content of the proposed policies.</i></p>

GOALS 4 and 5: Findings and Recommendations

As described above, the Task Force developed a common set of safety culture attributes (principles, characteristics and traits) that describe a strong, positive laboratory safety culture across the broad range of research activities that take place here at Stanford.

These attributes of a strong, positive laboratory safety culture fall within the following general categories:

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

The findings and recommendations of the Task Force are summarized and presented below and are aligned along these best practice attributes. Many of these Task Force findings and recommendations reflect some of the findings and recommendations in the recent National Research Council Report on Safety Culture Academic Chemical Research.¹⁸

The general order of presentation includes representative stakeholder comments related to the best practice area, followed by identification of significant findings and recommendations.



Figure 3. Attributes of a Positive Laboratory Safety Culture

Laboratory research group organizational dynamics

Stakeholder Comments

"What can the PI do for me? Support my interest to change the culture in our laboratory. I want to implement the suggested safety guidelines, but I have resistance from my PI." "Don't waste your time with the waste disposal. Go run your experiments. This I have heard about proper waste disposal, student training, and organizing chemical storage."

"Safety in group laboratories is overwhelmingly handled by students and post-docs. Two issues arise from this: 1) careful pass down of information from one safety officer to the next, 2) oversight of these officers (or training of them by STARS). PIs should be aware to engage in these ideas, since they are ultimately responsible."

"I wish our PIs and laboratory members were more involved in their laboratory safety; including emergency preparedness and laboratory safety and making sure the PI's laboratory members are trained on safe equipment handling..."

"Where should leadership for safety in a laboratory originate?"

"PIs should provide an environment where (they are) approachable to ask questions about standard operating procedures, not to have it be stressful/intimidating to talk about potential hazards."

Findings

- Stanford research groups do not function within a single laboratory safety culture; safety culture is local and varies group by group, laboratory by laboratory, building by building.
- 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. Some PIs hold separate safety meetings, others don't even mention safety at the outset of their weekly group meeting.
- Stanford stakeholders identified and commented on the potential implications for lab safety culture due to

¹⁸ National Research Council. *Safe Science: Promoting a Culture of Safety in Academic Chemical Research*. The National Academies Press, Washington, DC 2014

the power disparity between laboratory researchers and the principal investigators in whose laboratories they work. It has been well known for many years, and noted in the recent NRC Report that students and post-doctoral fellows are often dependent on the research faculty/PI for their continued research training and advancement.¹⁹ This relationship between PI and research students and trainees may involve a power differential that can impact research group dynamics and a student/post-doc's willingness to raise safety concerns.

- 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 did not agree with the statement "In our lab, safety is the highest priority" compared to <5% of PIs.
- The competitive nature of research, combined with the entrepreneurial spirit on campus, and the pressure to publish and obtain funding, promotes a culture where safety is not always viewed as a primary priority. New PIs represent a particularly vulnerable group as they often have no managerial training and are often under intense pressure to produce research results.
- Many PIs are not able to be in their laboratories very often due to administrative responsibilities, they rarely do bench research. They also travel a lot and they can't be the day-to-day enforcer of safety practices. That is left to the individual laboratory researchers' own responsibility, or to a PI designate such as a laboratory manager.
- 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 role.
- New PIs are not systematically trained on how to start a laboratory, nor how to build safe practices into their experiments beginning with their first day on campus. PIs don't get a "how to manage and run a safe lab" course when they first get to Stanford; nor are they evaluated on their laboratory safety

record. PIs work quite independently and do not learn from each other; good safety practices are not typically shared.

- PIs believe that Stanford must provide more safety resources (laboratory coat washing, ergonomic workspaces) and are resistant to paying for these kinds of things themselves.
- Laboratories have a much better safety culture if the PI actively supports safety as a priority. An active senior laboratory manager that does research can drive the safety culture much more than a PI who is seldom in the lab. A laboratory manager is often older and yields natural authority because of his/her seniority even if their education is less. Also, they develop authority because they are a resource the researchers come to appreciate. However, even some large laboratories do not have laboratory managers. Laboratory managers get their authority from a PI who backs them unequivocally. If they feel they are not backed up by their PI, laboratory managers can get cynical and ineffective in managing or enforcing safety. Laboratory managers can insist on appropriate PPE.



Unless the PI takes an active role in ensuring safety is a priority, research groups without lab managers often can organize themselves however they want where safety is concerned, and this can be far from optimal when it is not the PI's focus.

Some laboratories assign a senior grad student the safety role, in others it is assigned to new grad students; the latter is not ideal as younger grad students often lack the natural authority to correct non-safe behavior (although it depends on the personality). In some laboratories, researchers work independently and don't even talk with each other much; in others there is more cohesion. The layout of the laboratory and whether people work together on projects has a lot to do with this. A cohesive group is more conducive to having a positive safety culture as safety is enhanced when there is social pressure.

¹⁹ National Research Council. *Safe Science: Promoting a Culture of Safety in Academic Chemical Research*. The National Academies Press, Washington, DC 2014

RECOMMENDATIONS

Laboratory research group organizational dynamics

1. **A strong, laboratory group safety culture should be developed and supported by the PI as a critical element in the responsible conduct of research.** *Principal Investigators need to assure researchers under their tutelage understand and utilize safety within the context of responsible conduct of research. Include health and safety as a performance measure for Principal Investigators. Add compliance with health and safety as a job factor in all staff job descriptions and performance evaluations, if not already in place.*
2. **Develop research laboratory safety culture awareness outreach and information for current and incoming Principal Investigators.** *Brief them on their obligations, roles and responsibilities for health and safety and encourage more open safety communication between PIs and research trainees. Provide information on the best practices of a strong, positive laboratory safety culture. Faculty -PIs were viewed by the vast majority of researchers as the individuals who were most important in establishing a culture of safety. A unifying theme of our findings was that new faculty members are not systematically trained on how to start a laboratory, or how to build safe practice into their experiments beginning with their first day on campus. Rigorous "new PI" safety programs must be developed, offered, and perhaps mandated.*
3. **Principal Investigators must stipulate and provide assurance for everyone within their group that safety within their research laboratory is a top priority and must clearly define roles, responsibilities, authority and accountability for safety within the laboratory.**

Working behavior within the laboratory

Stakeholder Comments

"Worst problem: unaccountability, no one admitting, "they did it." Not acting safely because they can get away with it and no one notices."

"People should be less apathetic about others' safety."

"In the chemistry department, there seems to be a mentality of, "clean up, there's going to be an inspection," rather than thinking seriously about safety concerns and why the regulations that are in place are there."

"While for the most part, I think practices are carried out safely in my lab, there is not an emphasis on safety. In particular, students and post-docs have a wide range of familiarity with safety practices and guidelines, as we all come from different backgrounds, and there is a high tolerance for people with unsafe practices to continue those practices."

Findings

- The Task Force noted that turnover of scientists at universities is very high, much higher than in industry. Most researchers (post-docs, grad and undergrad students) in Stanford laboratories are still undergoing continued training and professional development in all aspects of research, including the identification and use of research safety tools.
- PIs do not hear about all of the new procedures conducted by researchers. More than 20% of researchers in the survey did not agree with the statement that they review risks and safety procedures prior to starting a new research procedure.
- Particular groups are especially at-risk, including 'volunteer' high school and undergraduate students, short-term undergraduate researchers, visiting scholars, and scientists from other laboratories working for short periods to learn techniques or to perform specific experiments. Also vulnerable are nonscientific staff who enter laboratories, custodial and maintenance workers, and non-Stanford vendors who should be made aware of particular

hazards or risks associated with the laboratory operations.

- Hazard analysis and risk assessment for hazardous materials remains part of the ongoing educational process for academic research personnel. Laboratory researchers write their own Standard Operating Procedures (SOPs), but SOPs are not shared between laboratories even though they may be using the same reagents, and very similar procedures. Additionally, there is no central repository to maintain SOPs and new generations of researchers must recreate SOPs for similar prior work. Researchers are not taught how to think about safety. What could possibly go wrong? There is no course on how to be safe in experiments. Developing an SOP is a good way for them to think through the possible safety steps, but not every student or researcher develops one for every new procedure.
- Lack of, or incorrect and inconsistent use of, Personal Protective Equipment (PPE) in a research laboratory is a significant issue and is a visual clue pointing to less than acceptable laboratory safety culture. For example, sandals and shorts are observed, but the sentiment is that everyone knows it's wrong and nobody cares. PPE is worn when necessary, but few places have strict rules such as always wear a laboratory coat and glasses when in the lab; hence PPE is largely left to people's own judgment. Some laboratories send people home that come in with shorts (the ones with laboratory managers). Many don't. 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.
- Newer, open laboratories create safety challenges with the placement of researchers' desk areas within operational laboratory spaces. This issue is often exacerbated by the open laboratory design that places bench researcher's desks immediately within the laboratory bench working areas.
- Online training is seen by some as important, by others as quite useless. Hands-on on-the-job training by a mentor is the most effective way to learn.

RECOMMENDATIONS

Working behavior within the laboratory

1. **Laboratory researchers need to conduct risk assessments** that properly identify and evaluate the hazards and risks of the proposed experimental process.
2. Laboratories need to **include a research group member onboarding process for new lab researchers** that includes clear expectations, requirements and accountability regarding working safely in the research laboratories and assure this information is communicated to and regularly reinforced with all incoming researchers.
3. For short-term transient scientists and untrained personnel, **mechanisms need to be developed to assure such researchers are properly trained** and certified to work in research laboratories on campus, and that volunteers in laboratories are not allowed, except through specifically designated school approved and supported programs. Particular groups are especially at higher risk, including 'volunteer' high school and undergraduate students, undergraduate researchers, visiting scholars and scientists from other laboratories working for short periods to learn techniques or to perform limited or specific experiments.

Mechanisms must be developed to ensure that untrained personnel and transient scientists and workers are properly trained and approved to work in research laboratories on campus, and that volunteers in laboratories are not allowed.

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RECOMMENDATIONS

Working behavior within the laboratory

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4. **Designate a laboratory safety coordinator for each laboratory group** (preferably a senior researcher). The PI needs to provide a clear role, responsibility and authority to the laboratory safety coordinator position. To ensure smooth transition in this role, a three month crossover between outgoing and incoming laboratory safety coordinators is recommended. Departments and PIs should collaborate with EH&S on developing a template for laboratory safety coordinator responsibilities and authority; EH&S should provide contact staff to work with and help support Laboratory Safety Coordinators.
5. EH&S and University Safety Partners (USPs) need to **develop and enhance programs for support of** and regular interaction with **laboratory safety coordinators**.
6. EH&S, with input from PIs, USPs, and laboratory safety coordinators, will **develop and institute a revised institutional Personal Protective Equipment (PPE) program** with laboratory and research procedure specific risk-based requirements. Consider making this a Stanford policy requirement for work in all wet laboratories at Stanford (research and undergraduate).
7. **Research laboratory design at Stanford must be reviewed and updated** to accommodate developing and new requirements for safety of personnel stationed within research spaces but not conducting research (such as working at writing desks, computers, etc.).

Communication about safety within the laboratory

Stakeholder Comments

“Our laboratory and department has recently been stressing the importance of removing gloves (or a glove) when you enter common areas like hallways, stairwells, open doors, etc. However, I have noticed in other buildings like Beckman or Lokey Stem Cell many researchers walking around and opening doors with gloves on in common areas.”

“Learn most about safety protocols from post docs; but not much comes through departments. This is where basic training happens, but not practical to cover more specific at this level. Video training may be most effective for more specialized training needs.”

“...students and post-docs have a wide range of familiarity with safety practices and guidelines, as we all come from different backgrounds, and there is a high tolerance for people with unsafe practices to continue those practices...”

Findings

- Poor communication is a major underlying component of the safety comments observed or received by the Task Force.
- Laboratory safety coordinators and departmental safety contacts often play an important role in driving safety culture within the laboratory. There are examples of many excellent laboratory safety programs in place at Stanford.
- Based on this Task Force review, hands-on training in the laboratory by a mentor is the most effective way to learn and retain laboratory safety information.
- It was noted that the physical presence of health and safety personnel in laboratories and at laboratory meetings may identify safety problems before injuries occur, and may also improve communication between bench scientists and health and safety personnel.
- Incidents and near misses are not effectively reported, within Stanford’s research community. As an educational institution, regular communication of safety information is important to sustaining a strong, positive safety culture. A change in the reporting and sharing of incident information, causes and recommendations for caution are much needed.

- There is a lack of good, readily available safety information on chemicals. Safety Data Sheets (SDS) are difficult to interpret for laboratory research use and often overstate the dangers. There is a real lack of “practical information.” Trustworthy, practical safety information has to come from other (senior) researchers; many don’t see EH&S’ website as a reliable source for practical information. People rarely go out of their research group to ask safety questions. Stories from accidents are probably the best way to remember but incident and near miss stories are not regularly collected and disseminated.
- Safety training programs are an important part of a robust laboratory safety culture.
- Continued education in laboratory safety should be as important as the scientific process in the early stages of academic research personnel career development
- All forms of lab safety training can be useful, but Stanford researchers have indicated that hands-on training in the lab is most useful and valued.
- Longitudinal training is an effective means to reach researchers. Such training 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.
- Annual training meetings and safety walk-throughs are important. It was noted that the physical presence of health and safety personnel in laboratories and at laboratory meetings may help identify safety problems before injuries occur, and may also improve communication between bench scientists and health & safety personnel. Resources should be provided to enable regular personal contact between health and safety staff and bench scientists.
- A system for reporting of minor incidents and near misses is an integral component of a laboratory safety culture.

RECOMMENDATIONS

Communication about safety within the laboratory

1. 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. Examples include incorporating safety as a standing agenda item in laboratory meetings and the inclusion of a “safety moment” at the start of every meeting, etc.
2. EH&S and departments need to **identify best practices of laboratory and departmental safety coordinators and others for communicating** health and safety information and supporting local implementation of health and safety programs within their units. Promote these best practices within and among other laboratories.
3. **Outreach and information programs for PIs and all scientists need to 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.
4. EH&S needs to **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.
5. **Examine the online and classroom delivery of safety courses** for both content and method of delivery. Explore new methodologies for delivery of training programs to enhance learning and retention of health and safety information. Evaluate need for periodic retraining of certain topics and refresh existing training as often as necessary.

Environmental Health & Safety programs

Stakeholder comments

“Update EH&S website and make it searchable. Right now, the EH&S website is hard to navigate and out-of-date. If I could easily look up safety practices for reagents, I would be safer.”

“As a safety officer for our laboratory, I interact with reps from EH&S fairly regularly – but I don’t feel like some of them understand what safety practices are prohibitive in terms of getting stuff done versus what are actually reasonable, and they don’t seem receptive to feedback (or even ask these types of questions).”

“Compliment: Richard, from EH&S, comes to the laboratory and makes comments and suggestions. Very helpful.”

Findings

- One of the most frequent comments from stakeholders is that the EH&S website is in dire need of major updating and rebuilding. It was noted that the website has good safety information but takes much too long to identify the necessary information. EH&S must provide better coordination of informational services that support the laboratory safety culture and many “practical” safety advice provided. EH&S must serve as a repository of laboratory safety information and resources for the research laboratories.
- EH&S must be able to understand chemical research processes and work collaboratively with laboratory researchers on Safety Operating Protocols (SOPs) for research experiments. EH&S staff could be more helpful if they spend additional time in the laboratory understanding experimental processes and explaining the rationale for compliance program elements. Some people have called EH&S but were made to feel like they are in trouble even though they were just trying to get information; such experiences discourage future reporting.
- EH&S conducts regular safety audits but there is a lack of collaborative follow up. EH&S does not enforce safety very strongly; some EH&S personnel are timid and don’t approach researchers easily. According to recently published information, safety inspections can be a major leading indicator of potential incidents in a robust safety culture program, and this will be explored further for application at Stanford.
- A number of lab research groups at Stanford have indicated they have experienced positive interactions and mutually supportive relationships

between EH&S staff and researchers. Such groups are noted to often have a lab manager or more robust laboratory safety culture.²⁰

- EH&S and research laboratories will require financial and personnel resources to enhance and promote advancement of the culture of safety for the Stanford Community.

RECOMMENDATIONS

Environmental Health & Safety programs

1. **Redesign the EH&S website** to make it useful, readily accessible and searchable by bench researchers and other constituencies. Almost all information needed is currently on the website, but difficult to find relevant info quickly when you need it. Improvements or redesign to the existing website must be researched and implemented. Organizations with effective web-based training, protocols, interactive chemical databases, and other web-based resources should be identified and replicated wherever possible. A comprehensive review and remake of the website is needed. Personnel and financial resources must be provided to EH&S by the university to accomplish this.
2. EH&S, in collaboration with local safety personnel and laboratory researchers, should **develop laboratory safety inspection tools** that aid in supporting a viable laboratory safety culture program.
3. More personal contact between EH&S / USP staff and bench researchers will **advance communications that support a positive safety culture**.
4. EH&S should coordinate with departmental representatives, including PIs and lab researchers to identify the types and themes of **training that supports a viable and robust lab safety culture**.

Institutional and organizational attitudes about laboratory safety

²⁰ See also NRC Report p.76

Stakeholder comments

“Safety is facilitated by laboratory design!”

“Safety should begin with the design of each new building.”

“My laboratory is very isolated from common laboratory equipment. I have to go through three doors to image my ethidium bromide gel. I try to be careful not to touch door handles to and from, but sometimes in a hurry it happens because I need to wear gloves to handle gel. If we can, make equipment available in a way that allows easy safe access.”

“There should be some mechanism for enforcing regulations (aside from informing/instructing).”

“Currently, there are no repercussions enforceable by laboratory safety coordinators, i.e., this person always wearing shorts, despite warnings.”

“Everything is monetized, but we need some core resources, i.e., laundry service. I work in a small laboratory. It is more expensive to have our laboratory coats cleaned than to purchase new ones. There also is no laundry facility so as a laboratory manager, I have to take laboratory coats home to clean in my personal washer/dryer. We end up using many disposable laboratory coats which do not offer the same level of protection because I do not want to wash radioactive coats at home.”

Findings

- Safety is a noted priority and a core value of Stanford University as evidenced in the University Health and Safety Policy (Appendix F). Periodic reinforcement of safety as a core value by the university President, Provost, Deans, Chairs and other institutional leaders is needed to promote safety as a core value.²¹
- Responsibilities for safety within the laboratory are not always clearly known or communicated.

- Stanford’s excellence in research must include a similar excellence in a strong, positive laboratory safety culture.
- Research laboratory safety begins with research building facility planning and design for safety. EH&S as well as scientists at all levels should be involved in conception, design and plan review to ensure that safety is thoroughly considered in new construction as well as planned renovation. Funding for these measures should be included as part of construction, as should oversight to insure space dedicated to laboratory safety is not redesigned in the final stages because safety is deemed less important than office or laboratory space.
- Simple things such as washing machines for laboratory coats, showers, better-designed emergency wash stations, handleless door opening devices are examples of measures suggested by scientists during our outreach. In addition to core health and safety code and regulatory requirements that must be met in laboratory designs, also further enhance process to account for human behavior in laboratory design. Ex: Gloves and doorknobs is a concern expressed by numerous individuals in the Town Halls and websites. Evaluate mechanisms to engineer out this problem for future buildings and renovations (e.g., installation of automatic door openers); implement administrative controls and educational campaigns for existing locations for the short term.
- In crowded laboratories, safety is often more compromised and accidents are more likely to occur. There is more stuff to knock over and crowded hoods can cause people to do experiments on the bench that really must not be done there.
- The gloves on door handle problem is exacerbated by the set-up of the laboratory (in the Lorry Lokey Stem Cell research facility, for instance, people must walk from room to room with samples so they have to wear at least one glove, and door handles cannot be opened with an elbow). Installing a vented storage cabinet in a building not originally designed to handle such a thing can be expensive (and therefore impossible). In one laboratory the installation of a chemical storage cabinet was refused, with the result that researchers must walk some 50 yards to get their chemicals, increasing the chance of accidents.
- In some laboratories benches are next to the desks, which makes food and drink on the benches and also not using PPE more likely. Who would want to sit in front of their computer all day wearing safety glasses and a laboratory coat? The distance of the laboratory from the PIs office has a great impact on the PIs ability to come by for inspections

²¹ See also NRC Report p.74

(McCullough-Moore is quite a distance; other PIs have offices directly next to or across from their labs).

- In laboratories in which researchers must share equipment, there can be positive social pressure to keep things clean and neat, whereas in laboratories where researchers have their own bench and hood, sloppiness is commensurate with an individual's own desire for cleanliness.
- Funding for safety equipment and requirements within the laboratory remain a continuing struggle for many. Reports have been received of researchers being required to use only gloves on one hand in a bio research laboratory, to launder their own laboratory coats, etc. Also, when additional, often costly safety equipment such as additional fume hoods or toxic gas monitoring is required for specific research, resources are very difficult to obtain.
- Everything is monetized, but laboratory operations need some core resources such as centralized laundry service. In some laboratories, it is more expensive to have laboratory coats cleaned than to purchase new ones. Also, there are no central laundry services, so some laboratory personnel have to take laboratory coats home to clean in their personal washer/dryer.
- Safety culture does not begin and end at the laboratory door. To some extent institutional safety culture begins with practices outside laboratories – bike safety, helmets, stopping at crosswalks, etc.
- Changing culture is not going to be easy, nor will it happen rapidly.
- Stanford has a good, basic research laboratory safety compliance program, but must also strive to move beyond compliance and focus on establishing a strong, positive laboratory safety culture.

RECOMMENDATIONS

Institutional and organizational attitudes about laboratory safety

1. Stanford University Health and Safety Policy highlights safety as a core institutional value. **Periodic promotion and reinforcement of this university policy** as well as demonstration of ongoing commitment for stronger programs and infrastructure to support laboratory safety by the university President, Provost, Deans, Chairs and other institutional leaders is needed to maintain and sustain safety as a core value.²²
2. **Clearly identify and promote the roles, responsibilities, accountabilities and authority for safety** of faculty, staff, researchers and students contained in the the Stanford Health & Safety Policy and other related safety regulations, policies and programs. Related to this, clarify how accountability for safety works including issues related to legal liability and responsibilities. Consider establishing a range of realistic consequences for failure to adhere to health and safety requirements.²³
3. **Provide opportunities for centralized funding support** for personal protective equipment (PPE), safety equipment and other safety requirements within research laboratories at the university. Personal Protective Equipment (PPE) in research laboratories is a significant issue and visual clue pointing to lack of a basic laboratory safety culture. For example, providing for safety glasses and laboratory coats and laundering is an issue that could benefit from better institutional support. Clarify sources of funding to support EH&S requirements within the laboratory. Ensure there are no unfunded institutional-based mandates

²² See also NRC Report p.74

²³ See also NRC Report p.75

Next Steps

Many of the goals of this Task Force were fully or partially addressed during this review and deliberations process. Ensuring a strong, positive safety culture within the research laboratory group is very important as it is estimated that the four to five year turnover rate of those conducting research in Stanford laboratories is approximately 60-80% of the laboratory bench researchers. This constant turnover of bench research personnel creates unique challenges for sustaining a robust laboratory safety culture. Because the focus of academic research is the advanced training of researchers new to the field, the change in bench researcher populations (comprised mostly of post-doctoral fellows and graduate students) requires a strong laboratory safety culture to ensure a consistent level of safety practices within the laboratories. The primary consistent elements during this change in population are the respective departments, the principal investigator (or laboratory manager for those groups with such a person) and Environmental Health & Safety support personnel. These three organizational elements must coordinate closely to develop and provide programs and tools to aid principal investigators and laboratory managers in supporting and managing a strong safety culture within their respective laboratories.

Changing and nurturing safety culture in an organization with such turnover in the bench research community changes requires an ongoing commitment of the university, but most importantly, from faculty-PIs who provide the basic constancy within Stanford's research laboratories. Therefore, there is ongoing work to be done to realize actualization of these recommendations and also to develop support tools and information for both faculty-PIs and others who support the research laboratory safety culture at Stanford.

NOTE: Appendices are not included in this report. To view Appendices, please review the Report with Appendices or the Appendices Only document.

List of Appendices:

Appendix A: Charge to the Task Force on Advancing Laboratory Safety Culture at Stanford

Appendix B: Safety Culture Presentations to the Task Force

Appendix C: Summary of Stakeholder Meetings and Online Submittals Information

Appendix D: Laboratory Safety Culture Survey and Ethnography Review (PARC)

Appendix E: Attributes of a Strong, Positive Research Laboratory Safety Culture at Stanford

Appendix F: Health & Safety Policy at Stanford