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

Table of Contents

Task Force Members 4
Preface 5
Introduction 6
Executive Summary 7
Summary of Findings and Comments 7
Laboratory research group organizational dynamics 8
Working behavior within the laboratory 9
Communication about safety within the laboratory 10
Environmental Health & Safety programs 11
Institutional and organizational attitudes about laboratory safety 11
Recommendations 12
Research Laboratory Group Leadership and Initiatives 12
Institutional Policies/Initiatives 12
Environmental Health & Safety (EH&S) 13
Technology Solutions for Health and Safety Support of Laboratory Research 13
Task Force 15
Overview 15
Objectives and Goals of the Task Force Review 15
Task Force Activity 16
Perspectives on Laboratory Safety Culture 16
Task Force Plan of Action 18
Task Force Outcomes 18
Research Laboratory Safety Culture 18
GOAL 1: Review and evaluate the existing state/perception of safety culture in academic research laboratories 18
GOAL 2: Identify best practices of a sound, proactive laboratory safety culture 21
GOAL 3: Identify roles, responsibilities, authorities and accountabilities for laboratory safety 23
GOALS 4 and 5: Findings and Recommendations 25
Laboratory research group organizational dynamics 25
Working behavior within the laboratory 27
Communication about safety within the laboratory 29
Environmental Health & Safety programs 31
Institutional and organizational attitudes about laboratory safety 32
Next Steps 34
Appendices 35

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Appendix A: Charge to the Task Force on Advancing Laboratory Safety Culture at Stanford 35

Appendix B: Safety Culture Presentations to the Task Force 39

B-1: Measuring Patient Safety Culture / Climate in Hospitals by David Gaba 39
B-2: Moving the Bar: Advancing a Culture for the Conduct of Safe Science in Academic Research Laboratories by Larry Gibbs 41

Appendix C: Summary of Stakeholder Meetings and Online Submittals Information 44

C-1: Summary of Stakeholder Input Graphical Analysis 44
C-2: Stakeholder Input Summary Analysis 45
C-3: Representative Comments from Stakeholder Input 46

Appendix D: Laboratory Safety Culture Survey and Ethnography Review (PARC) 47

D-1: Survey Results Summary (Organized by Attribute) 47
D-2: Survey Results Presentation 51
D-3: Ethnographic Review and Interviews Report 61
D-4: Survey Form (for Principal Investigator) 115
D-5: Survey Form (for Laboratory Researchers) 121

Appendix E: Attributes of a Strong, Positive Research Laboratory Safety Culture at Stanford 127

Appendix F: Health & Safety Policy at Stanford 129

APPROVALS

Original approved and endorsed by the University Committee on Health and Safety (2014)

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.

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Preface

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

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Introduction

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.

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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.

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Laboratory research group organizational dynamics

Findings

- 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.

Comments

- 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.

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Working behavior within the laboratory

Findings	Comments
• Turnover of researchers (post-docs, grad students) at universities is very high, much higher than in industry. 60-80% of laboratory researchers change over a four to five year period. • New procedures and experiments are devised continually by laboratory researchers and it is rare that PIs are aware of every procedure carried out in their laboratories. • Risk assessment and hazard analysis of experimental procedures are not always conducted in academic laboratory research. More than 20% of researchers in the survey do not agree with the statement that they review risks and safety procedures prior to starting new research procedures. • In some laboratories, compliance with regulations and the wearing of personal protective equipment (PPE) is seen as integral to safety; in other laboratories, there is wide variation regarding use of appropriate PPE. • Particular groups are especially at-risk, including 'volunteer' high school and undergraduate students, short-term undergraduate researchers, visiting scholars, rotating graduate students, and scientists from other laboratories working for short periods to learn techniques or to perform specific experiments. Also vulnerable are non-scientific staff members who enter laboratories, custodial and service support workers, and non-Stanford vendors. • Newer, open laboratories create safety challenges with the placement of researchers' desk areas adjacent to or within operational laboratory spaces, as well as lack of good communication within laboratory groups or across different laboratory groups in open laboratories.	• All researchers (post-docs, grad and undergrad students) in Stanford laboratories are here to continue and advance their education and training; however, they may not have the necessary expertise and knowledge to identify or fully understand the hazards and risks associated with advanced laboratory research. A strong, proactive laboratory safety culture will aid in the development of the necessary knowledge and skills to work safely in the laboratory, and better prepare Stanford researchers for their ensuing professional careers. • 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

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Communication about safety within the laboratory

Findings	Comments
• 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.	• 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.

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Environmental Health & Safety programs

Findings	Comments
• 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]	• 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
• Roles and responsibilities are not always clear to those in research laboratories. The relative roles and responsibilities of faculty/PIs, those working in the research labs and EH&S personnel should be clearly promoted. • Research laboratory safety begins with laboratory facility planning and design for safety. New open laboratory designs place researcher work desks immediately adjacent to bench tops where research with potentially hazardous materials is being conducted. Simple facility and building items such as washing machines for laboratory coats, showers, better-designed emergency wash stations, and hand-less door opening devices are examples of measures suggested by bench researchers during our outreach. • Funding for safety equipment and requirements within the laboratory remain a continuing struggle for many. Everything is monetized, but laboratory operations need some core resources focused on safety support. • In crowded laboratories safety is often more compromised, there are more accidental chemical and reagents spills and incidents; crowded hoods can cause researchers to perform their experiments in unapproved and undesignated areas.	• Stanford's excellence in research ought to include a similar excellence in its laboratory safety culture. • Safety is an identified priority and a core value of Stanford University as evidenced in the University Health and Safety Policy (Appendix F). Periodic reinforcement by the University President, Provost, Deans, Chairs and other institutional leaders is needed to promote safety as a core value.[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

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

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

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#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.

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Task Force

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

[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

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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 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]

[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

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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.

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.

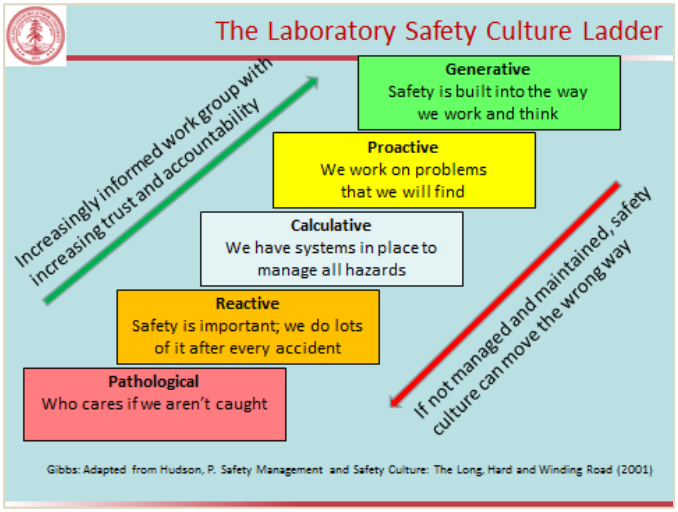

Figure 1. Safety Culture-Spectrum Ladder

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

[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.

[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).

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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

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:

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- 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.

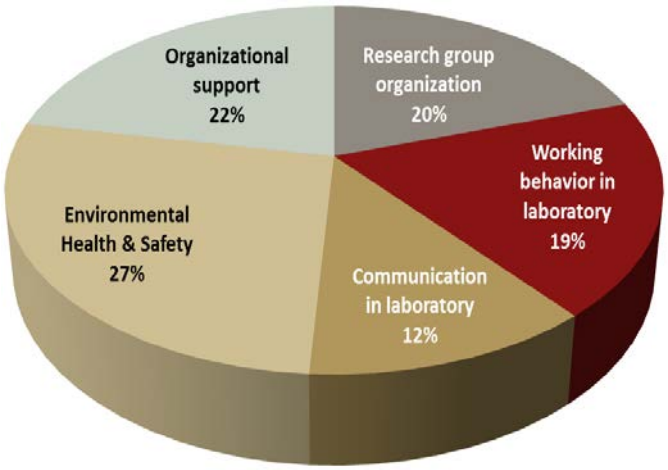

Figure 2. *Distribution of Comments by Laboratory Safety Culture Attribute*

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

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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: ±9% for the principal investigator survey and ±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,

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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]

[17] See also NRC Report p.76

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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 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.

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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.

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.

"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"

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.

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Table 1.
Principles, Policies, and Procedures: Roles and Responsibilities from the Health & Safety Policy at Stanford. (Appendix F)

Role	Responsibilities
Managers	**University managers, academic and administrative, are responsible for ensuring that:** • 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	**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:** • 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	**Faculty, staff and students are responsible for:** • 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	**Environmental Health & Safety (EH&S) is responsible for:** • 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. *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.*

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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 recommendatons reflect some of the findings and recommendatons 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

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

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.

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- Stanford stakeholders identified and commented on the potential implications for lab safety culture due to 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 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

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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

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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

(…continued)

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

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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 andsafety 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.

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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.**

[20] See also NRC Report p.76

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Institutional and organizational attitudes about laboratory safety

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]
- Responsibiilties 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, handless 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.

[21] See also NRC Report p.74

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- 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 (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

[22] See also NRC Report p.74

[23] See also NRC Report p.75

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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.

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Appendices

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

University Committee on Health and Safety

The Stanford University Committee on Health and Safety (UCHS), established in 1988, is a standing faculty-led committee reporting to the President of the University. The University Committee on Health and Safety is charged with advising the President on the adequacy of Stanford's health and safety programs, policies and organization; recommending needs, priorities and strategies to promote good health, safety and environmental practices on campus; and recommending to the President University-wide policies with respect to health and safety matters.

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

The unique management culture in universities creates challenges for establishing and maintaining an effective and responsive culture of safety in the laboratories. A culture of excellence pervades the research and teaching activities at Stanford. Stanford should aspire to a similar culture of excellence for laboratory safety. To explore opportunities to improve the safety culture at Stanford, the UCHS at Stanford, in coordination with the Office of the Vice Provost and Dean of research, has convened a Task Force under the auspices of the University Committee on Health and Safety to review Stanford's organization regarding laboratory safety culture and how the American Chemical Society (ACS) identified characteristics of a strong laboratory safety culture are aligned at Stanford.

The significance of an effective and responsive safety culture has been highlighted by several serious incidents in university research laboratories over the past four years. At UCLA, the tragic death of a laboratory staff research assistant resulted from release of a highly pyrophoric liquid during a laboratory transfer procedure, causing clothing she was wearing to catch fire. Another serious accident occurred in January 2010 in a Texas Tech University chemistry department laboratory in which a graduate student attempted to conduct a scale up production of a highly reactive material lost three fingers on his left hand, burned his hands, and injured his eyes. Since the Texas Tech incident in January 10th through 2012, 65 accidents have occurred at academic, government, and industry chemical research labs, according to a Chemical Safety & Hazard Investigation Board (CSB) investigator. Those accidents injured 136 and killed two persons.[22]

Both of these high profile incidents have received significant review and follow up. The Cal/OSHA investigation report on the UCLA incident and the Chemical Safety Board (CSB) report on the Texas Tech incident both suggested a deficient safety culture within the university organizations and within the institutional research laboratories as a root cause of the incidents. Three common themes to advance laboratory safety culture in academic research from follow up to both incidents have emerged: the need for a good internal reporting system for incidents and near misses; the need for creation and use of standard operating procedures for hazardous materials; and the need for more comprehensive oversight of and attention to safety within academic research laboratories.

These serious incidents and the aftermath have created significant interest in laboratory safety culture, as evidenced by frequent editorial articles, blog posts, and publications. The ensuing discussion has focused on many aspects including response of regulatory agencies, legal liabilities, lab management responsibilities and the various roles of myriad organizations and personnel involved at all levels in academic research laboratories. The bottom line is how to develop a sustainable and robust laboratory safety culture within academic research laboratory communities.

Although there has been much review of what could have been done differently in the reported incidents, a broader discussion has emerged on how to prevent laboratory research related incidents from occurring, and how to ensure that all academic researchers (faculty, laboratory managers, research associates/ assistants, postdoctoral fellows, graduate and undergraduate students) are better informed of laboratory safety risks and become more involved through enhancement and advancement of safety culture

22 http://cen.acs.org/articles/91/i20/Safety-Probe-Academic-Labs.html

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throughout laboratory research in higher education.

Key lessons reported from the Chemical Safety Board investigation of the Texas Tech incident include:

1. An academic institution modeling its laboratory safety management plan after OSHA's Laboratory Standard (29 CFR 1910.1450) should ensure that all safety hazards, including physical hazards of chemicals, be addressed.

2. Academic institutions should ensure that practices and procedures are in place to verify that research-specific hazards are identified, evaluated and mitigated.

3. Comprehensive guidance on managing the hazards unique to laboratory chemical research in the academic environment is lacking. Current standards on hazard evaluations, risk assessments, and hazard mitigation are geared toward industrial settings and are not fully transferable to the academic research laboratory environment.

4. Research-specific written lab safety protocols and training are necessary to manage laboratory research risk.

5. An academic institution's organizational structure should ensure that the safety inspector/auditor of research laboratories directly report to an identified individual/office with organizational authority to implement safety improvements.

6. Near-misses and previous incidents provide opportunities for education and improvement only if they are documented, tracked, and communicated to drive safety change.

In 2012, the American Chemical Society (ACS) assembled a Task Force to report on "Creating Safety Cultures in Academic Institutions." Their report defines safety culture as "a reflection of the actions, attitudes, and behaviors of its members toward safety" and suggests seven characteristics of a strong organizational safety culture:

1. Strong Leadership and Management for Safety
2. Continuous Learning about Safety
3. Strong Safety Attitudes, Awareness and Ethics
4. Learning from Incidents
5. Collaborative Efforts to Build Safety Culture
6. Promoting and Communicating Safety
7. Institutional Support for Funding Safety

The ACS report does highlight the importance of safety education in undergraduate teaching and academic research laboratories with an expectation that such focus will carry over in students that move forward into graduate studies in science research. The prior Cal/OSHA follow-up and Chemical Safety Board recommendations, as well as the ACS Task Force report focus significantly on the need for evaluating and advancing the safety culture throughout higher education and within all academic research laboratories.

A robust and positive laboratory safety culture is critical to maintaining, supporting and advancing the research excellence at Stanford. The Task Force will solicit information and input regarding laboratory safety culture elements from the various entities and personnel involved in the academic research laboratory environment. The Task Force is co-chaired by three senior research faculty from the schools of Engineering, Humanities and Sciences, and Medicine, and includes representatives of the various stakeholder constituencies directly involved in laboratory research and safety management at Stanford (graduate students, Post-docs, research associates/assistants, laboratory managers, faculty/PIs, university safety partners, EH&S, school and university research leaders, among others).

Specifically, the Stanford Task Force will examine the current status of laboratory safety in academic research at Stanford relative to the referenced characteristics of a strong laboratory safety culture. It will review the various Stanford laboratory stakeholder entities and operations that provide support for laboratory safety, and meet with and gather information and input from those conducting laboratory research including research faculty, laboratory managers, postdoctoral fellows, research associates and assistants, teaching assistants, and graduate and undergraduate students. It will compare practices and prevailing attitudes in the laboratory setting with knowledge and standards supporting promotion of a strong safety culture from current literature and best in class organizations and will make recommendations, as appropriate, for systems, practices and activities with the goal of continuing the advancement of a culture of laboratory safety as a core value and essential element in the responsible conduct of research at Stanford University.

Task Force Charge and Objectives

The overall charge to the Task Force is to prepare a report on the status of safety culture within academic research laboratories at Stanford and provide recommendations for

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continued advancement of a positive culture of safety within academic research laboratories at Stanford.

Although there are many diverse aspects involved in organizational safety cultures, the Task Force's initial efforts will focus in three specific organizational areas identified as core elements to supporting and advancing safety culture in academic research laboratories:

1. Within the frontline research groups conducting work at the bench top;

2. Within departments and schools with major academic research laboratory activity; and

3. Within the institutional organizations that provide safety support for research activities at Stanford, including leadership and senior administration, Environmental Health & Safety and the University Safety Partners.

To this end, the Task Force plan of action is to meet with principals, participant representatives and stakeholders of these three organizational areas to solicit input, information, perspectives on safety culture/safety program status and needs, and to receive suggestions for improvement and advancement of the laboratory safety culture in research at Stanford. With this organizational area focus, and bearing in mind the characteristics of a strong safety culture listed previously, the following general Task Force objectives have been 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 research laboratory environment within the:

    a. Research laboratory and amongst the research group (PI, Post-docs, grad students).

    b. Departmental and schools management systems.

    c. 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.

Recognizing the complexity of these tasks and goals, the Task Force recognizes that information gathered in initial stages of the evaluation may well inform directions for subsequent follow up. Therefore, the goal is to complete the initial stakeholder meetings and gathering of informational input (items 1 and 2 above) within winter quarter and, depending on findings from the initial informational gathering, complete the remainder of goals within spring quarter. This timeline is subject to many variables, and may need to be revisited as the process and information needs dictate.

Task Force Membership

Task Force membership consists of representation from a broad spectrum of the laboratory academic leadership and the laboratory research community. As necessary during the review and information gathering process, smaller work groups, including personnel not part of the main Task Force, may be formed to focus on specific program or topical reviews on behalf of the Task Force. The overall goal is to maintain efficiency while ensuring completeness resulting from thoroughness of stakeholder input and information gathering.

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Task Force 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 and 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

Task Force Members

- Anthony Appleton, recent post-doctoral fellow in Chemical Engineering at Stanford; currently Adjunct 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 for 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 and Safety Programs, School of Medicine; University Safety Partner Representative
- Nickolas van Buuren, Postdoctoral Research Fellow, Microbiology and Immunology
- Jessica Vargas, PhD student in Chemistry and Member, University Committee on Health and Safety

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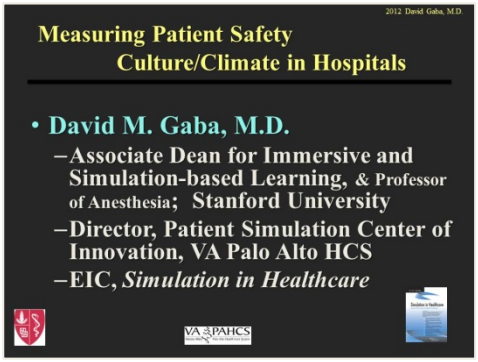
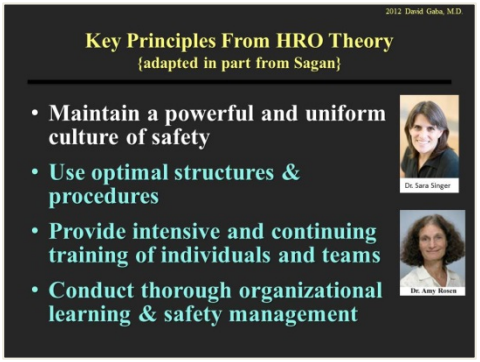
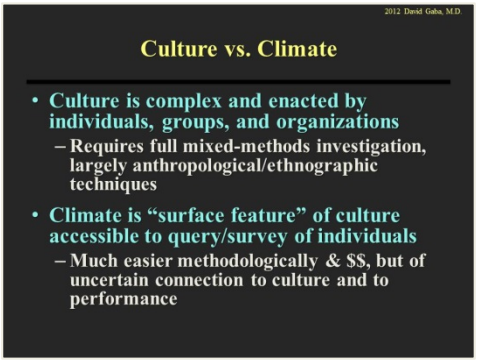
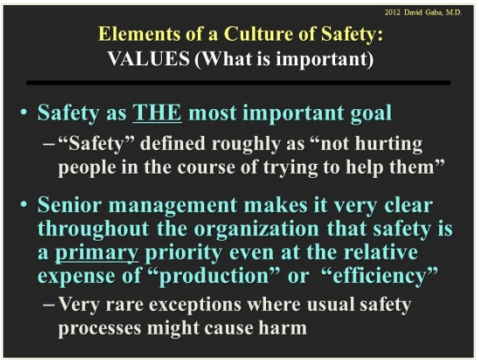
Appendix B:
Safety Culture Presentations to the Task Force

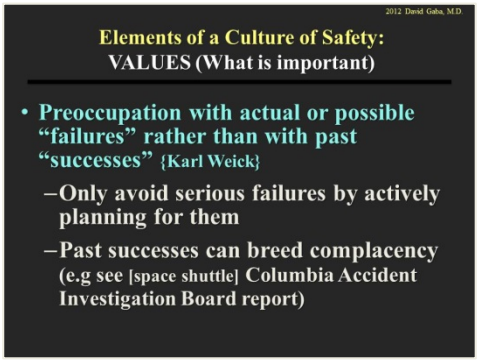
B-1: Measuring Patient Safety Culture / Climate in Hospitals by David Gaba

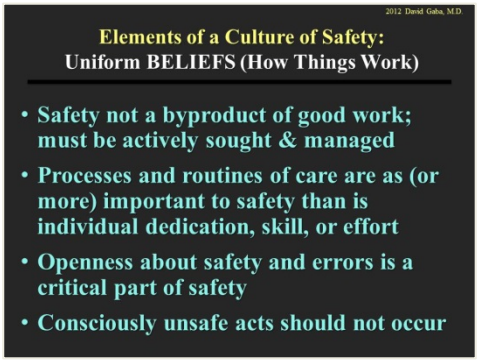


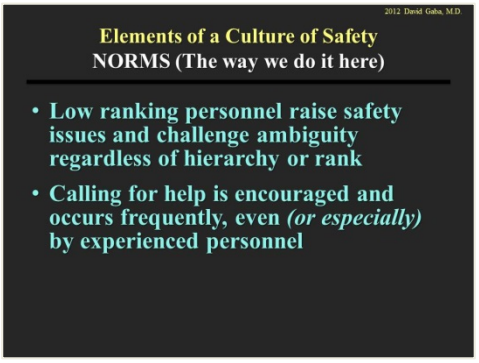


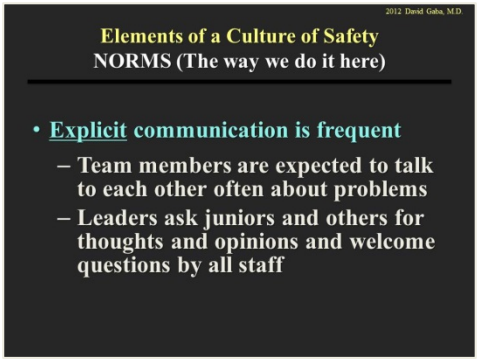


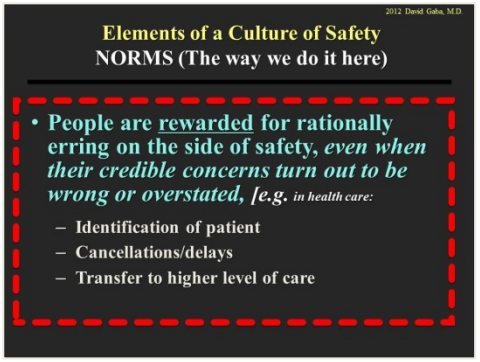


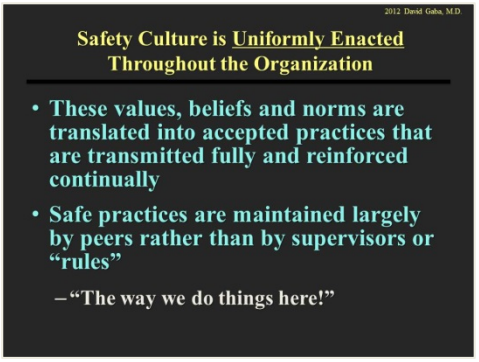












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(Appendix B-1 continued)

2012 David Gaba, M.D.

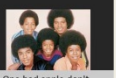
Patient Safety Climate in Healthcare Organizations Survey (SU & [now] HSPH)

- 38 questions; 5-element Likert scale
- Administered to >20,000 personnel
- Stratified administration: 100% sr. managers; 100% physicians; 10% others (mostly nursing)
- 3 waves with tracking of non-responders (allows some assessment of selection bias)
- 23 (2003) or 16 (2010) questions matching those in Ciavarelli's CSAS instrument
  - CSAS administered to >15,000 naval aviation personnel

2012 David Gaba, M.D.

Uniformity of Safety Culture is Critical

- Assumption *(albeit not well-tested)*: unless safety culture is adopted & accepted with high uniformity, high reliability performance will be UNlikely
  - How large a minority is a concern is yet to be determined



2012 David Gaba, M.D.

Analysis Focus on % Problematic Response (PPR)

- Looking for size of minority who do NOT have pro-safety values/beliefs/norms
- Problematic response = fraction who answer each question (or combinations) in way that is antithetical to safety/safety climate
- What is the threshold for a "problem" in safety climate?
  - No one knows; HRO consultants K Roberts & A Ciavarelli have guesstimated > 10% would be "an issue"

2012 David Gaba, M.D.

Average safety climate among 92 US hospitals, 2004

Item	PPR*
Average of 38 items	17%
I am asked to cut corners to get the job done. (R)	16%
In my unit, there is significant peer pressure to discourage unsafe patient care.	20%
My unit recognizes individual safety achievement through rewards and incentives.	47%
Telling others about my mistakes is embarrassing	32%
In the last year, I have witnessed a coworker do something that appeared to me to be unsafe for the patient	34%

* PPR = percent problematic response, indicating LOW safety climate

-- Singer, et al. 2009. "Patient Safety Climate in 92 US Hospitals: Differences by Work Area and Discipline." *Med Care* 47(1): 23-31

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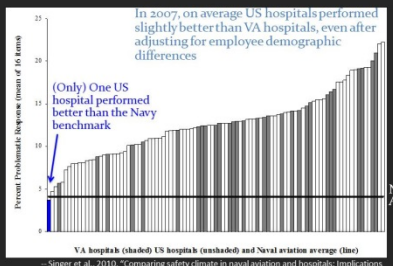
2012 David Gaba, M.D.

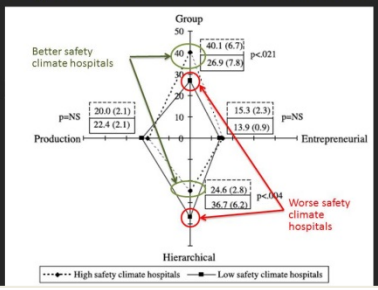
US & VA hospitals vs. benchmark



-- Singer et al., 2010. "Comparing safety climate in naval aviation and hospitals: Implications for improving patient safety." *Health Care Management Review* 35(2): 134-46
-- Singer et al., 2009. "Comparing safety climate between two populations of hospitals in the US." *Health Services Research* 44(5, Part I): 1563-84.

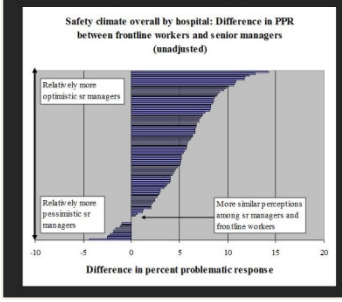
2012 David Gaba, M.D.

Group Orientation of unit generally fosters better safety climate than a Hierarchical Orientation



2012 David Gaba, M.D.

Notable "gap" in perceptions of Front-line vs. Senior Managers



-- Singer, et al., 2008. "Patient safety climate in US hospitals: Variation by management level." *Medical Care*. 46(11): 1149-1156

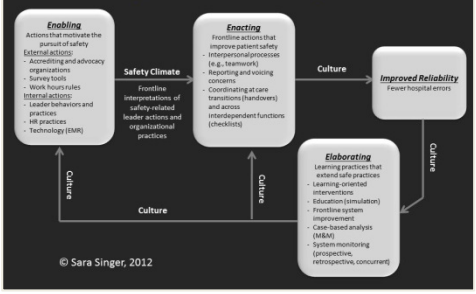
2012 David Gaba, M.D.

Senior Managers May Not Really Understand Risks at the Frontline

- Reports from below tend to downplay risks unless they are egregious
- Reports in general are incomplete & hindsight-biased
- Senior managers may discount reports as overblown or 'grumbling'
- Senior managers sometimes are not familiar with newer practices, technology, or risk pathways

2012 David Gaba, M.D.

A Cultural Approach to Reliability Interventions



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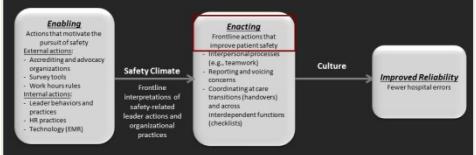
Lessons Learned: Measuring Safety Culture

- Must get better handle on the culture that is enacted: **Ethnography** -but who will pay?



2012 David Gaba, M.D.

Lessons Learned: Measuring Safety Climate

- Reliable measurement is tough
- We think that focusing on problematic response of the minority (rather than the size of the positive majority) is worthwhile
- Ethnography will be needed to complement survey work – what culture is actually enacted?
- Safety and safety climate is a never-ending battle

2012 David Gaba, M.D.

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B-2: Moving the Bar: Advancing a Culture for the Conduct of Safe Science in Academic Research Laboratories by Larry Gibbs

Moving the Bar: Advancing a Culture for the Conduct of Safe Science in Academic Research

Larry Gibbs
Associate Vice Provost for EH&S
Stanford University

Background

- High consequence incidents (low probability?)
  - UCLA
  - Texas Tech
  - Others
- Reviews by agencies with focus on research laboratory organizations (Cal/OSHA, CSB) - most focus on causal analysis of incidents
- Recommendations for organizational and programmatic approaches for prevention/enhancing lab safety culture (CSB, ACS, NRC/NAS

ACS Task Force Recommendations

1. Strong Leadership and Management for Safety
2. Continuous Learning about Safety
3. Strong Safety Attitudes, Awareness and Ethics

"the Safety ethic: value safety, work safely, prevent at-risk behavior, promote safety, and accept responsibility for safety"–robert hill

4. Learning from Incidents
5. Collaborative Efforts to Build Safety Culture
6. Promoting and Communicating Safety
7. Institutional Support for Funding Safety

American Chemical Society, *Creating Safety Cultures in Academic Institutions*. American Chemical Society 2012

National Research Council's *Prudent Practices in the Laboratory*[1]

- "The ultimate responsibility ..for encouraging a culture of safety rests with the head of the organization and its operating units. Leadership by those in charge ensures an effective safety program is embraced by all."
- **"Teaching safety and safe work practices in the laboratory should be a top priority for faculty as they prepare students for careers. By promoting safety during undergraduate and graduate years, the faculty will have a significant impact not just on their students but also on everyone who will share their future work environments."**
- "The ability to accurately identify and assess hazards in the laboratory is not a skill that comes naturally, and **it must be taught and encouraged."**
- "**Forming the foundation for a lifelong attitude of safety consciousness, risk assessment, and prudent practice is an integral part of every stage of scientific education**. Teaching and academic institutions must accept this unique responsibility for attitude development."

[1]National Research Council, *Prudent Practices in the Laboratory: Handling and Management of Chemical Hazards – An Update. Washington, DC: National Academies Press, 2011*

Why Not Emulate Industry Leaders?

- Dow, Dupont, Others
  - Strong central management and support
  - Strong vertical hierarchy of command and control
  - Centrally resourced – personnel and funding built into research programming support

Letter from Dow and Dupont to C&EN

- **"The facts are unequivocal," the letter asserts. "Occupational Safety & Health Administration statistics demonstrate that researchers are 11 times more likely to get hurt in an academic lab than in an industrial lab."**
- **Rebuttal: Facts are not unequivocal, but are incorrect and based on non-lab related data – points out the need for good sound data**

Unique Characteristics of Universities

Facility:

- Site is more like a city than a business
- Have virtually every regulatory issue that is present across all businesses lines
- Additional concerns and issues to manage relating to large on-site residential populations and lands management
- Often visible local/regional/national political targets

Organizational:

- **Numerous and individual cultures** - somewhat like different business units in one large corporation
- **Management structures**
  - Schools and depts/units may have differing structures
  - often reflective of the type of work/research that they do
  - results in very wide span of control (i.e. flat structure with local authority/accountability)

Characteristics of Universities-

POPULATIONS

- **Role of Principal Investigator (Faculty)**
  - key to fostering safe and compliant attitude in laboratories; but this role is not standardized
- **Entrepreneurial spirit (resistance to central leadership)** - like "herding cats," (very smart cats!)
- **"Worker/researcher" population in labs**
  - relatively youthful, often their first 'job'
  - increasingly diverse cultures: foreign languages; safety/compliance attitudes and practices developed in other countries
  - high turnover in lab population - ~30% per year
  - concern by individual over future if views vary from faculty member

Resulting Challenges for Safety Culture Development

University facility, organizational and personnel characteristics create unique challenges

- **High turnover in laboratory personnel**
  - Research populations with 25-30% annual turnover (1500-2000) – majority of bench researchers are post-docs and graduate students
  - Challenge to keep up centrally with all personnel changes
- **Role in student education**
  - Students learning to work safely so that they take this knowledge and attitude with them when they leave and move on to next level

Resulting Challenges for Safety Culture Development

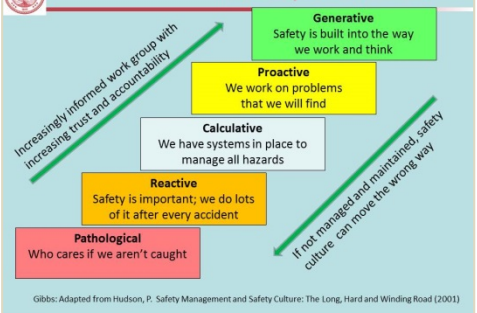
- **Line responsibility**
  - Role of PI/faculty is mostly self-defined
  - Strict line management, top down enforcement approach **alone** is not well received and does not typically work long-term in these organizations
- **Significant intolerance** for doing something just because it is a mandate – want to see a valid connection to cause-effect (scientific or deductive reasoning process)
- **Managing a central program in a decentralized organization** - (likened to working with 500 independent small businesses at one time!)

Factors of a weak lab safety culture

- no clear commitment of institutional administration to actively promote safety at all levels (weak or deficient leadership in safety);
- failure to establish accountability for safety among leaders, managers, supervisors, employees, and students;
- Lack of interest in spending significant time or resources on safety;
- Weak or missing safety management system;
- failure to adequately educate students in safety and to build strong safety skills;
- failure to evaluate students' safety knowledge and skills through tests and observations;
- failure to build and maintain strong safety awareness and interest in safety;
- failure to learn lessons from past incidents and implement changes (improved safety practices) to prevent future incidents; and
- Weak collaborative interactions within the safety program and on safety issues.

American Chemical Society, *Creating Safety Cultures in Academic Institutions*. American Chemical Society 2012

The Safety Culture Ladder



Gibbs: Adapted from Hudson, P. Safety Management and Safety Culture: The Long, Hard and Winding Road (2001)

New NAS Study: Establishing and Promoting a Culture of Safety in Academic Laboratory Research

- Meetings with stakeholder input – other than committee deliberations, meeting is open to public
  - May 15-16 Washington DC
  - June 26-27 Berkeley, CA
  - August 28-29 Cambridge, MA
- Similar Format
  - Panels of faculty members and chairs; post-docs and grad students; EHS personnel; industry EHS; National lab reps
- Common theme to date from presentations
  - Post-docs and grad students perception is safety is not a priority in academic research; believe most important attribute for advancement of safety culture in research group and at the bench top is relationship with and leadership actions by faculty/lab manager

http://dels.nas.edu/Study-In-Progress/Safety-Culture-Academic-Laboratories/DELS-BCST-11-04?bname=bcst

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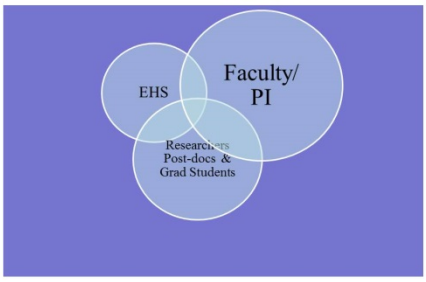
(Appendix B-2 continued)

Issues Needing More Focus to Advance Lab Safety Culture in Academic Research

- Ability to evaluate lab safety climate – need for good evaluation tool for gauging and evaluating the lab safety climate in research labs
- Dynamics within the academic research laboratory itself – at the bench and within the research working group
- Interactions between PI/Lab Manager – Lab Researchers – EH&S

Laboratory Safety Partnership



Attributes in the Lab Safety Culture Matrix

- Communication about safety within the lab
- Organizational attitudes about safety within the laboratory
- EH&S program support for lab safety
- Organizational behavior about the lab status
- Working behavior in the lab (individual and group)

Lab Safety Culture Matrix Attributes

Culture / Attribute	Pathological	Reactive	Calculative	Proactive	Generative
Safety Communication	Nobody is informed; no feedback; everybody is passive; no care/ knowledge about safety; don't see(k) or ask the problem; collect what is legally required.	PI demands data on environmental health & safety (EHS) failures; lab researcher denial until forced to admit; top-down flow of information; bottom-up incidents; lots of statistics nobody understands; safety is hot issue after lab accident.	Environment of command and control by PI; lots of safety information but no follow up; info goes top down; failures bottom up; little top-down feedback; regular lab safety meetings; safety procedures exist but are only once read; action is delayed after knowledge is transferred	PI/management go out and see/seek lab safety status for themselves; they know what to change and how to manage; the feedback loop on safety issues (bottom-up and top down) is closed (addressed) at supervisory level; safety topics become part of regular lab meetings; near misses reported regularly; safety is asked for by lab members; they need detail to understand WHY lab near misses and accidents happen.	No threshold between PI and lab members; PI participates/shares activities (dialogue); Lab safety is number 1 issue; all feedback loops are used and closed; safety is integrated in other lab and department meetings; no special safety meetings required as lab members keep themselves up-to-date on safety; they demand information so they can prevent problems.

Lab Safety Culture Matrix Attributes

Culture / Attribute	Pathological	Reactive	Calculative	Proactive	Generative
Organizational attitudes	No belief or trust in lab; environment of punishing, blaming and controlling the lab members for incidents or safety lapses	Failures caused by individuals; no blame assigned but responsibility accounted for; lab members need to be educated and follow the procedures; PI and management overreact in eyes of lab members.	Lab members are more involved; little effect on procedures, designs, practices; lab members do not understand the problem; PI/management is seen as obsessive with EHS, but they don't 'mean' it. (Walk the-talk).	Lab member involvement is promoted but ruled/organized by PI/supervisory and management staff which is obsessed by EHS reporting and statistics.	PI/management is recognized as a partner by lab members; PI/ management respects lab members; PI/ management fix systematic failures; lab researchers identify them to PI/ management.

Lab Safety Culture Matrix Attributes

Culture / Attribute	Pathological	Reactive	Calculative	Proactive	Generative
EH&S Program	No EHS status feedback provided; EHS issues are ignored; minimal requirements; no rewards on good performance; safety is inherited but not known; reliance on each individual's lab safety experience.	Meets legal requirements; collects statistics but no follow up; design or program is changed after accidents; procedures are rewritten to prevent previous accidents; no update or improvements.	EHS well accepted; program collects data and creates own statistics; EHS rewards/responds for positive and negative performance or design; quantitative methods, procedures to solve unsolved problems; standard procedures preferred from the shelf; large numbers of procedures but few checks on use/knowledge.	Central EHS staff promote improvement, but try to reduce the inconvenience to lab members; for good EHS initiatives there is career enhancement for Sr. EHS staff, EHS is in the early stages of design; safety procedures are rewritten by lab members; integration with competency; complaints by lab about externally set targets.	EHS department is small, advising the management on strategy; group gets no special rewards for safety performance; individual pride and fulfillment; safety procedures are integrated into all lab procedures; continuous improvement by lab; small numbers of procedures are integrated in training.

Lab Safety Culture Matrix Attributes

Culture / Attribute	Pathological	Reactive	Calculative	Proactive	Generative
Organizational Behavior	Denial that anything is wrong; avoid EHS discussions; PI and lab management is hierarchical and stagnant to changes; focus on productivity, not on lab members; lab members have lots of freedom-> PI/management don't care about safety.	PI/management holds lab members responsible for failures; PI/management overreacts. PI/mgt. states that it takes safety seriously, but is not always believed by lab members.	Detailed and focused on safety; playing with numbers; believe lab is safe in spite of contrary; safety targets are not challenged; inability to admit that solutions may not work the first time.	PI/management know the risks; interested in lab EHS; takes lab culture into account; safety is priority over research production which leads to incompatible goals; lots of PI/management walk-about; regular communication and assessments about lab accidents and near-misses and their consequences.	Safety is equal to lab production, enthusiastic communication between lab members and PI/management-lab researchers have a lot of freedom-> trust to do the right thing and work safely at all times

Lab Safety Culture Matrix Attributes

Culture / Attribute	Pathological	Reactive	Calculative	Proactive	Generative
Working Behavior	Workplace is dangerous, messy; no (legal) health requirements; procedures not always followed when others not around; PI/management does not CARE and does not KNOW.	Basic regulatory safety requirements are implemented; housekeeping is temporarily improved when inspection comes; PI/management KNOWS but not always CARES.	Clean and tidy laboratory environment; safety and lab housekeeping is very important (prized); PI/ management CARES but not always KNOWS.	PI/management CARES and KNOWS; regular discussion and promotion about lab safety prioritization; time and resources are available for improvements even before accidents happen.	PI/management CARES and KNOWS; lab members furnish and manage their own safety environment; management passes the exemplar experience around to other labs

Attributes in the Lab Safety Culture Matrix

- Communication about safety within the lab
- Organizational attitudes about safety within the laboratory
- EH&S program support for lab safety
- Organizational behavior about the lab status
- Working behavior in the lab (individual and group)

- Are their other attributes that you can identify? With spectrum of examples?

Stanford Self-Evaluation Program

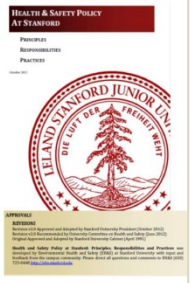
Site review/report

- ➢ Management's support for framework of culture of safety
  - ✓ Stanford University's culture of safety has grown from and is supported by a strong framework set in place by the University leadership
- ➢ Stakeholder perceptions
  - ✓ Those in leadership positions hold a favorable view of Stanford's safety culture.
  - ✓ Those more involved in the day-to-day research ongoing within the laboratories, for example, postdoctoral scholars and graduate students, are less cognizant of Stanford's framework in support of safety and hold a lesser view of the current safety culture
  - ✓ **Disconnect between Post-doc/grad students and PI**

Safety Culture Advancement

Updated Institutional Health and Safety Policy

"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 and safety laws and regulations."



Next Steps at Stanford

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

- Convened under auspice of University Committee on Health and Safety (UCHS is faculty led committee and standing committee that reports directly to University President) and Dean of Research
- Three faculty co-chairs with additional broad stakeholder membership (lab bench researchers/faculty/chairs/deans/EHS)

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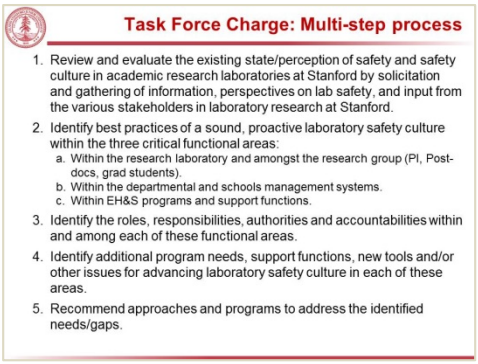
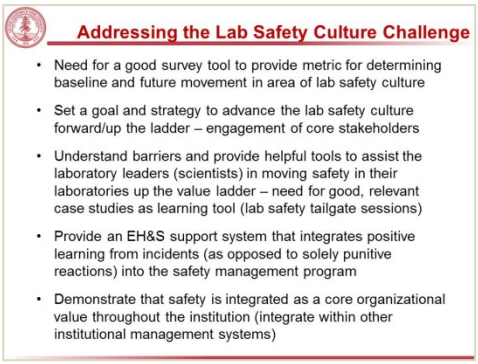
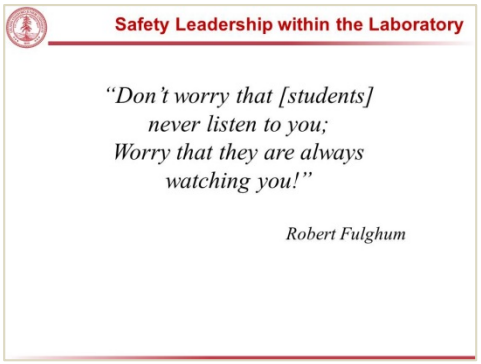
(Appendix B-2 continued)







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Appendix C:
Summary of Stakeholder Meetings and Online Submittals Information

C-1: Summary of Stakeholder Input Graphical Analysis

Task Force for Advancing the Culture of Laboratory Safety at Stanford

Charge: The charge to the Task Force is to report on the status of safety culture and to provide recommendations to advance the positive culture of safety within academic research laboratories at Stanford.

Subgroup Charge: Identify, summarize and evaluate feedback from town halls, website

Methods:

1. Use *Attributes of Positive Lab Safety Culture* defined by L. Gibbs and colleagues to individually evaluate responses from town hall meetings and website submission.

1. Pool individual responses from our subgroup members to determine general consensus (trend).

Task Force: Advancing the Culture of Laboratory Safety

Sources: Townhall Meetings, Website comments: Nov 2013 – February 2014

- 232 Townhall comments – 303 attribute scores
- 48 Website comments – 83 attribute scores
- Total: 383 attribute scores

Attributes:

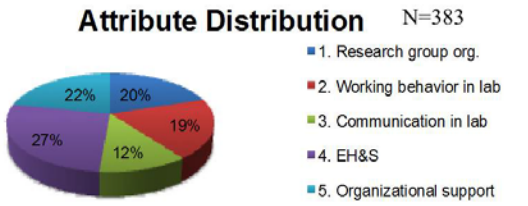
1. Research group organizational behavior ***(P.I.)****
2. Working behavior within the laboratory ***(bench researchers)***
3. Communication about safety within the laboratory ***(P.I. + researchers)***
4. Environmental health and safety program ***(EH&S)***
5. Organizational attitudes about laboratory safety ***(University)***

**primary stakeholder per attribute (sub-group interpretation)*

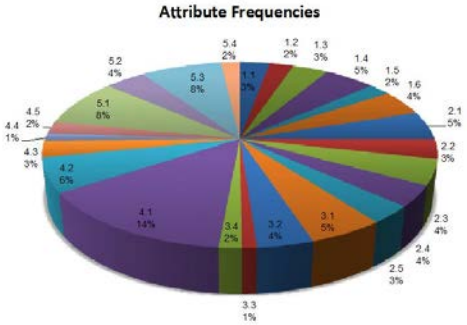
Example:
"Older grad students/now postdocs are hesitant to ask others about safe practices (for fear of embarrassment, judgment, etc) "

Score: 1.1, 2.2, 3.2

Task Force: Advancing the Culture of Laboratory Safety



Task Force: Advancing the Culture of Laboratory Safety



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C-2: Stakeholder Input Summary Analysis

Subgroup on Laboratory Safety Culture Attribute Summary:

Leadership	Training (PI and Researchers)	EH&S
• Re-promulgate the health and safety roles and responsibilities for all faculty, staff and students under the Injury, Illness Prevention Program, Research Policy Handbook, and other key health and safety regulations, policies and programs via clear statements. • Include health and safety as a performance measure for Principal Investigators [Note: Add compliance with health and safety as a job factor in all staff performance evaluations, if not already in place.] • Related to the above, clarify how accountability works. Consider establishing a range of realistic consequences for failure to adhere to health and safety. • Clarify source of funding to support EH&S requirements. Note: Costs are already 60% from operating budgets, will PI's support? Ensure there are no unfunded mandates.	• Create a health and safety awareness course for current and incoming Principal Investigators to brief them on key health and safety regulations, SU EH&S Programs, their obligations/roles/ responsibilities for health and safety. As part of this, encourage more safety communication between PIs and trainees by including a safety topic as a standing agenda item in laboratory meetings or the inclusion of a "safety moment" at the start of every meeting (or both). • 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.	• Redesign the EH&S website to make it useful and accessible and searchable by bench researchers and other constituencies. Almost all information needed is currently on website, but hard to find relevant info quickly when you need it. • More personal contact between EH&S / USP staff and bench researchers.

Building Design	Personal Protective Equipment (PPE)	Best Practices
• 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. • Identify possible alignments between energy conservation/sustainability and laboratory design, while ensuring health and safety requirements are meet.	• Lack or incorrect use of Personal Protective Equipment (PPE) is an overarching issue. For example, sandals and shorts are observed, but the sentiment is that everyone knows it's wrong and nobody cares. • Laboratory coat laundering is a big issue. • Recommendation: Promulgate revised institutional Personal Protective Equipment Program. Consider making this a Stanford policy requirement for entry in to all wet laboratories (research and undergraduate).	• Designate laboratory safety coordinator in each laboratory (should be fairly senior if possible). To ensure smooth transition, recommend a six month crossover between outgoing and incoming laboratory safety coordinators. • Departmental contacts often play an important role in driving safety culture. Identify best practices of these individuals for communicating health and safety information and supporting local implementation of health and safety in their units. • Safety communication is a regular part of ALL group meetings (e.g., develop and promote "safety moments.") • Overarching observation: How do we drive increased communication between PI's, researchers, EH&S, University Safety Partners and Stanford. Poor communication is a major component of almost all safety comments observed by Task Force subgroup.

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C-3: Representative Comments from Stakeholder Input

Framed by Positive Attributes of Laboratory Safety Culture (March 18, 2014)

Attribute	Comments
Research Group *Organizational Dynamics*	• "What can PI do? 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 postdocs. 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 PI's and laboratory members were more involved in their laboratory safety. Including emergency preparedness & laboratory safety. Making sure the PI's laboratory members are trained on safe equipment handling…"
Working Behavior *within the laboratory*	• "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. Also, there seems to be very little emphasis on earthquake safety overall at Stanford; I'd think that in this area, that would be a much bigger concern. As our PI recently said, those little lips on the edges of the shelves aren't going to help a whole lot if there's a really big earthquake. What are the precautions that should be taken, both in laboratories and in our homes? What do we need to know to be prepared?"
Communication *about safety within the laboratory*	• "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…"
Environmental Health & Safety	• "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."
Organizational Attitudes *towards Safety*	• "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." • "Safety is facilitated by laboratory design!" • "Where should leadership for safety in a laboratory originate?" • "My laboratory is very isolated from common laboratory equipment. I have to go through 3 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."

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

D-1: Survey Results Summary (Organized by Attribute)

Palo Alto Research Center (PARC)
Mike Kuniavsky
03/25/14 (version 1.0)

Methodology

Dates
02/14/14-03/19/14

Data collection method
Stratified random sample of opt-in responses to targeted email and newsletter invitations

Sample size
461. 97 Principal Investigator
364 Bench researchers

Sample margin of error:
PI: ±9%
Researcher: ±5% for 95 percent confidence level.

Executive summary

People feel that they work safely and that their environment is safe. This broad optimism is probably an accurate representation of people's feelings towards safety: Stanford is a pretty positive place.

PIs score a little more positive and often with statistical significance. This could be a concern because PIs may underestimate safety issues. However, 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 do seem to have taken the survey seriously, and varied their scores appropriately.

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.

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Analysis by attribute

Research Group Organizational Behavior

The faculty-PI/laboratory manager and group members maintain a safety conscious research work environment in which personnel feel free to raise safety concerns without fear of retaliation.

- People generally feel comfortable refusing tasks they believe to be unsafe, with a small minority of researchers disagreeing.
- People share experiences of unsafe behavior…and they view their own behavior more positively than that of others.
- 20% of researchers, and 13% of PIs, do not agree that they always report safety problems, though only 7% of researchers and 1% of PIs disagree.
- The majority of both PIs and researchers do not believe that there will be negative consequences for someone reporting safety incidents.
- Most researchers believe that they are more safety-conscious than their co-workers (which is potentially a problem, since everyone can't be above average), and significant minorities do not agree that their PIs or laboratory managers regularly visit or have clearly designated responsibilities.

Faculty-PIs and laboratory research personnel demonstrate ownership for safety in their day-to-day research activities.

- The vast majority of people believe researchers understand the potential hazards associated with their work in the lab.
- Most people believe that researchers know what to do in case of an emergency, though the belief is less strong in researchers than in PIs.
- A significant minority (~15%) of researchers do not agree that their responsibilities had been clearly communicated, whereas nearly all PIs believe they had.
- Most researchers believe that PIs are concerned about their safety, though ~7% feel that their PIs are not concerned about their safety.

Decision-making reflects that safety is a priority over research production and is compatible with good research science.

- A proportionally small, but significant, number of researchers say that there's pressure to compromise safety.

Processes for planning and controlling research activities and tasks ensure that individual researchers, faculty-PIs, and other research personnel communicate, coordinate, and execute their research work in a manner that supports safety.

- 97% of PIs believe that all safety-related mistakes are swiftly corrected, but 20% of researchers do not agree.
- Although both PIs and researchers feel that safety procedures are either never or rarely disregarded, 10% of researchers feel that such processes are either regularly or always disregarded.
- People generally feel comfortable refusing tasks they believe to be unsafe, with a small minority of researchers disagreeing.

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.

- Most people believe that researchers know what to do in case of an emergency, though the belief is less strong in researchers than in PIs.
- Most people believe they have the necessary tools to work safely.

Faculty-PI/laboratory manager understands the risks, is actively involved and interested in laboratory safety and take laboratory culture into account.

- Nearly 30% of researchers said that safety is not the highest priority.

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Working behavior within the laboratory		
Laboratory members are considerate of others working in the laboratory and maintain a laboratory environment where safety and laboratory housekeeping are very important. • More than 20% of researchers do not believe that their laboratory is clean and uncluttered, as do 6% of PIs. • Researchers and PIs both see social pressure to work safely, somewhat less so with researchers.	**Laboratory members openly discuss laboratory safety concerns and prioritization regularly.** • A significant minority of researchers disagree that all safety issues are discussed.	**Laboratory members identify and manage their own safety environment and are receptive and responsive to queries and suggestions about laboratory safety from their laboratory colleagues.** • Most people believe that they are more safety-conscious than their co-workers. • A significant minority of researchers believe that that their laboratory does not adequately teach safety procedures, as does a small number of PIs. • Both researchers and PIs strongly believe that researchers are comfortable calling each other on unsafe behavior.
Laboratory members conduct their research using protocols and procedures consistent with best safety practices in the laboratory.	**Faculty-PI/laboratory management evaluates the laboratory safety status themselves and they know what to change, if needed, and how to manage the change to enhance safety in the laboratory.** • Approximately 12% of researchers do not agree that PIs or laboratory managers visit the laboratory regularly.	

Communication about safety within the laboratory	
The laboratory group ensures that issues potentially impacting safety are identified and appropriately communicated commensurate with their risks and potential consequences. • There is some disagreement about consequences for violating safety procedures with more than 20% of researchers, and more than 10% of PIs disagreeing that the consequences of deliberately violating safety procedures are clear. • PIs do not hear about all of the new procedures conducted by researchers. More than 20% of researchers disagree that they review risks and safety procedures prior to starting new research procedure.	**The laboratory supports a continuous learning environment in which opportunities to improve safety are sought, communicated and implemented.**
The feedback loop on safety issues (bottom-up and top down) is closed (addressed) at the faculty-PI/laboratory management level. • About 10% of researchers disagree that there is appropriate follow-up to issues.	**Safety discussions become part of regular laboratory meetings; near misses 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.**

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Environmental Health & Safety program		
EH&S provides easily accessible laboratory safety information. • Hands-on training is considered most useful. Many people did not get classroom training. Many consider online training useless, especially researchers.	**EH&S staff promotes laboratory safety improvement while trying to reduce the inconvenience to laboratory members.** • 60% of researchers interact with EH&S at least once a year. • 20% of researchers do not find their interactions with EH&S helpful. • 67% of researchers say EH&S visits their laboratory at least once a year • 90% of researchers consider EH&S competent.	**EH&S staff is involved in the early stages of laboratory and experimental design and provides technical consultation and safety support.**
EH&S supports adaptation and localization of safety procedures by laboratory members so long as they meet the intent of the intended safety requirements. • Although most researchers and PIs say they discuss the risks and safety implications, approximately 20% of researchers say they do not.	**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.** • 50% of researchers do not believe that safety-related incidents elsewhere are campus are communicated to them with a causal analysis.	

Organizational attitudes about laboratory safety	
Roles, responsibilities, and authorities for safety in academic research laboratories are clearly defined and reinforced. • Approximately 10% of researchers say that their PI has not clearly delegated safely responsibility.	**The organization's decisions ensure that safety in academic research is maintained and supported.**
The organization ensures that the facilities, infrastructure, programs and other resources needed to ensure safety in academic research conducted at the institution are available. • There is nearly universal agreement that researchers have the tools, supplies and equipment to work safely.	**Management acknowledges and rewards exemplar laboratory safety experiences and promotes as examples to other laboratories.**

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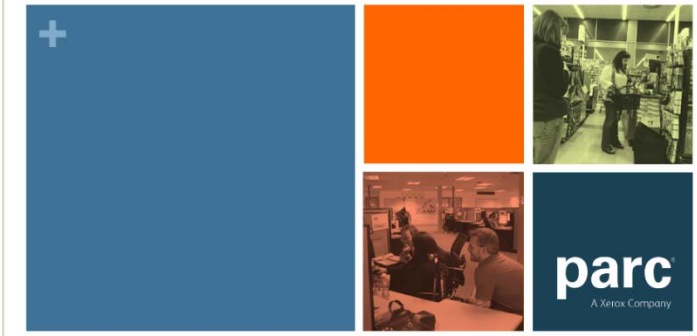
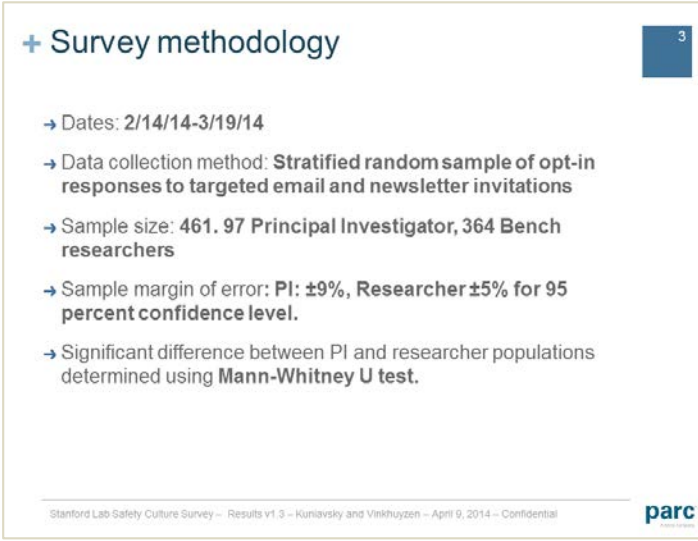
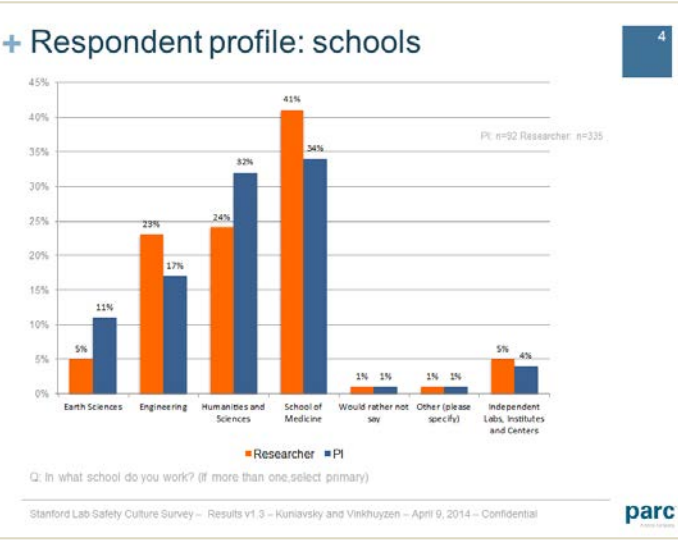
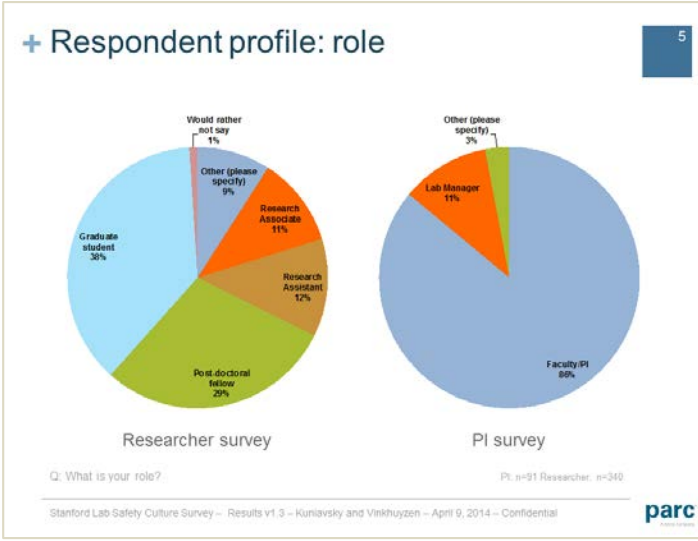
D-2: Survey Results Presentation

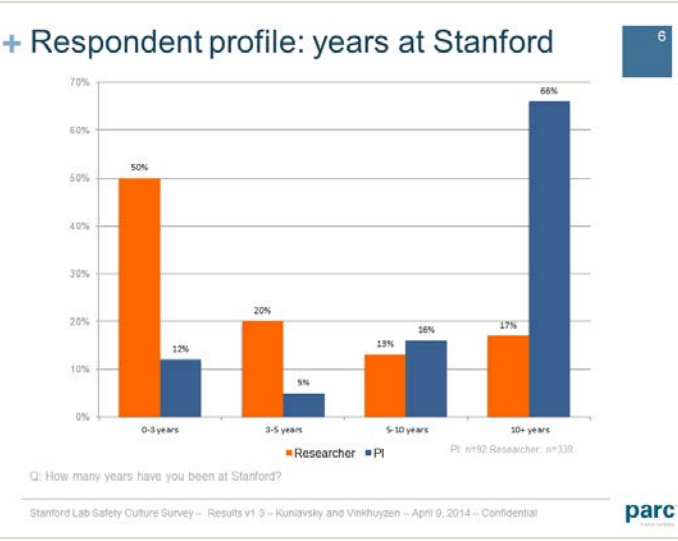
Palo Alto Research Center (PARC)
Mike Kuniavsky and Erik Vinkhuyzen
04/09/14 (version 1.3)











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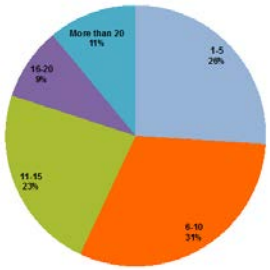
(Appendix D-2 continued)

Group sizes are split evenly between groups with 5, 10 and 15 people.

7

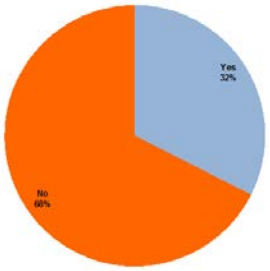


PI: n=53

Q: How many people are in your research group?

Most researchers do not supervise others

8



Researcher: n=339

Q: Do you directly supervise others?

Executive summary findings

Broad observations

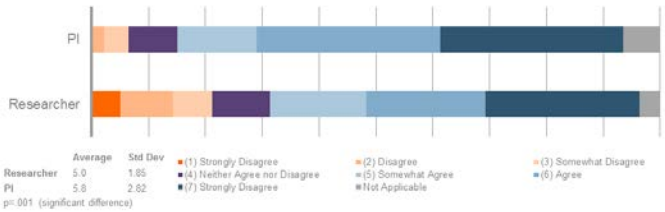
10

- People do seem to have taken the survey seriously, and varied their scores appropriately.
- Overwhelmingly, both researchers and PIs feel that they work safely and that their environment is safe.
- On most questions, PIs score a little more positive and often with statistical significance. This could mean things aren't as rosy as PIs think.
- A few questions seem to indicate that PIs indeed do not know about much that goes on in their lab.
- More telling than the mean and standard deviation of the answers are the outliers. Approximately 5-10% of researchers feel that their workplace is not safe and their PIs are not concerned about safety, or that there is pressure to finish work even though safety is compromised. While mostly people feel safe, there appear to be some labs at risk.

Selected observations

PIs do not hear about all of the new procedures conducted by researchers

12



Analysis: The difference between the responses of the two groups indicate that PIs may not hear about all the new procedures that their researchers start.

Q: PI: When individuals in my group start a new research procedure we discuss the risks and safety implications
Researcher: When individuals in our group start a new research procedure we review the risks and safety procedures

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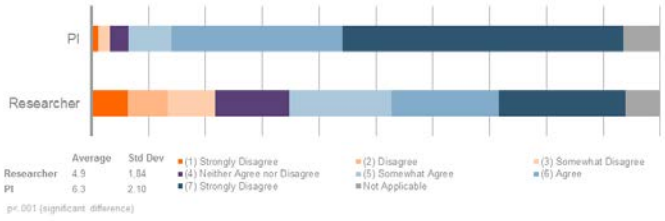
(Appendix D-2 continued)

A significant group of researchers disagree that all safety issues are discussed.

13



	Average	Std Dev
Researcher	4.9	1.84
PI	6.3	2.10

(1) Strongly Disagree, (2) Disagree, (3) Somewhat Disagree, (4) Neither Agree nor Disagree, (5) Somewhat Agree, (6) Agree, (7) Strongly Disagree, Not Applicable

p<.001 (significant difference)

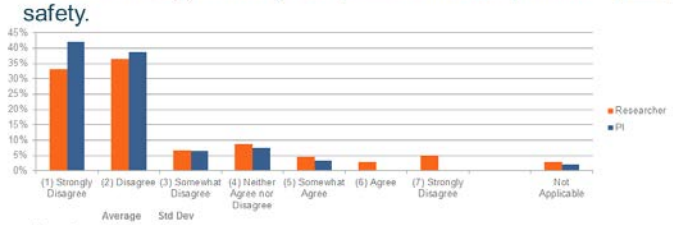
Analysis: There are significant differences between PI and Researcher responses with a significant minority of researchers disagreeing that all safety issues are discussed. NB: questions are differently phrased and "regular" may be responsible for part of the variance.

Q: PI: If there are safety issues, we discuss them in our group meetings
Researcher: In our regular lab meetings, we discuss all safety issues

parc

A proportionally small, but significant, number of researchers say that they feel pressure to compromise safety.

14



	Average	Std Dev
Researcher	2.4	1.66
PI	1.9	1.04

p<0.001 (significant difference)

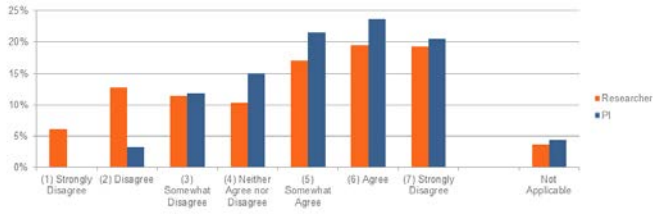
Analysis: Although most PIs and researchers do "disagree" that there is pressure to finish work even if safety may be compromised, there is a number of researchers who say "agree" and "strongly agree." This could mean there are labs in which there is pressure to compromise safety.

Q: PI: People in my lab sometimes feel pressure to finish a project even though safety may be compromised
Researcher: In our lab there is pressure to finish a project even though safety may be compromised

parc

There is some disagreement about consequences for violating safety procedures

15



	Average	Std Dev
Researcher	3.6	1.91
PI	5.2	1.42

p=.03 (marginally significant)

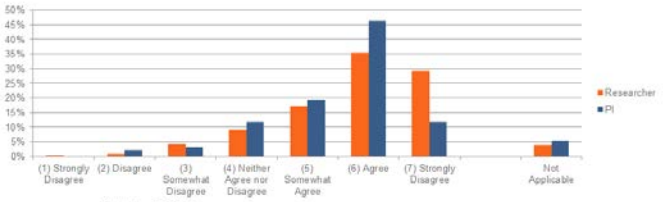
Analysis: although the majority of PIs believe that such consequences are understood, there is a significant minority of researchers who do not, which implies a disconnect in expectations.

Q: In our lab there are well understood consequences for intentionally violating safety procedures

parc

People share experiences of unsafe behavior…and they view their own behavior more positively than that of others.

16



	Average	Std Dev
Researcher	5.0	1.18
PI	5.5	1.11

p=.02 (marginally significant)

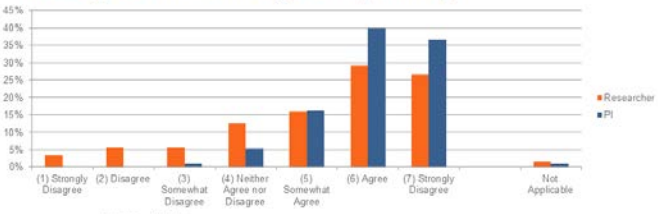
Analysis: This is one of the few questions where researchers tend to agree more strongly than PIs. People tend to answer questions about their own behavior more favorably

Q: PI: When the people in my lab accidentally do something unsafe they share it with the group to prevent future incidents
Researcher: If I accidentally do something unsafe, I share it with my group to prevent future incidents

parc

Nearly 30% of researchers said that safety is not the highest priority

17



	Average	Std Dev
Researcher	5.3	1.64
PI	6.1	.092

p<0.001 (Significant)

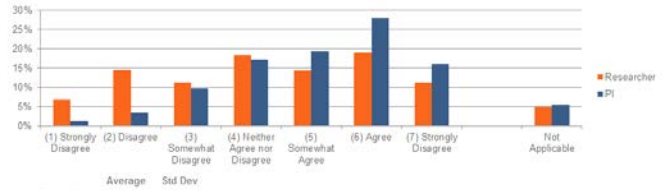
Analysis: The question was phrased exactly the same for both groups, and there is statistically significant difference between the two groups. While mostly positive, it should give us pause that 28% of the researchers do not "agree" with this statement, but answer neutral or disagree.

Q: In our lab, safety is the highest priority

parc

50% of researchers do not believe that safety-related incidents elsewhere are campus are communicated to them with a causal analysis

18



	Average	Std Dev
Researcher	4.3	1.81
PI	5.1	1.43

Analysis: This points a lack of awareness about incidents, and an area where there is opportunity for improvement

Q: PI: When a safety-related incident occurs elsewhere on campus, I communicate it to my group
Researcher: When a safety-related incident occurs elsewhere on campus, it is communicated to me with a causal analysis

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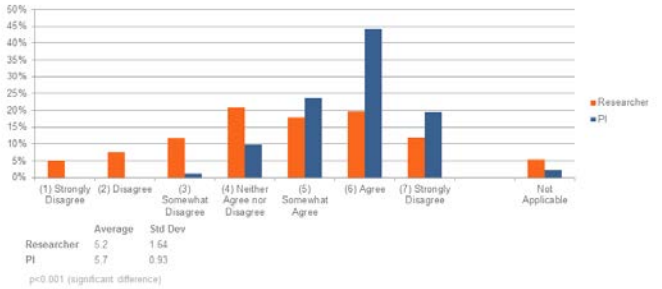
(Appendix D-2 continued)

Researchers and PIs both see social pressure to work safely, somewhat less so with researchers

19



	Average	Std Dev
Researcher	5.2	1.64
PI	5.7	0.93

p<0.001 (significant difference)

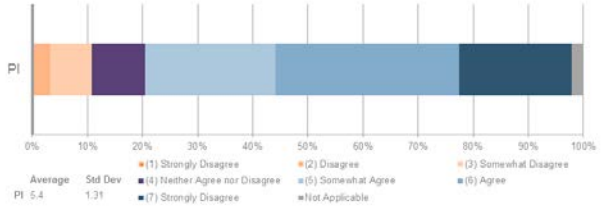
Analysis: Although most people agree that researchers encourage each other to work more safely, a significant number (~40%) of researchers do not agree, implying that in their labs they feel little peer pressure.

Q: PI: The researchers in my lab encourage each other to work safely
Researcher: My lab colleagues exert strong peer pressure on me to work safely

parc

Some PIs are not involved in the day-to-day safety of their labs

20



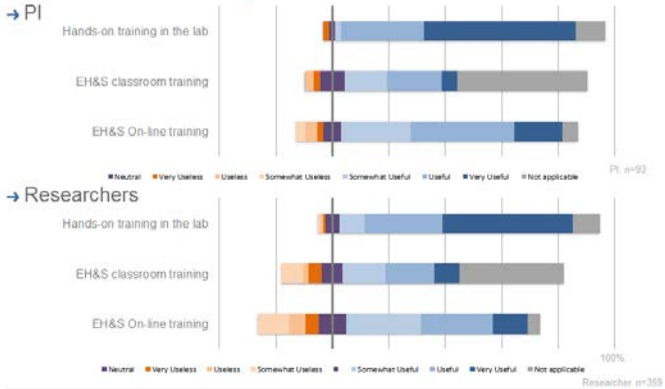
	Average	Std Dev
PI	5.4	1.31

Q: PI: I am personally involved in the day-to-day safety practice in our lab

parc

Hands-on training is considered most useful. Many people did not get classroom training. Quite a few consider online training useless.

21



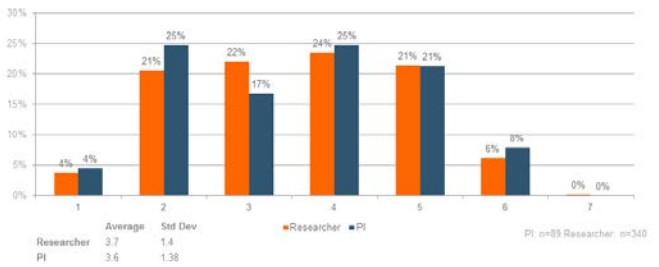
parc

General safety

parc

How potentially hazardous is your laboratory research work?

23

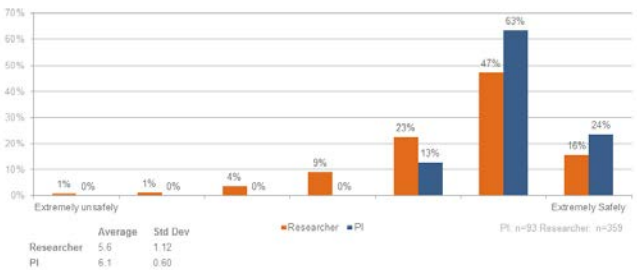


	Average	Std Dev
Researcher	3.7	1.4
PI	3.6	1.38

parc

How safely do people in your lab carry out their work?

24



	Average	Std Dev
Researcher	5.6	1.12
PI	6.1	0.60

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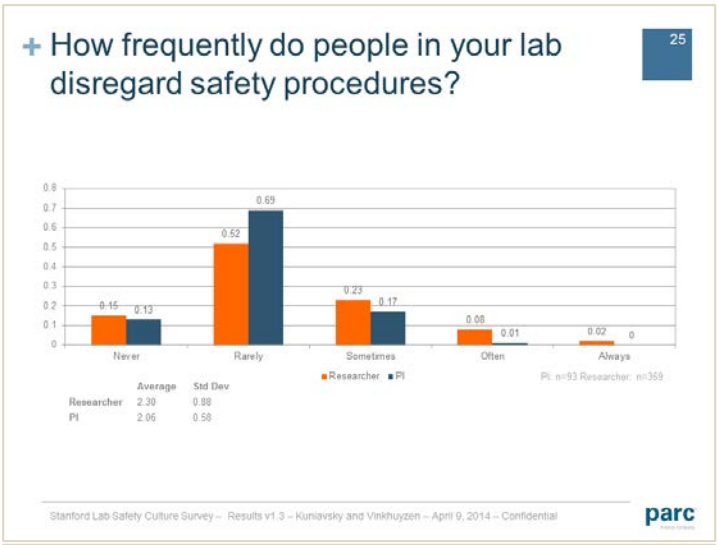
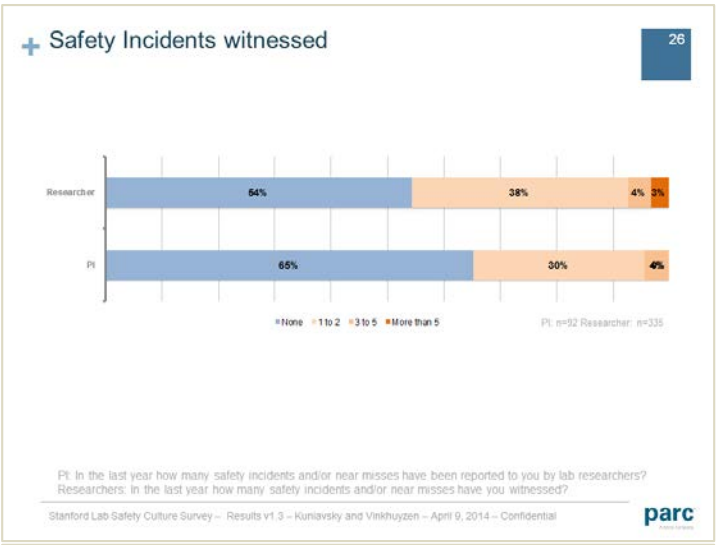
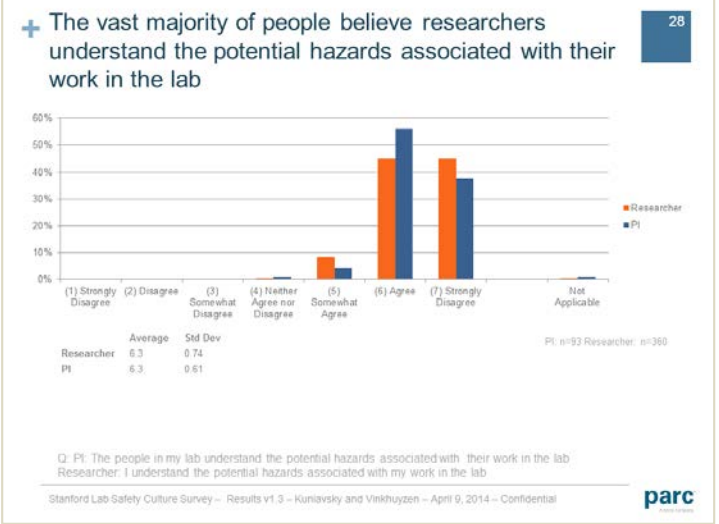
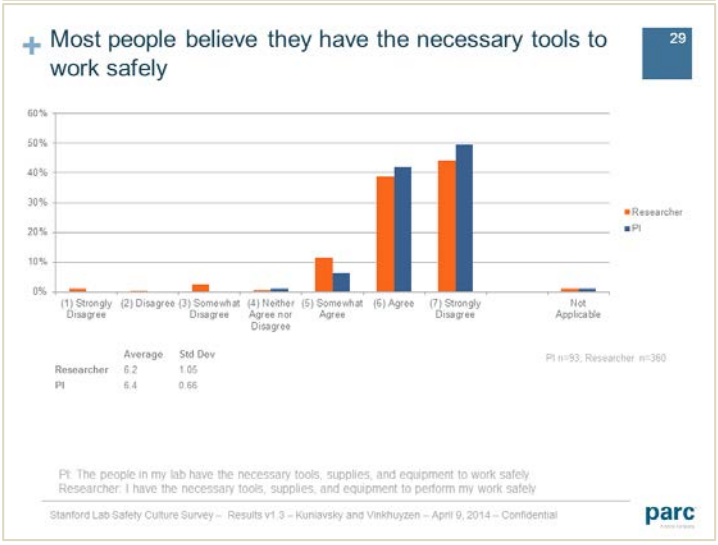
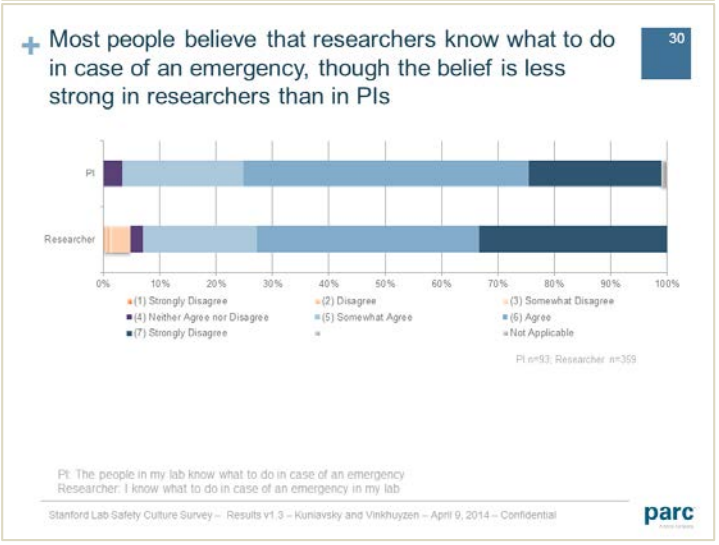
(Appendix D-2 continued)











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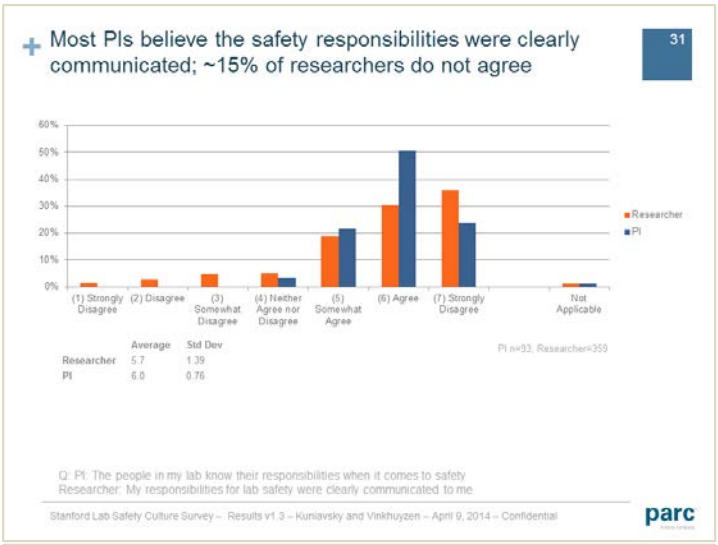
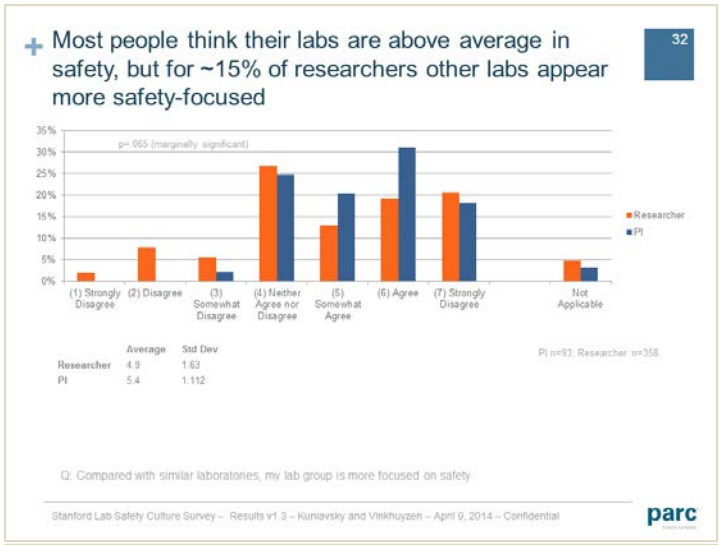
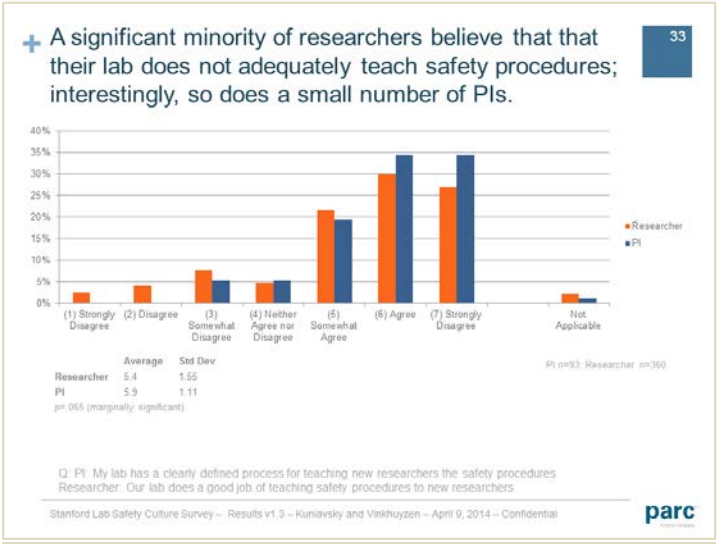
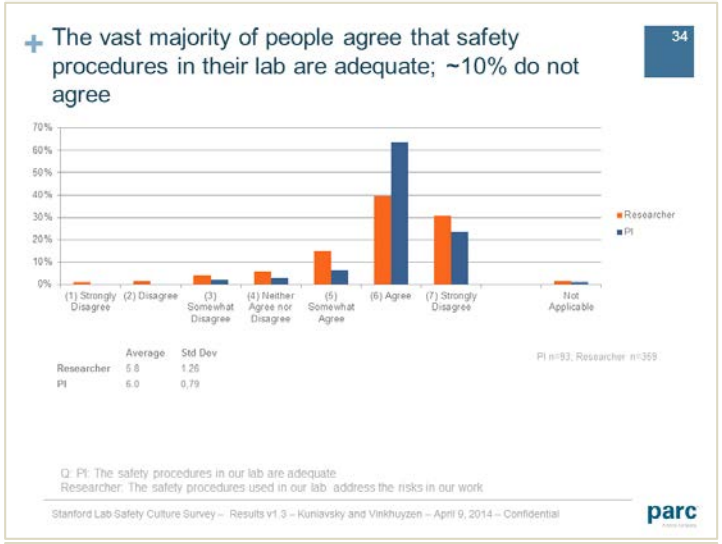
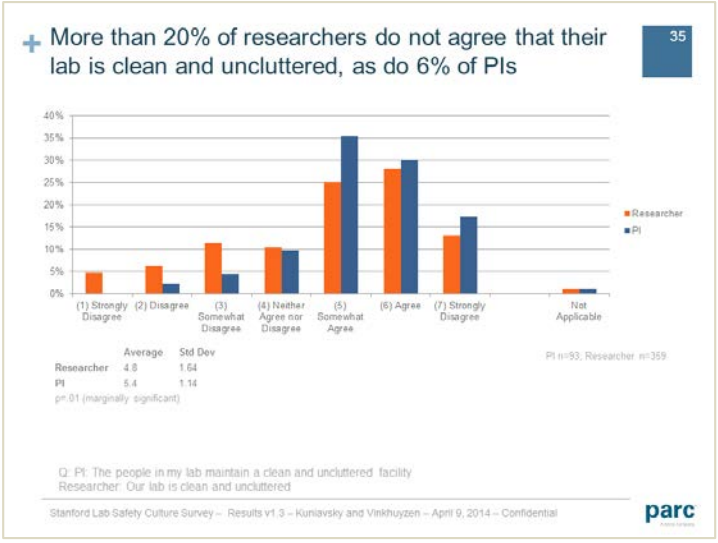
(Appendix D-2 continued)

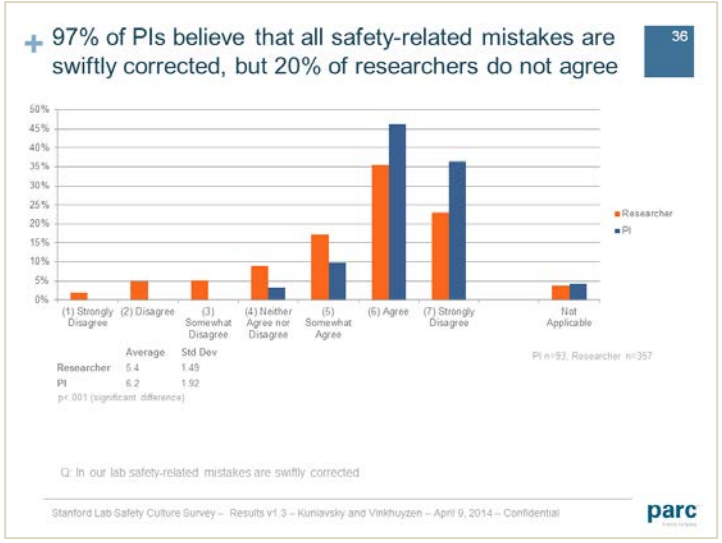












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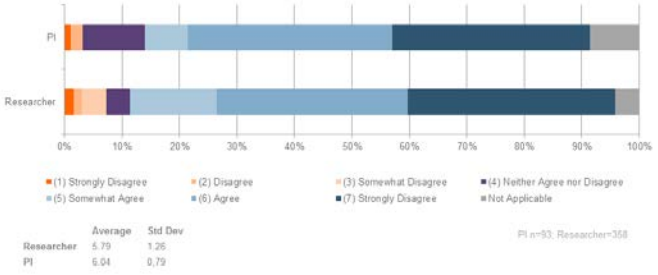
(Appendix D-2 continued)

People generally feel comfortable refusing tasks they believe to be unsafe, with a small minority of researchers disagreeing

37



	Average	Std Dev
Researcher	5.79	1.26
PI	6.04	0.79

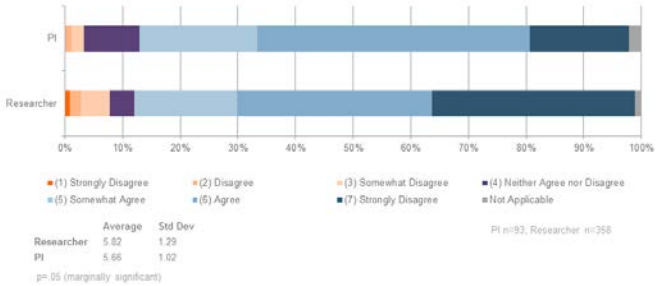
PI n=93; Researcher=358

Q: PI: The people in my lab feel comfortable refusing a task they think cannot be done safely
Researcher: I feel comfortable refusing to do a task I think cannot be done safely

parc

Both researchers and PIs strongly believe that researchers are comfortable calling each other on unsafe behavior

38



	Average	Std Dev
Researcher	5.82	1.29
PI	5.66	1.02

p=.05 (marginally significant)

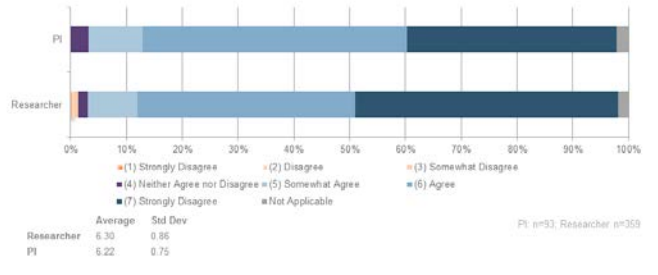
PI n=93; Researcher n=358

Q: PI: If a researcher in my lab sees another person doing something unsafe, they feel comfortable addressing the individual directly
Researcher: If I see a person in my lab doing something unsafe, I feel comfortable addressing the issue directly with the individual involved

parc

Virtually everyone believes researchers are comfortable asking for help learning proper safety procedures

39



	Average	Std Dev
Researcher	6.30	0.86
PI	6.22	0.75

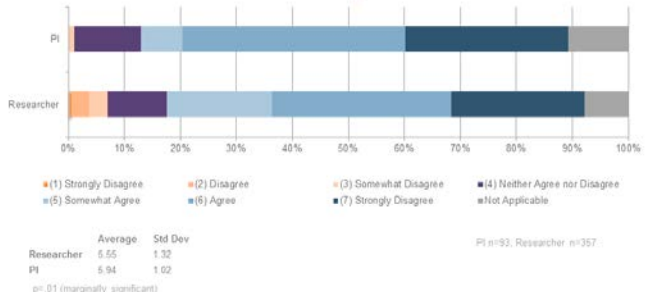
PI: n=93; Researcher n=359

Q: PI: People in my lab feel comfortable asking for help when asked to perform a task for which they don't know the proper safety procedure
Researcher: If someone asks me to perform a task for which I don't know the proper safety procedure, I feel comfortable asking for help

parc

20% of researchers, and 13% of PIs, do not agree that they always report safety problems, though only 7% of researchers and 1% of PIs disagree.

40



	Average	Std Dev
Researcher	5.55	1.32
PI	5.94	1.02

p=.01 (marginally significant)

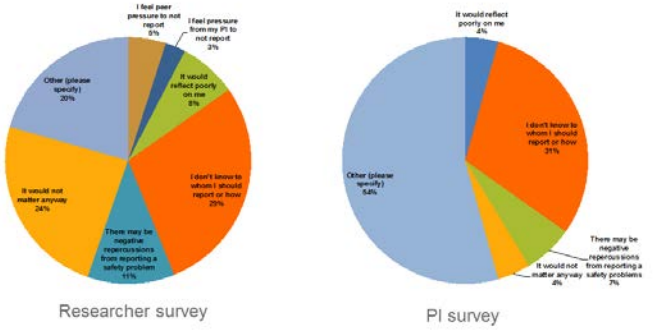
PI n=93; Researcher n=357

Q: I always report safety problems

parc

Most people do not report safety incidents for a variety of reasons, many because they don't know to whom or how.

41



I don't always report safety problems because: (check all that apply)

parc

Reasons why people don't report problems

42

- not clear what issues need to be reported
- I always report problems what I am aware of, there may be things I am not aware of.
- we usually report safety problems...
- Have not had major safety incidents requiring reporting
- Not applicable; we report
- I report such problems - but the question doesn't ask report to whom??
- I always work to resolve any safety issue and report any safety violation
- addressed within group
- I don't report minor safety incidents that can be quickly corrected (band-aid, clean up spills etc. would report non-minor incident.
- Poorly worded: Major issue is clarity in what are reportable problems; some are clear (SU-17); other "safety problems" are not clearly defined
- Sometimes I'll tell people in another lab over and over that they need to quit doing certain things, and they just ignore you.
- They are minor issues and corrected in the lab.
- Usually we are able to correct the safety issues without engaging others
- I do not work with very many unsafe practices in my lab. The only time there was a safety concern, my graduate student asked for a safety review
- I don't report it if it is minor and can be dealt with immediately and without accident or potential injury
- I haven't had a serious safety issue in my lab in the 12 years I've been here.
- We haven't had any safety problems that I am aware of.
- irrelevant
- I would simply correct minor safety problems, and report significant safety problems.
- There never has been a safety problem. I run a 100% computational lab. This survey is not relevant except tripping over wires and fire risk from stacks of paper, which is the same as in dorms and at home.
- We have never had an accident and are far more capable of managing our own safety than anyone outside the group since we understand what is in our lab better than <facility manager>.

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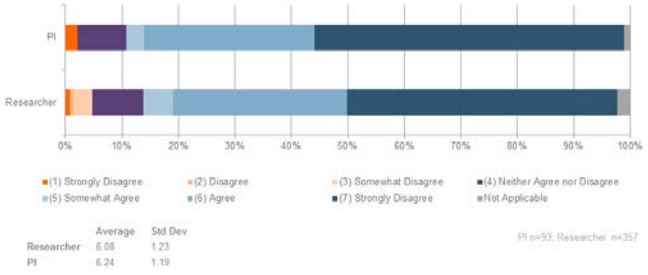
(Appendix D-2 continued)

The majority of both PIs and researchers do not believe that there will be negative consequences for someone reporting safety incidents

43



	Average	Std Dev
Researcher	6.08	1.23
PI	6.24	1.19

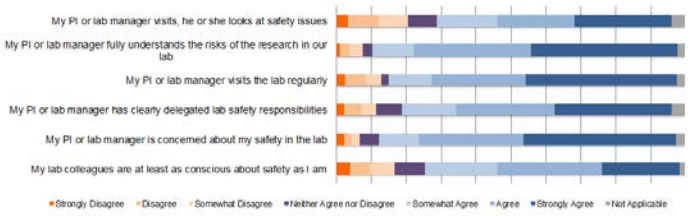
PI n=93; Researcher n=357

Q: Reporting a safety incident or concern will NOT result in negative repercussions for the person reporting it

parc

Researcher-only perspectives on safety practice

44



Analysis: almost 30% of researchers do not agree that their PIs or lab managers regular visit the lab to check on safety or have clearly designated safety responsibilities

parc

A sample of incidents researchers reported experiencing

45

- volatile material opened inside hood sprayed out of hood. It was reported appropriately and EH&S was contacted
- "Blood splash without glasses
- Liquid nitrogen dewar tipped over due to uneven ground left by a SESI project
- a faulty valve on a machine made an aerosol that sprayed into a researcher's eye (but it was water). WE now require goggles.
- human blood exposure
- and cleaned after every BSL-2 use. If I see any deviation from protocol the researcher is informed of any oversight
- "lock optical tables to ground for earthquake safety. After 1989 quake this took three years to resolve
- A Senior Research Associate cut his finger while fabricating a plastic liner for a lab dish; it required a trip to urgent care and surgical glue to stop the bleeding.
- improperly operating building heating and ventilation
- One grad student splashed a small quantity of methanol in his eye. There were no serious consequences, but he mistakenly thought the proper antidote was to consume a lot of ethanol by mouth. Getting drunk IS the correct antidote for methanol ingestion, but not for topical exposure!
- Several years ago a cryogenic insert shot out of a Dewar towards the ceiling, and one of my students did not want it to be damaged, so she ran over and caught it. No one else was in the lab. We all thought she was a hero, but now that I am taking this survey, probably I should have told her not to put herself at risk. We did have discussions as a group about how to avoid such accidents in the future.
- An airtight chamber imploded when a vacuum was pulled on it. Unlabeled solutions get reported on the group email list 3-5 times each year even though we keep telling everyone to ALWAYS label their solutions.
- Electrocution hazard in an etching setup was identified (by me) and was modified to improve safety. It currently being upgraded to further improve its safety.

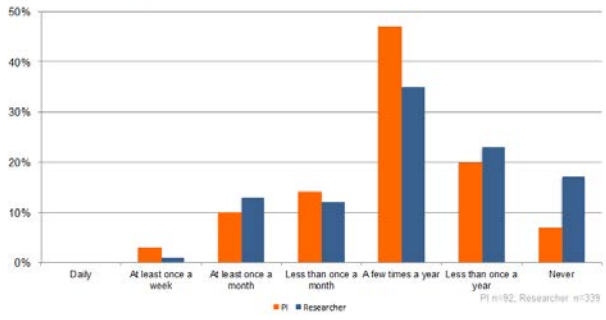
parc

Relationship w/EH&S

parc

Most people interact with EH&S a few times a year, with PIs more frequently than researchers, approximately 15% of whom has never interacted

47

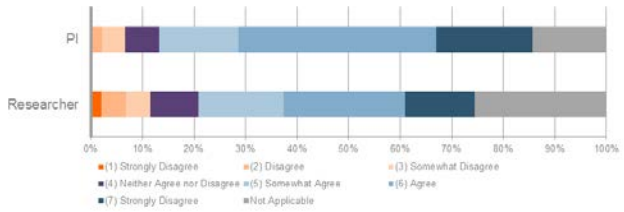


PI n=92; Researcher n=339

parc

Most people find their interactions with EH&S to be helpful, researchers somewhat less than PIs

48



	Average	Std Dev
Researcher	5.13	1.56
PI	5.63	1.20

PI n=91; Researcher n=340

The large group of "not applicable" mean that more outreach must be considered

Q: I find my interactions with EH&S personnel very helpful

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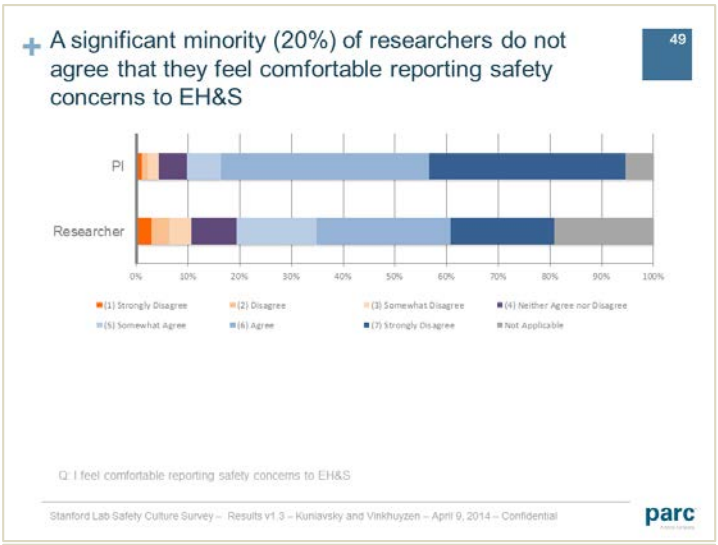
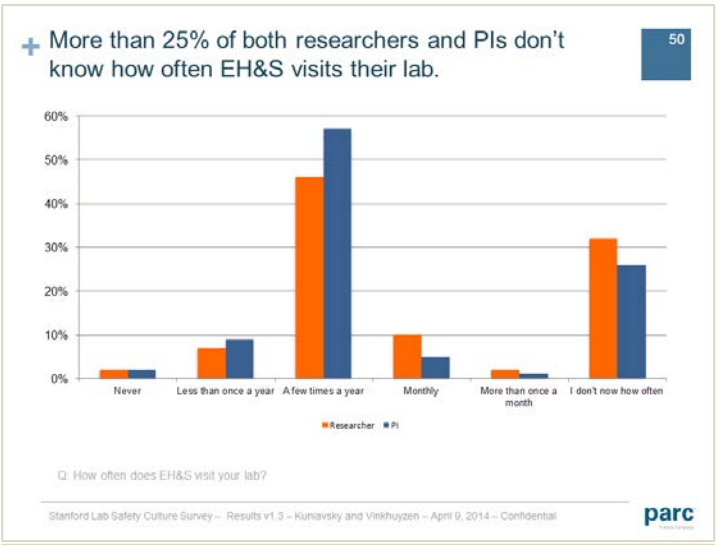
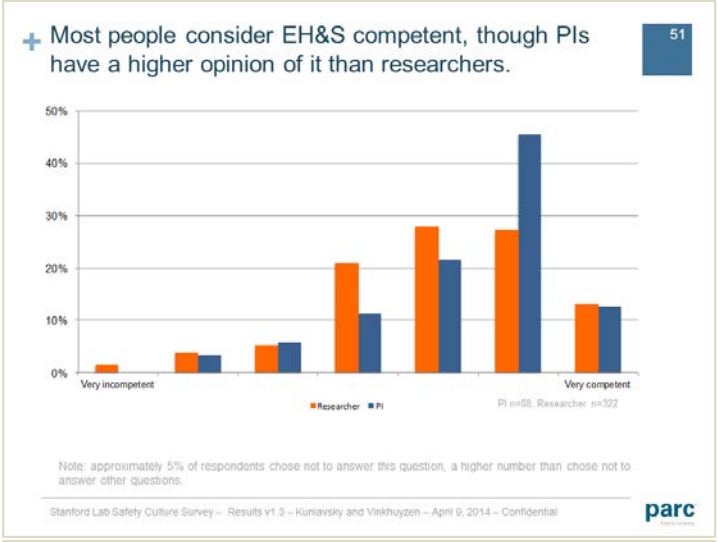
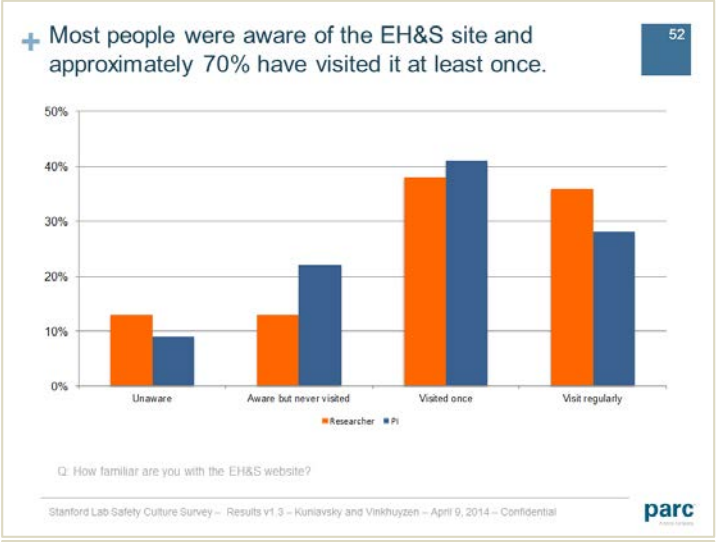
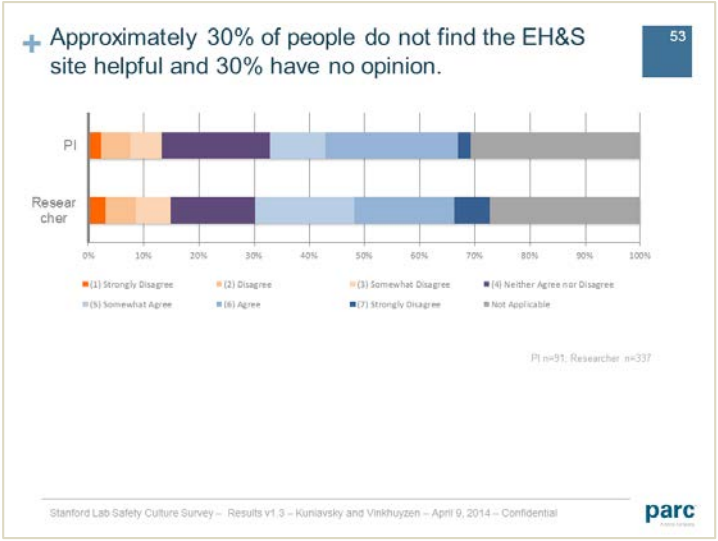
(Appendix D-2 continued)

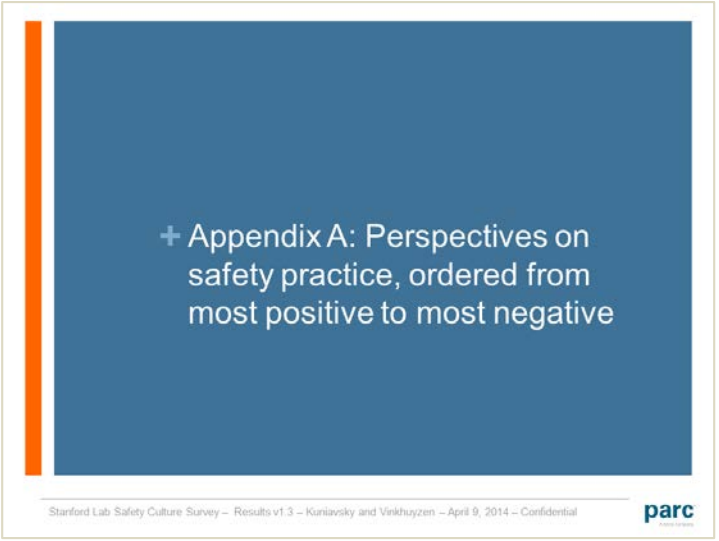












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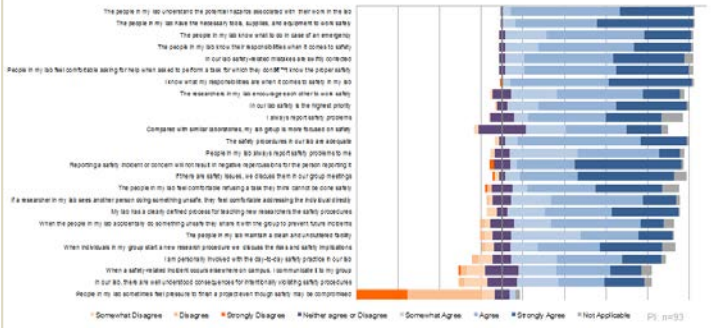
(Appendix D-2 continued)

PI: Please rate your agreement or disagreement with the following statements

55



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Researcher: Please rate your agreement or disagreement with the following statements

56

Researcher: n=360

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57

THANK YOU

Mike.Kuniavsky@parc.com
Erik.Vinkhuyzen@parc.com

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D-3: Ethnographic Review and Interviews Report

Palo Alto Research Center (PARC)
Erik Vinkhuyzen & Mike Kuniavsky
05/08/14

Laboratory Safety Culture Interview Results

Erik Vinkhuyzen
Mike Kuniavsky

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Laboratory Safety Culture Interview Results - Summary

Erik Vinkhuyzen & Mike Kuniavsky

June 7, 2014

Executive Summary

General

- *Lab safety culture is very much local, and changes group by group, and building by building.*
- *In hazardous environments (e.g., Chemistry), being compliant with the safety rules is not enough to be safe, whereas in less hazardous environments sticking to the safety rules can be all that is required to be safe.*

Principal investigators

- *Many PIs do not show up in their laboratories very often, they rarely do bench research. They travel a lot. So they can't be the day-to-day enforcer of safety practices. That is left to the lab researchers' own responsibility.*
- *While PIs are certainly a major factor in a laboratory's culture, their influence on the day-to-day practices in their lab is often quite limited.*
- *Effective communication of the safety rules and their rationale is necessary for the safety rules and regulations to take hold in the research community.*
- *Stanford can help instill a more uniform attitude towards safety in their laboratories by educating their PIs better.*
- *Lab meetings are a primary means by which PIs can show how much they care about safety. But many PIs don't take the opportunity. PIs have no training in how to hold effective lab meetings.*
- *While all PIs care about safety in their group, PIs vary greatly in their approach of how to instill a culture of safety.*
- *All PIs are managers, yet they receive but little training in how to manage.*
- *While it makes sense for PIs to be the arbiters over most of the consequences of safety violations, here too Stanford could do much by educating its PIs about effective approaches to consequences.*

Organizational structure

- *The way independent labs organize safety should be the example for safety for the rest of the University.*
- *Overall, independent labs and the way they run safety should be the example for safety for the rest of the University.*
- *The lab manager position is inconsistently defined and the way they approach safety is also quite different. Stanford should train lab managers or set up some knowledge sharing programs for lab managers so they can be more effective in implementing safety.*
- *A lab manager with a responsibility for safety can have an enormous impact on day-to-day laboratory safety and should be considered a best practice for laboratory organization, and something all labs should strive for, especially larger labs that do a lot of hazardous work.*

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- *Safety coordinators are mostly concerned with compliance issues not with overseeing that the researchers work safely. They don't feel like they have the authority to check whether people are safe, and don't view it as their role; they have little impact on the lab's overall safety or the prevention of accidents*

Group dynamics

- *Social cohesion can foster the safety culture and should be a goal for the PI*

Infrastructure

- *Research changes over time and so does group size which can require infrastructure changes necessary to maintain safety. Stanford should look into its processes for retrofitting buildings, some labs grow to be unsafe.*
- *The practical work of doing laboratory research work should always be considered whenever Stanford designs new research buildings that contain laboratory spaces.*
- *Stanford should investigate its current lab spaces—the advantages and disadvantages for research, collaboration, and safety—and create design principles that must be taken into account for all new construction.*

Training and learning

- *While Tier one and two training is generally perceived to be quite good, Tier three training is deemed much more important, yet is inconsistently implemented in the labs. Stanford should investigate Tier three best practices and then spread these best practices throughout the labs.*
- *Stanford should investigate how it can implement a more effective way of learning from accidents and near misses; EH&S should involve independent researchers in the writing of the accident reports.*
- *Stanford does not enforce a "Stanford" approach to safety training, and PIs don't get trained on how to instill a safety culture within their group. Stanford should investigate the ways in which new PIs are enculturated into Stanford and what kind of training they receive.*

EH&S organization

- *Stanford EH&S is not an organization that takes an active part in the day-to-day safety practices in the laboratories; it is mostly compliance driven. EH&S may have to expand its role if it wants to instill a Stanford-wide safety culture.*

PPE & Dress code

- *PPE is largely left to the researchers own judgment. They determine whether they need glasses or a lab coat.*
- *Stanford should create a centralized lab coat laundry service—it would send a message to all researchers that they are expected to wear them and that Stanford takes this requirement seriously.*
- *Stanford's rules concerning PPE are not very well communicated to the laboratories and researchers*

SOPs

- *Stanford should build a library of SOP videos made by researchers which can be accessed by Stanford researchers and are considered best practices for doing research*

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Laboratory Safety Culture Interview Results - Detail

Erik Vinkhuyzen & Mike Kuniavsky

May 8, 2014

Introduction

This report is prepared for Stanford's EH&S as well as for the Task Force for Advancing the Culture of Laboratory Safety at Stanford University (Task Force). It is the final report that combines findings from the Survey, which we conducted earlier in the year, with an analysis of the interviews we conducted between December 2013 and April 2014. The goal of the interviews was to gain a deeper understanding of laboratory safety culture than would be possible with the survey. The focus of this report, therefore, will be interviews, although we will use the results from the Survey to illustrate certain findings where appropriate.

The organization of the report is by analytic themes, as they emerged from the analysis of the interviews. The themes are illustrated with verbatim quotations from the interviews. We have anonymized these quotations and given the interviewees a number rather than a name. The numbers are consistent throughout the document; that is interviewee 102 always refers to the same individual.

We are grateful to all the interviewees who spoke with candor about safety practices in their lab and Stanford.

Method

The interviews were conducted in a loose semi-structured manner, as much as possible in or near the workplace/laboratory of the subject. This method allowed for the conversation to proceed as naturally as possible and would allow me to experience the environment in which the work is done. The interview guide that we used is attached in Appendix D-3-C. Most interviews were followed by a lab tour, during which the subject would show us aspects of the laboratory, their benches, the fume hoods, we took some pictures with their consent.

We also attended 2 lab meetings that were led by PIs because we wanted to get a taste for how these meetings go and how safety is addressed in them. And we accompanied EH&S personnel as they went about their inspections in different buildings.

The interviews were recorded with the consent of the subject (the vast majority consented), and then transcribed. The transcripts were anonymized. The interviews were then coded in to themes, and the themes form the basis for this report.

Interviewees

The 48 interviews were conducted between December 2013 and April 2014. To increase the chances that interviewees would agree to be interviewed, we used our contacts at Stanford to identify interviewees and introduce us. We requested a variety of folks to talk to, with a focus on bench researchers. In addition to the interviewees we received

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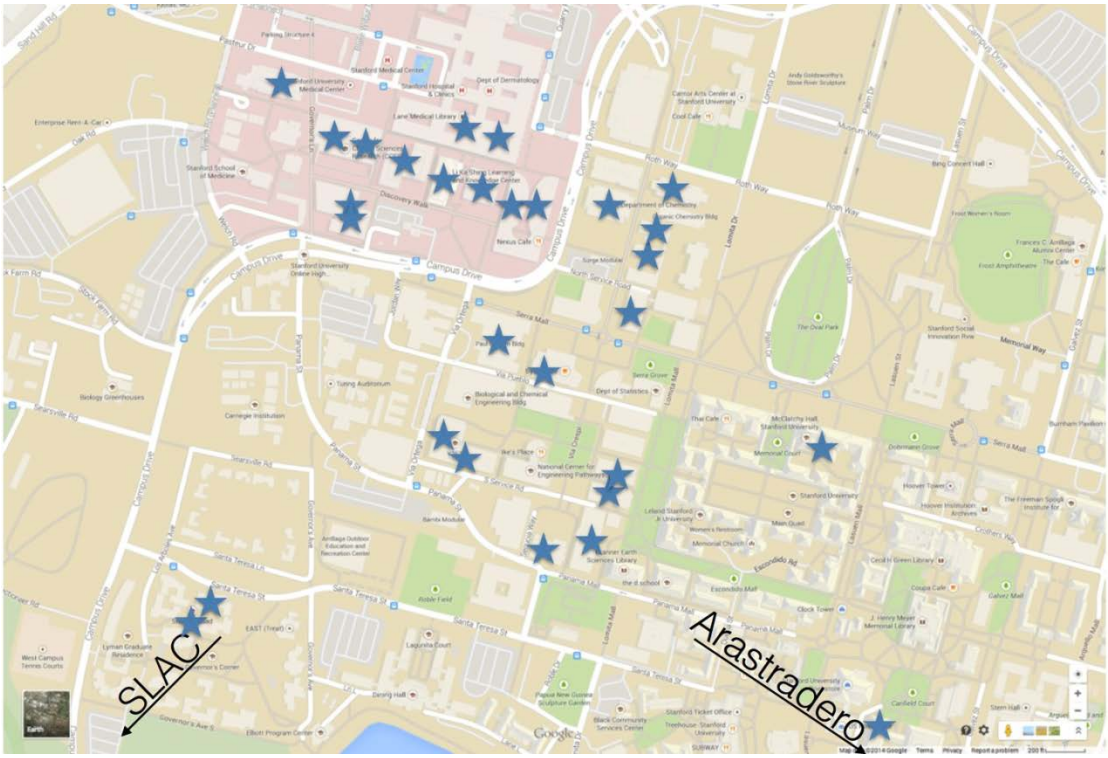
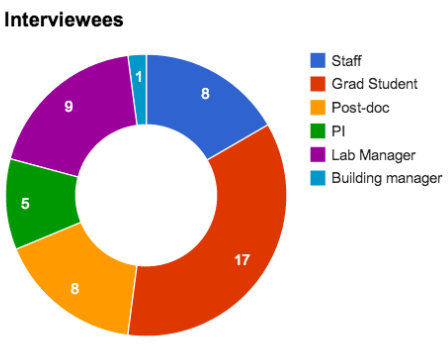
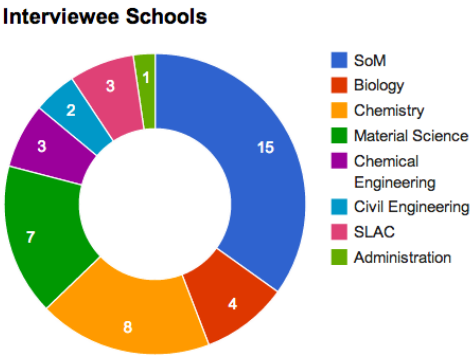
through this method, we also received a number of contacts from the survey, as respondents were asked to volunteer their e-mail address if they were interested in following up. We contacted all those folks as well.



Overall we contacted 93 people and spoke to 48. We spoke to PIs, Lab managers, Staff, Post-docs, and Grad students and were able to get a variety of perspectives.

Interviewees came from Material Science, Chemistry, the School of Medicine, Biology, Civil engineering, Earth Science, SLAC, Physics, and Chemical Engineering and ranged from graduate students, to post-docs, lab managers, and PIs.





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Laboratory safety culture

At the outset of this project, there was much talk about Stanford's laboratory safety culture as if there is a single Stanford laboratory safety culture. But it became clear quickly that there is no unified safety culture in Stanford, and that

> *Lab safety culture is very much local, and changes group by group, and building by building.*

While it is impossible to enumerate all the factors that play a role in creating a laboratory culture, there are a number of factors that stand out as particularly important when it comes to laboratory safety culture:

- Perceived level of danger in the lab
- The Principal Investigator (PI)
- The organizational structure of the lab
- Group dynamics
- Infrastructure
- Training and learning
- Environmental Health & Safety
- Personal Protective Equipment (PPE) and dress code
- Standard Operating Procedures

In the next sections, we will deal with each of these topics in turn. Our goal in this report is to let the interviewees do most of the "talking". There are many quotes that together make the arguments. In Appendix D-3-A we list many of the Accidents/Incidents we heard about in the interviews as we deemed it interesting to have them catalogued. In Appendix D-3-B we review what the interviewees had to say about the EH&S web-site. Appendix D-3-C contains the interview guide. Throughout this report, we will present summarized findings in italics.

Perceived level of danger in the lab

One of the most important aspects that play a role in people's attitude towards safety is the perceived danger of the work. Researchers in material science may be working with arsenic and other toxic compounds, while researchers in the school of medicine may be working with relatively benign virus strains. Here are some quotes that show the range:

136: Metalorganic chemical vapor deposition. Yeah. That actually has the most toxic things that I work with, arsenic and phosphorous based materials, but that's not.
PI: Toxic flammable explosive.

EV: Talk about what's dangerous in your work.
154: Sure. Generally I don't feel that things are dangerous. I feel pretty safe. I would say I work with blood samples essentially, so I use universal precautions. I assume that everyone has HIV even though they've all been tested and they really shouldn't have HIV. I use universal precautions, and generally I feel pretty safe.

172: Okay. The Department of Homeland Security has keyed us as the most dangerous building on campus. <laughs>
EV: Really?
172: Yeah. Because we're using toxic gases, pyrogenic gases-- pyrophoric, sorry. We do-- can you see the big tanks out here?
EV: Yeah.
172: Those are all liquid gas sources. Oxygen, hydrogen. Hydrogen is behind there and lying that way. Argon, and nitrogen. This is actually water. <laughs> We use—

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EV: Fairly innocuous compared to the other things you were mentioning.
172: To the other things, exactly. In addition to that we use acids like sulfuric acid, hydrofluoric acid, hydrochloric acid, in cleaning processes primarily. We use radiofrequency, power supplies, tons of them and that's mostly what's in my particular area. High voltage, spinning parts, known carcinogens, got the whole thing.
EV: You have everything.
172: We got everything.

What is more important than the "objective" standards of danger, is how dangerous researchers feel their work is. After working with certain very toxic materials for a while this researcher got used to the safety procedures and became a little over confident.

106: I find I guess when you get more comfortable doing something you probably get less safe with it because now I work with a pH13 solution on a daily basis and it really doesn't faze me at all but if I thought about it maybe I should be a little more fazed than I am.

The level of danger obviously has a lot to do with how careful researchers are in their work and whether they wear PPE, for example. Different levels of danger require different levels of caution and thus how conscious researchers are of the dangers their work presents. Thinking through the possible safety implications of research experiments is something that is perhaps particularly hard to do in chemistry, where new reactions can create new safety challenges that researchers ought to think through ahead of time. Certainly,

> *in hazardous environments (e.g., Chemistry), being compliant with the safety rules is not enough to be safe, whereas in less hazardous environments sticking to the safety rules can be all that is required to be safe.*

Designing experiments in those hazardous laboratories requires careful thinking and planning, which is something that is not explicitly taught, but are skills that must be acquired during tier three training, and ultimately in the course of a research career. While we found that Chemist and Material scientists working with hazardous materials are aware of the hazardous nature of their work, their tier three training was not necessarily formalized or well organized, as we shall see later.

The Principal Investigator (PI)

When asked, most people point to the Principal Investigator as the primary source for setting the safety culture in a lab.

137: So it's, you know, it's as simple as that. It's as simple as expressing that this is important. **The students really do take their cues from the PIs**.

Or here is a person in charge of certain aspects of safety in the Nanofabrication lab.

EV: … part of what I think is interesting about what your situation is that you get to see so many different people coming to you from different labs.
172: Uh-huh.
EV: Perhaps you get to see a variety of lab cultures if you will come in here.
172: Yeah.
EV: You have a sense for what drives the difference between-- do you—
172: You want to know the truth? I'm going to tell you the truth, the PI. Not so much now because the group is dwindled, but you could tell a specific PI's people by how they acted in the lab. "Oh, that's a X person," and I'd be right every time.
EV: Really?

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172: Yeah. **So I think that the PI has an incredible amount of influence** over this stuff. I don't know how well they wheeled it, and in fact when their students come here they sort of give over to us.

Indeed, one of the conclusions of the Task Force on Laboratory Safety was that PIs are key to the safety culture:

> 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 lab group membership identified above, PIs provide the single point of constancy over time within Stanford's research laboratories.

While it is clear that PIs have a massive impact on the safety culture in their laboratory, we need to unpack just how this impact is made, and also recognize that there are limits to their impact.

Involvement with the lab

PIs involvement with the actual practical work of doing the research varies enormously from PI to PI. Some PIs are still active and may even still do some bench research, while many others rarely set foot in their laboratory and certainly don't do any wet bench research any more. For most PIs, they are busy with writing grants, papers, giving presentations, and teaching (as some put it "become famous") and other administrative tasks. They leave the doing of actual experiments to their students.

Here are some quotes about PI involvement. A grad student who works in two labs:

103: …I'd say in neither case the PI isn't sort of walking through the lab all the time, so it's not really a matter of being worried that I'm going to get caught doing something unsafe.

101: No, so our PI doesn't come check on us to make sure that we're doing.. you know, everything as we should.

EV: Is this organized by your PI? Or by...
118: No. It's just organized by the students.
EV: Okay.
118: He kind of has the approach if it's not a problem, don't bother him with it. So we do that.

EV: So would you go to your P.I. and ask him how to do it? He's probably done it.
106: No.
EV: You don't think he has?
106: **Maybe he has and maybe he hasn't. But even if he had time to talk to me about something like that he would probably say "You can look that up and you can do that on your own." Or "Read a paper about it." He does not come in the lab**.

EV: And so let me talk a little bit about the PI, because as you said, things are different when they come from the PI. How often does she? Is it a lady?
135: She.
EV: Visit the lab?
135: It's, you know, there's times when she's in, maybe frequently, because she's giving tours to, like, companies, or other people, or media. **I would say no more than once a week, no more than once a week, so it could be as little as maybe once a month, but no more than, I would say, once a week.**

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EV: How often are the PIs in the lab? How often do you see <name> on a weekly basis?
175: If he's in town he probably walks through the lab a couple times a week, but how much does he like walking down the benches? Only if there's someone that he needs to talk to that's down their bench.

Moreover, when PIs come into the lab it is not to inspect the lab, but mostly to connect with their group members.

EV: Okay. Does he do any kind of inspection of the place…
181: Never.
EV: ..with safety in mind?
181: No.

The lack of presence in the laboratory means that, in effect, PIs don't have much control over what goes on in their lab even if they care deeply about safety. Here is a comment from a Chemistry graduate student who works in a lab with a PI who is widely lauded for his leadership in safety.

EV: So, I think it's interesting <PI> seems to be very conscientious about safety. I mean obviously he's very concerned, but nevertheless he's very busy. And he doesn't necessarily have time to oversee what goes on in the lab as a practical day-to-day kind of affair. Do you think that he maintains a good safety culture? Or do you think that he has too little control over it? Or-- too little, I mean-- I don't want to make a judgment here, but I guess **what I'm trying to say is because he has no-- because he's not a presence on a daily basis, he might not actually have that much impact on the safety aside from his meeting.**
175: I think that's a good characterization. Or at least it's a good characterization to bring up in terms of the spectrum of worst case scenario, <PI>'s ideal, where we are, and the worst case potential scenario. I am sure that the way work is conducted in the lab currently is probably not up to his ideal. ….as much as he has all these conversations with us, do we completely follow through? Or do we actually go along with everything? And it ends up on a person to person basis and how much they follow through with it themselves. And that also depends on kind of how rushed you are at the time.

Even PIs who are quite concerned about safety, then, do not exert much control over the actual day-to-day practices in their laboratory.

Many PIs do not show up in their laboratories very often, they rarely do bench research. They travel a lot. So they can't be the day-to-day enforcer of safety practices. That is left to the lab researchers' own responsibility

In many labs the day-to-day safety is left in the hands of the more senior members in the group:

102: Sure, I mean I started research as an undergraduate and it was just working really closely with people in my role now, working with Post-docs, and the **PIs have always kind of been hands off and just left it to like the more senior people in the lab to just instill upon the new people proper laboratory practice.** And, so just working really closely with Post-docs and watching what they do, asking when you had questions, and just that's kind of how you learn.

While PIs are certainly a major factor in a laboratory's culture, their influence on the day-to-day practices in their lab is often quite limited

Attitude about safety

Mostly, PIs are quite concerned about safety, but in the interviews there were divergent views about how concerned PIs really were.

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The PIs attitude towards safety shows up in the very first day a graduate student arrives in a lab. Here is a comment from a graduate student describing the difference between two laboratories in which he works:

175: I had a conversation with the safety coordinator at the time about kind of how the lab works. The <PI1> lab has a very large safety packet that I had to read through. And then I had about a two to three hour conversation with <PI1> where he grilled me on safety related issues, wanted to make sure that I at least was aware at that time of how to respond to certain situations as well as what the emergency protocols were.
EV: Yeah.
175: And that was the <PI1> lab safety training. The <PI2> lab was here's the lab. Let me sign your paper after I watched all the videos.

Here is a comment from a graduate student who changed groups in part because of the attitude about safety in his former lab.

152: But also definitely the outlook is very different [between the two groups]. So it's brought up in the meetings and it's discussed and just… So sort of like something I said at the meeting, **if there's a procedure that we want to do and I go to my current adviser or somebody else in the group says, "I want to do this, but there's some safety concerns," it's very much appreciated. "Okay. Let's figure out the right way to do this, or if we can do it." Whereas I very much got the feeling in the previous group that it was, you know, "It's not that dangerous. Figure it out,"** kind of thing.

Or these comments from a post-doc whose PI is very concerned about safety, but who has experienced other situations as well:

104: Yeah, I mean I think <PI name> has a very good sense of safety and he's had a lot of experience. He's also very engaged in students in the lab, he's very concerned about them in general, not just about them in the lab but just them as people. And so that translates over to them being concerned about them working safely and other things like that.
EV: Without bad mouthing everybody else, but do you think that that is common in <inaudible> or do you think that this is pretty unique?
104: I think he's the exception. But I can't comment too much, you know, there's definitely a balance, I think there's definitely a balance in different professors, but I think a lot of professors are not too concerned, it's my impression is just they're not too concerned with their students' wellbeing.
EV: They figure they have to figure it out.
104: They got to figure it out, "This is part of your responsibility, we all had to do it and just now, just get it done and…
EV: Learn to be safe.
104: …get these paper-- get me some publications and get the hell out of here and learn to be safe." And some people, they don't even care. My boss used to brag about not wearing any lab gloves, so she said, "I didn't wear lab gloves when I did some of these-- " like this was something to be proud of, not wearing lab gloves.

One of the ways in which a PI shows his/her attitude towards safety is by showing a respect for the safety rules. 190 is a PI whose conscientious approach to safety is undoubtedly very effective in instilling the importance of safety in the group:

PI(190): Yeah. Well, one of the things I do is I never complain about a safety rule. I show complete respect. I always talk with respect about anything involving safety. I never complain about it because there's probably some things to complain about, but in the big scheme of things those are much less important than the positives that you could say about lab safety. I've never had any bad experiences with accidents or anything. I've seen a few.

Other PIs certainly don't have the same attitude when it comes to safety rules that they consider "lacking in logic":

161: Well, I think sometimes some of the vector-- certain viral vectors; sometimes I think the containment rules are overly strict. I mean, some of them have been relaxed over the years, but sometimes I think they're over regulated, or over..

….

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161: And there were rules about what you could or couldn't spill down the drain. Sometimes I think certain things they allow you to do and certain ones they don't, it just makes no sense to me. There were rules about ethidium bromide, which I think is a carcinogen. You don't want to spill it, but you could spill so much down the drain. I don't know how that's changed. **But there used to be some pretty crazy rules.** But then chlorine or a little bit of..
EV: Bleach.
161: Bleach. I mean, you couldn't spill that down the drain. To me it doesn't..
EV: <Inaudible>
161: Yeah, it doesn't make sense. So again, I just think there's logic.

While we can all understand the PIs point of view, this is an attitude that probably does not help instill a culture of compliance to safety rules. Here is a comment from a post-doc in Chemistry who at the end of the interview described essentially that she felt safety was overdone and was starting to get in the way of doing research.

102: Yeah, I think we're operating at a very high level of safety especially with what I was trained in in my graduate work. I think there actually could be like a middle ground, like at points I think it's counterproductive. I guess that might be a little bit the wrong thing to say, but you spend so much time on safety with the meetings and the getting ready for an inspection and like I said you can't put anything down the drain. You can actually get in the way of research if you spend too much time on it. If you're operating at a pristine level of safety already, if it's working then stop trying to fix it.

PI-161 and Postdoc-102 display exactly the kind of attitude that PI-190 conscientiously avoids because once you question the rationality of certain safety rules you lose credibility when you try to enforce others. The attitude displayed by interviewees 161 and 102 is more prevalent than 190s, given academic scholars' (inherently good) inclination to question rules, even though it may not be something they are likely to say; note how post-doc-102 displays an awareness for the politically incorrect position she is taking when she says: "I guess that might be a little bit the wrong thing to say".

Clearly, effectively communicating to the research community the rationale for safety rules is a challenge and can be improved. PI-190 provided the following compelling rationale for safety rules:

EV: It seems draconian to people because they feel like, you know, "If I'm at home I would do this, and now here at Stanford I can't do this." It seems silly.
190: Well, they don't understand what it is to have a really, really big operation. But there are affects of scale here, and what you might do in your home is not something that you could do piecemeal all over the university. And it's just like-- well, I don't know. If you were engineering something, for example, what you might do as a home repair, and yeah, that'll do, is not something that you would allow to be done if you're making a really, really big building. It's going to have bigger stresses. So it's just managing a big operation you need to have certain kind of standards--

We found this kind of forceful language very impressive but also quite rare.

Effective communication of the safety rules and their rationale is necessary for the safety rules and regulations to take hold in the research community.

The attitude towards safety among the PIs is certainly not uniform, and Stanford as an organization could enhance their training.

Stanford can help instill a more uniform attitude towards safety in their laboratories by educating their PIs better.

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Lab meetings

Since, as we have seen, PIs do not necessarily come to the lab all that often, the Lab meetings are one of the main occasions in which they can address safety with their group members. In many industrial labs and in some academic labs as well, they have instituted a "safety moment" at the beginning of the meeting. However, has with so many things, PIs run their lab meetings in their own idiosyncratic waus and safety is not necessarily on the agenda:

EV: So let me ask you then, so for instance, in your lab meetings, is that the first thing that's being discussed, safety issues?
181: No, it's never discussed.

There are plenty of labs in which safety is not a standard part of the agenda in the lab meeting, there are some labs in which it is conscientiously discussed. For instance, in this lab in the school of medicine, the PI communicates clearly the kind of experiments that will be going on in the lab, so everybody knows what the others are working on and the particular hazards they will be exposed to.

187: She's [PI] very concerned. She makes sure everybody has a lab coat, everybody has safety glasses for the work done in the tissue culture room. **We talk about it at our group meetings once a week about things that are being done, what experiments are being done. Everybody in the lab knows when a big virus experiment is coming up and the amount of viruses begin ramped up. Everybody's kept very aware of all of the experiments that are happening in the lab.** If somebody has a big radioactive experiment, a big pulse chase or something, then it's notified in the lab meetings. So she does take it very seriously.

In another lab, the safety coordinator has to present the result of her inspections to the lab every week.

106: No, so there is the safety checklist that you're supposed to go through quarterly. We actually do those weekly and so whoever is giving group meeting presentation that week actually has to do one before their presentation and then the first ten minutes of every group meeting every week is are there any safety issues. And so the presenter has just done the checklist and they go through and they tell everybody what we found or what they did to fix it or maybe we need to go back after the presentation and look at this experimental set up; somebody needs to clean it up.

Similarly, in a chemical engineering group:

135: What we also do is actually-- what's mandatory after each meeting on Fridays, for our group meeting, each person who presents also has to present one or two slides on safety. So typically what we do is take pictures of like, misdemeanors or things that shouldn't have happened. So for instance, I took a picture of, like, a needle that was sitting on top of a needle waste bin. Someone simply didn't put it in the hole, they left it on the top, and I took a picture, I was like, okay, let's find out what's wrong with this. You know, the container is there, it's not like there was no container to put this in the waste, but this is simply not okay.

Even if safety is not explicitly discussed, lab meetings can give rise to discussions that are very useful for safety if the PI encourages this. For instance, in a Material Science lab meeting, the researchers speak in turn about the experiments they are doing and any results worth mentioning. One of the researchers talks about a new experiment and several others speak up about safety issues the researcher should be concerned about—there is a possibility that a poisonous gas is created, so they urge him to be thinking about that. He is in the process of writing a Standard Operating Procedure (SOP) for the new experiment, and will have it verified by someone in EH&S. The input he receives from more senior researchers in the group can only help him think about the safety in the work.

A PI in Chemistry held group meeting dedicated to safety. During the group meeting, most of the students are actively engaged in the discussion, and it is obvious that the PI has created an environment in which discussing safety issues can

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be done without any fear of retaliation. For example, after some introductory comments, the PI solicits information about incidents "that I don't know about":

PI: All right. But what I'd like to do is to go back and say, okay, what happened in the last year and a half in the lab? What incidents have come up, and what's happened that we need-- that we can learn about from, so are there any-- did anybody have a fire in the last 12 months that I don't know about?

In response, several people mention fires and other incidents that they have caused, clearly not afraid of retaliation. One researcher mentions that he broke a muffler that contained 10ml of mercury. He tried to clean it up with a spill kit, but the spill kit did not work for the quantity of mercury he had spilled (only good for 1ml or less). He ended up picking it up with a piece of paper and putting it into a 20 ml and it was still sitting in his hood. This is clearly not an optimal way of handling the problem. However, the professor response to the incident is quite measured:

PI: All right, okay, so this is really important. So any time-- so the mercury kit is for, like, a mill of mercury, okay?
GS1: Basically nothing.
PI: And secondly, so if you break a bubbler, or something like this, we have to call EH&S and we should do it now. Okay, because, because the-- so there's two things. It's a hazard, what's the hazard with mercury? Look, it's volatile, you breathe it in, it's not very good for you. It's not like immediately toxic, but it's-- with a large volume of mercury, you really shouldn't be dealing with, and on a spill that size, we should just have the EH&S come in and clean it up. The other issue is that because the sinks are flush in the hood, there is no doubt in my mind that some mercury went down the drain.

Note how the PI explains that in cases like this the Graduate student should have handled the problem differently. There is no scolding here, but a calm explanation of why a spill this size must be reported to EH&S. When a professor does this in front of his entire group there is a good chance that his people will know how to act when they spill mercury in the future (and that this mercury gets removed, which could have taken a long time if it had not been brought up). His message to his students appears to be, "I trust that you are working safely, but I know that there are inherent dangers to doing chemistry and that accidents can happen. Sharing incidents with each other can only help the overall safety in the group."

The dedication of a special meeting once a month to safety can foster learning across the lab. For instance, consider the discussion about heat guns in this lab meeting. Note how several people start their turns with "oh"; the suggestions for storing the heat gun are news to them: this is how very practical safety ideas can spread across a lab.

J: I mean, this is generally not an issue, but I mean, like, sometimes I-- **sometimes heat guns are stored relatively hazardly**.
M: I think that's a great point, yeah, where, after you've used them, they're closer, if not being hung somewhere, they've being placed on pieces of plastic etcetera.
E: Yeah, it might be good to have an SOP for usage and storage of a heat gun, and not that I have one, but it would be good to probably do that. I mean, like, **James has a ring on a ring stand right next to his hood, that, every time he's done using the heat gun, it goes back in there inverted, so nothing can spill on the hot filament or anything like that**. And that's not generally-- that's not my practice, and that's not most people's-- not everyone's practice, and I think--
PI: **Oh, that's a good idea**, actually, that's pretty easy to set up, so--
M: I think some of them have it, like the one near me has--
PI: So let's just write that down, and we'll send that. So that-- so the issue is that, if the heat gun is still hot, and some solvent or something spills in it, then-- concern, okay.
M: It would actually--
W: You can also use gas cylinder caps, are also really good sheaths for heat guns.
G: Oh yeah, that's true.

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While some PIs make a point of discussing safety every lab meeting, other PIs don't see any need to bring up safety unless there is a problem:

EV: So a lot of labs they do safety at the beginning of their lab meeting, do you guys do that? It's just always a topic; there might be a five minute issue or something. You guys don't do that?
193: No. And I guess I don't really see why that would be beneficial unless there were specific situations that should be brought up.

But this misses the point of the Safety Moment, which is to instill through repetition the notion that safety is something that requires constant vigilance.

The lab meetings are one way in which PIs get to show of their managerial skill and they are an opportunity for them to instill their values with regards to safety. However, there has been no guidance on how to run a lab meeting, as can be seen in this PIs response:

EV: I've heard other PIs, I've been in their group meetings, and they'll open the group meeting to I want to talk about safety first, is there any safety issue. Do you ever do that sort of thing?
127: No, that's a great idea, though.

Lab meetings are a primary means by which PIs can show how much they care about safety. But many PIs don't take the opportunity. PIs have no training in how to hold effective lab meetings

Practical knowledge

While there are exceptions, PIs are often so rarely in their laboratory, that they are no longer able to give much practical advice about laboratory work. 104 is a post-doc in Chemistry who describes how he did not trust his own PI's recommendation for how to perform an experiment:

104: …. So for instance when I was first starting, I wanted to use ethylene oxide which is a gas and it's reactive and I didn't know exactly how to handle it. **My boss kind of told me, "Oh, just do it, set it up like this." And I wasn't quite satisfied with her explanation and she had never handled it before either but she just kind of gave me this hand wavy, kind of just set it up like this and that's it. And I didn't do it because I wasn't satisfied with her explanation,** I wasn't sure who to go to talk to. And then a couple of years later I needed to use chlorine gas which is really toxic…

Another grad student in Chemistry who works in two labs says that he would not approach either of his PIs with practical questions, as he would be unlikely to receive helpful answers.

103: Yeah, or I may not-- I mean, I feel like where I am now I feel comfortable with all the things that I'm doing, but maybe there's things that I don't know about that I should be more careful about, and just because I don't know about them the sort of unknown enemy is your worst enemy. And so I think it ends up being that a lot more safety culture is put in place by the other students in the lab, and I think that that is sort of the way that a lot of labs are set-up. **I think between the two labs that I'm in one of them-- it tends to be pretty much 100 percent talking to grad students, because a lot of times we don't feel comfortable going to our PI and talking about safety issues, because it'll sort of spark a long, overdrawn-out conversation about overarching goals of safety and not "I have a question about whether this chemical is going to kill me or not." It sort of ends up being the activation barrier to going to talk about something. It's not a conversation that I don't think anybody in this lab would sort of feel comfortable doing or feel like it would be all that useful to us.**

We will revisit "practical knowledge" later in Appendix D-3-B when we consider where practical knowledge resides and how it is best communicated.

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Management style

PIs are managers of their groups, but they were not selected to the leader of their group for their managerial skill, but for the quality and productivity of their research. It is not surprising, then, that their managerial skills vary considerably.

Some PIs appear to take a rather gentle attitude towards safety. Consider for instance what this graduate student said about her PI who is very concerned about safety:

113: Right. Professor <name> takes safety really seriously but students don't have to implement, that's the problem. And he's really a nice guy, he won't force you to, "You have to do this. You have to do this." He thinks students will do this spontaneously.

Implicit in what 113 said is that students don't necessarily do what the professor tells them they should do.

A "trust" approach without checking is not necessarily effective. On the other hand, here is a story from a grad student who describes a much more authoritarian PI:

152: And occasionally, there would be an event, something somebody would e-mail out to the group like, "Hey, this gas line got left open," or whatever it might be. We've told people, "Don't do this." And the response-- and I don't know how much of this was just a language barrier or a cultural barrier kind of thing, but **the response typically from the PI would be like, "Who did this? I want them to come see me immediately."** Like not really a constructive thing, just like it seemed more like--

152: And I remember there was one time there was something where it was like there was something happened or some safety problem and **he called an emergency safety meeting Sunday afternoon, sent the e-mail Sunday morning** or something. It was like, "Everybody has to be there," kind of thing.

152: But that it also just kind of, it seemed more like a show, right. Like, "Oh. We're going to have this really important safety meeting that everybody's going to come to on Sunday afternoon." But what does that really accomplish? That's not serious, right? If you have a serious thing you give people time to plan ahead so they can show up to the meeting and discuss concerns.

152: Not just come and be scolded or whatever.

152: But it was things like, "Oh, do we need to install webcams in the lab to like--"

152: "--monitor who's doing what?" kind of thing. And not something that was going to be changing the culture of--

It is likely that from the PIs perspective calling a meeting on Sunday shows just how important the issue is, but this may be a cultural difference. This student did not feel like safety was addressed in a serious way by holding a scolding session on a Sunday afternoon. In any case, this aggressive approach towards safety by the PI does not encourage graduate students to actually raise safety issues, and instead to cover them up, which is an undesirable outcome.

> *While all PIs care about safety in their group, PIs vary greatly in their approach of how to instill a culture of safety.*

There are many ways of running a group, at Stanford PIs have enormous latitude in how they organize their lab. While all are great scientists, they are not necessarily great managers. Stanford provides no training for PIs to build their managerial skills.

> *All PIs are managers, yet they receive but little training in how to manage*

Part of a PIs management style is the way s/he deals with safety violations. We already saw an example of a PI who essentially trusted his group members to work safely and tried to instill a culture of safety in his people by having a

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monthly team meeting in which they discussed safety. Trusting graduate students to be safe has the disadvantage that researchers feel little pressure to be safe. Here is a grad student of that trusting PI's lab who speaks frankly:

175: But needless to say kind of that doesn't really help with [PI]'s authority, and I suspect if he tells us to do certain things and only a third of the lab really does it and then two-thirds doesn't because they don't feel any pushback when they don't, there's no consequences to them not performing a given task, [PI] doesn't really keep on top of them about it at all, and so then it becomes a culture of not really doing it, and so people will only do it if they feel like it, if they believe it helps them. If they don't really believe there's a significant help to them they just forget about it, because they know there aren't any consequences of not doing it.

When it comes to safety, then, a PI must convey the importance of safety and that there will be consequences for not working safely. Consider for instance the strong impression a PI made on graduate student 171 when he described a fire that happened in his laboratory some years earlier:

171: …. We also get stories from the lab's past of other incidents from the lab's distant past and we see how disturbed our PI is from those, so he still remembers these things that happened 15 years ago.
EV: And, you will probably remember this.
171: I'll remember it. And, he tells us about it and he tells us about how shocked he was and what a big problem it was at the time.
EV: Give me one example.
171: Somebody in the distant past caused a small fire in the lab and put it out before it damaged very much, but when our PI tells that story he always mentions that he was ready to fire the Post-doc who did this and he's not the type of PI that fires anybody. So, it gives you the feeling of how serious he took that incident. So, I think that's an example of how you see from the top down what a big deal this can be if there's a problem.

Clear consequences can set the tone for a laboratory that unsafe behavior will not be tolerated. This is a story from a lab manager:

EV: If you have a person who is a repeat offender do you escalate?
174: I've never had that happen. Fortunately they're smart people here, and they are conscious of the consequences, and they want to work in a safe environment. They understand that it could get very dangerous. So I've never had anybody repeat, no. And then <PI's name> very good, our PI. He's very good about such things too. There was one person. He wasn't a repeat offender, but he did something that annoyed the janitors where he threw in some sharps in the janitor, so he banned him from the lab for a week. So I do give that example to everybody that <PI's name> is a hard taskmaster. He is very safety-conscious. You do something that…

One PI told a story that she had let a graduate student go because he was not taking responsibility for his actions, and was not being safe. Her point was that if a researcher does not take safety seriously, then there will be other problems, implying that the science of a person who is not safe cannot be trusted either.

190 (PI): It was not the only problem with that person, no. Somebody who's going to cause an accident and then not take responsibility for it, that's not going to be the only problem with such a person, right? **That's one of the other things about safety. If you're not good at that it's probably because there's other problems. So somebody who won't take it seriously it's not a good sign.** There's no reason for somebody to think it's wrong to be safe, right?

This PI strongly felt that she was the one that set the standard for safety in her group. The importance of being safe should be emphasized in no uncertain terms.

190: The faculty member has to take responsibility and has to be willing to talk to every single person and say, "Continued work in this group depends on best practices and honorable treatment and consideration of others.

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> Lack-- being unsafe is totally inconsiderate of other people. It's also bad, sloppy science. You can't trust your science if you act like that.

Compare the firm position of PI 190 about safety with the situation in a Chemistry lab in which a post-doc who caused the incident was not let go and several people wondered how come the accident was so clearly the result of careless practices on the part of the researcher. That the post-doc is continuing to do chemistry sends a profoundly ambiguous method to the other researchers about how the institution treats safety violations.

> *While it makes sense for PIs to be the arbiters over most of the consequences of safety violations, here too Stanford could do much by educating its PIs about effective approaches to consequences.*

The organizational structure of the lab

One way in which labs vary is the amount of permanent staff with safety responsibility. We distinguish between three different models, although there are gradations in each category.

1. **Independent labs.** Some labs are not owned by a PI but are independent and provide a service to many different researchers. SLAC and the Nanofabrication Facility are the two examples we encountered. Both have extensive permanent staff that oversee the research.
2. **Labs with a lab manager**. Then there are labs that have a lab manager. This is common in the School of Medicine, for instance. The lab manager does work for a PI or sometimes multiple PIs of a shared lab facility. And while the lab manager's role is different in every lab, in most cases the lab manager is the most senior researcher in the group and exercises a level of control over safety practices in the lab.
3. **Labs without a lab manager**. These are labs without permanent staff, and the lab is made up entirely of post-docs and grad students. In some of these labs post-docs outnumber grad students but not necessarily, so the average age varies but can be quite young. In these labs there is usually a division of labor with the PI distributing jobs among his group members, the safety role often assigned to one or a few members.

In the following sections we will describe each.

Independent labs

The two independent labs in which we conducted interviews are the Nanofabrication facility and SLAC. Neither of these labs works for a specific PI, but researchers from different groups use the labs to perform their research. In SLAC research time is carefully scheduled, and many applications for research projects (in which they request SLAC Beam time) are rejected, even though the facility is open 24 hours a day.

In both facilities, safety is handled by permanent staff and they make an effort to oversee the work of the researchers. Training in these facilities is very strict and organized and violations of procedures is not tolerated. Procedures are specified and detailed. Consider for instance how access to the laser is restricted to authorized personnel:

> 112: Yes. So anybody who is called a qualified laser operator for hatch five has to be qualified by me and by receiving a practical. We have a little lab with a laser set up that we go and we train those QLOs and then they also get an interview from our laser safety officer, Mike Woods, who confirms that they've received their training. They will also have to do a certain set of coursework that's available online and some is classroom based. So after they've passed their coursework, their practical training, their interview and some of what I call on-the-job training which is basically them working with me in the end station in the experimental end station for some period of time, then they're qualified to work.

In shared laboratories there is often an additional amount of pressure to work safely. For instance, in the Nanofabrication facility there is much more stringent control over the people that work in the facility. This is a staff

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member of the Nanofabrication facility comparing her facility to other smaller labs she heard about in the town hall meetings:

172: Well, there was people [in the townhall meetings] talking about people eating as they're doing experimentation in these little desktop sorts of areas and that sort of stuff and the kind of fear of us hearing from students. It was a real eye opener to me. I thought, ooh, okay, so we're kind of ahead of that game. The lack of safety officers or anyone that even remotely responsible for safety-- and I get it, I get that there's lots of little tiny private labs around, and **I think part of the duty of being a shared lab is you do have people that do oversight, like me**.

In SLAC, too, there is oversight of all the experiments:

EV: Do you go and inspect that work?
108: Yeah. So anything that happens in the lab we do daily lab walk throughs to make sure people are wearing safety glasses, to make sure people are wearing gloves, to make sure they don't have any new chemicals that they didn't tell us about previously. So, yeah, there's a lot of lab oversight of all the experiments that are going on.

Training is extensive and strict. Incidents in such an environment are rare.

172: So basically what happens is when someone gets an account here, and there's a procedure by which you are deemed whether or not you can get an account. They then have to go through our safety training. That involves online reading and links, and all that kind of stuff. There's an online test that they have to take, and then when they finally come here on site then they're taken on a safety tour, and that's about an hour and a half of someone going through the facility pointing out stuff, especially things like safety shower, toxic gas alarms and alerts, and pull stations for fire and all that kind of stuff, and then when we train on a specific piece of equipment we also mention the safety hazards involved in that. A lot of this stuff is interlocked, thank goodness, but a lot isn't <laughs> and **in terms of our safety record we've done incredibly well, let me knock on wood <knocks> because we haven't had any major incidents**. We've had a couple of scares, but nothing major.

Or, when they do happen, they are investigated thoroughly:

112: So it's interesting that you ask because **I had an incident recently. In fact, it was investigated by DOE** and my incident was we were supposed to be in the class one mode, meaning all the beams are blocked and there's no hazards, so when we are in class one mode, the lasers are still on, but the beams are all terminated, so you can take your eyewear off. So I thought that everything was working fine. I'd taken my eyewear off and I suddenly realized that there was a lot of light in the room and I shut immediately the lasers off and I started to try to figure, understand what was going on and it turned out that a pair of those shutters that block one of my lasers had failed and now it wasn't. What was very awkward about this incident was the fact that we have two shutters, so one shutter and a redundant one, and both of them had failed and this is a very rare occasion. So we had to go and understand whether there was somebody tampering with them or somehow something happened and there was a mechanical failure of both at the same time. So that was the incident. **There wasn't any injury, but it was an alarm because over here we have a redundant system and yet both of the shutters failed**.

So these independent labs are characterized by a high level of procedures and oversight and accidents are rare and often caught early. Obviously, this is in part because the dangers are very real.

136B: But it's just like when I go up to SSRL to do X-ray diffraction up at the Synchroton. They have really good safety procedures and a good safety record with regards to radiation exposure, but I still worry about it because you would die if you got hit by the X-ray beam at SSRL.

Their approach to Standard Operating Procedures is also quite much stricter than in most other labs:

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108: Yeah, there's-- there is rules about that and we pretty much adhere to all those rules. So the SOP has to be posted outside of the lab door so that other people working in the lab are aware of what's going on in the lab and we cover all that when we do our lab training. And then we also post hazard symbols on the door as well so that people know what the main hazard is that's present in the lab and then—
EV: Do you do that or--
108: Yes, I do that, and then the users get a copy once we have signed and approved so ES&H also approves any SOPs. It has to be approved by the lab manager and the ES&H director so once they have approved and signed we send a copy of that to the user and they generally always have it out with them in the lab.

Such close scrutiny of the research work is quite uncommon in the other research labs. And, of course, independent labs can implement strict consequences for people that violate safety procedures (unlike a PI who has a personal relationship with all his group's researchers). Here is what a staff of the SLAC said regarding consequences for breaking the rules:

108: No. So all the lab doors are key combo, and so they have to do training in order to get into the lab to begin with, so **if anyone doesn't follow the rules, I change the codes, and they can't get in anymore**. That's an extreme situation. I don't normally have to resort to that.
EV: Have you ever?
108: I have done that, yeah.

In the Nanofabrication facility, too, the organization keeps pretty close taps on the researchers that use the facility. The clean room is monitored by cameras and when researchers do something egregious they can be banned from the equipment, as access is computer controlled.

172: The kinds of offenses that'll get you thrown out are blatantly going against the policy or the operating instructions which are written online, posted at the station where something horrible could have happened. Sharing accounts, that's another one. You and I are qualified to use the same tool. You turn it on and I use it. No, no, no, no. It's got-- or you're qualified, I'm not. You turn it on and I use it? Oh no, no, no, no, no. So it's that kind of thing. So we want to make sure that everyone that is using a tool has been qualified on it and understands all the little bits and pieces.
EV: But now in order to catch something like that you would almost have to be next to them and see it.
172: Oh it's easy. It's easy.
EV: Really?
172: Yeah. There's a history in our computer system. We just call it up and take a look.

And they are not afraid to use this power to lock people out of the facility:

172: Yeah, because they see it very loose. They've had to go through six weeks of training and that kind of thing. Also their jobs are on the line if they screw up, and that's not true here. It's not like we can kick a kid out of school. <laughs>
EV: But you could kick him out of here.
172: We can. We could really mess with their research.
EV: But you don't do that obviously lightly. I understand that. But over the last five years how many people have you had to do this to?
172: Let's go with two a year.

The way independent labs organize safety should be the example for safety for the rest of the University.

They have implemented safety and scrutinize safety in their labs more closely because they have permanent staff dedicated to that work.

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Lab Managers

Many labs in the School of Medicine and some labs in other parts of Stanford University have permanent Lab managers. Lab managers work for a PI, and indeed they often have long relationships with their PIs.

189: No. I have a bachelor of science in biology and biochemistry so I do-- most of the work we do here is cell biology, protein biochemistry, looking at how proteins bind to one another both in the test tube and in the cell itself, looking at how cells-- how these proteins localize in the cells. You can label it with a fluorescent marker and then put it on a microscope and watch it either fixed or alive, we have microscopes that'll allow you to look at that, but anyway **I came with <PI> from Philadelphia. And so I worked with him for about a year and a half there and he got a position at Stanford and said, "Do you want to come?" so I did so-- yeah, so it's been great. So I've been with him for over 25 years** and I mean I started out being just a tech—

Several other lab managers I talked with had come to Stanford with their PI. They become an invaluable resource for the PI and s/he does not want to loose their symbiotic relationship when they move from one university to another.

Lab managers' role differ lab by lab, but generally they have multiple responsibilities, which can vary from doing bench research, teaching, doing the budget for grants, to doing travel arrangements for the PI. It all depends on what the PI and the Lab manager have come to agree on. Frequently, they are in charge of safety in the lab.

Lab managers take their safety role differently as well. But the advantage of having a lab manager is that they have a stake in keeping the lab in proper working order and keeping the researchers on their toes when it comes to safety:

189: … I certainly walk around the lab, look at hazardous waste tags, look at things that are just lying around unlabeled and have to tap people on the shoulder with a generic e-mail that says, "I'm finding this. It needs to be corrected. I don't know who it is" but-- so even with seasoned people I—

The great thing about having a lab manager is that they are often more senior than the researchers and therefore have a natural authority over their peers. Besides, in most cases, Lab managers have the ear of the PI.

189: I don't actually 'cause I wind up having to clean up and I really hate to have to clean up and keep writing e-mails. It seems like everybody's too busy **so I'm the dragon lady when it comes to that kind of stuff**.
Q: It works?
189: Oh, yeah. They know better, yes.
Q: There's not a lot of that.
189: There's not a lot but when it does happen and I say something it's addressed because **I figure if I don't say it then I go to the top but usually I don't have to**, usually, 'cause they know that I mean this is a compliance issue and since we're in a shared area it goes just as well for the other lab that we share the space with. If I find something that is not in compliance, I'll tell them as well

A lab manager with a responsibility for safety can have an enormous impact on day-to-day laboratory safety and should be considered a best practice for laboratory organization, and something all labs should strive for, especially larger labs that do a lot of hazardous work.

This PI specifically looks to his lab manager to police PPE:

127: And also, my senior scientist slash lab manager, he's-- that's something we discuss. And I make sure that he sort of polices that they're wearing their goggles or their lab coats, or wearing gloves, things of that nature. There's definitely policing action. And then the final thing is-- I had a final point, but it's escaped me at the moment.

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There are exceptions. For instance, this lab manager in the School of Medicine felt that she did not have the authority to enforce safety.

EV: Right, right. So let me ask you a couple things about PPE, do the people in your lab, are they pretty good about PPE and do you enforce it, I mean would you go and say, "You need to wear gloves," or whatever?
181: Well I do say that, I think I'm the only one that does this; I'm the only one that wears lab coats and gloves constantly here. **And I do say that to them, it's like, "For your own personal protection, I'd really recommend a lab coat. However, if you would prefer to bring the chemicals home to your two year old daughter, that's up to you and your two year old daughter that's going to be hugging you with the chemicals on your clothes. So, just thought I'd tell you that, that the lab coat is there for a reason**."

Note that, in the way she talks—her sarcastic tone—this lab manager sounds more like she is a peer for the other researchers, and not a person with authority. In talking more with this lab manager, it became clear that she was only recently promoted to the lab manager position, and her primary responsibility is still to do bench research. So she was still figuring out how to be a lab manager.

The lab manager position is inconsistently defined and the way they approach safety is also quite different. Stanford should train lab managers or set up some knowledge sharing programs for lab managers so they can be more effective in implementing safety.

But mostly, lab manager's authority is not questioned and her/his instructions are followed:

EV: When you walk around, you see somebody not wearing safety glasses, do you say something?
137: **At least, half the time.** Yeah. I try not to-- I try not to--
EV: Pester people?
137: **Try not to be a jerk about it but I try to encourage it**. And, you know, we've gotten better and better and better over the years. We had the general Stanford rules up until maybe-- God, maybe 10 years ago. The general Stanford Rules were that safety glasses are not-- well, at least at that time, safety glasses were not required at all times in all labs. So a lot of biochemistry labs they don't wear them because they don't perceive eye splash threat. They're not working with corrosives or whatever else you might perceive as a direct eye threat. **But then over that time period we switched to mandatory and it's gotten better and better over the years.** And, you know, people are really good about wearing them when they're doing acid washing or when they're working with something that they immediately perceive as dangerous. It's when they're walking around the lab, when they're coming just in and out, when they're working on their laptop or their notebook.

This kind of walking around authority is very helpful in maintaining a level of compliance and safety:

193: Not at lab meeting, no, but I will say things to people right in person. If I see it right now I'd be like, "Hey what are you doing here?" So, I do it that way, but not at lab meetings so much.

Safety coordinators

In many labs there is no permanent staff outside of the PI, and as we already saw, many PIs are not involved in the daily operation of their laboratories. In these labs, PIs appoint a graduate student to be the safety coordinator. Their role varies a little from group to group, but generally, they are involved with such things as doing the chem tracker, calling for waste pickup, quarterly reporting, giving lab safety tours, and preparing for inspections; they are usually the contact person for EH&S.

In general, safety coordinators are not involved in checking whether other researchers in the laboratory work safely.

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103: No, **I don't think they really have a monitoring function**. I think the original idea behind setting-up that position I think was something more along the lines of if you do see something that somebody is doing that's unsafe and don't feel comfortable going to them that you could go to the safety officer instead. And then maybe the safety officer is in a position where they would feel more comfortable going to the PI if that was what was necessary. I don't necessarily think either of those levels of comfort are there, though, unfortunately. It seems like they end up much more just being the person who does the training and the person that organizes inspections and things like that, more like preparing for countywide inspections and things like that, not somebody that's walking through on a daily basis looking for problems or something, because, I mean, they're a grad student too. They have their own work to be doing, and so they're going to probably be one of the safer people in the lab just because they're exposed to this stuff a lot more but not necessarily looking for issues, I'd say.

This grad student concurs completely: checking on whether other students are being safe is not part of the job.

EV: .. aside from he quarterly walk around checklist thing that you do, do you go and check on people and basically like, okay, what are you doing here?
101: No, and I don't think that..
EV: That's not expected?
101: **Yeah, that's not expected**. Everyone is certainly expected to be responsible for their own personal safety.. yeah, so it's not anyone's really checking on.

It can be awkward for a safety coordinator to tell other people in the laboratory to clean up their area/act. So in some labs, they have further divided the safety role so people are in charge of a particular bench or area in their lab.

EV: … And so that system of having people being in charge of a certain area works somewhat?
118: It works somewhat. **It's just I hate to, like, constantly nag people about things. But that's sort of the only way that people will follow through on things. So the idea with having different people in charge of different areas was that you could, sort of, delegate the nagging.** So that each person would just nag-- you know, if you're in charge of this particular area of the counter, and you see that somebody's leaving stuff there, that person who's in charge of the counter can nag that person. And not me, as safety officer, nag everybody about all parts of the lab.
EV: Yeah, yeah, yeah. Because otherwise, you would become somewhat...
118: Unpopular.

This was a very common sentiment in my interviews:

EV: One of the things that's interesting about your lab is you have somebody who's safety coordinator, right? <name>?
175: Mm-hmm, <name>.
EV: Does she come around and tell people "You shouldn't be doing it like this"?
175: **No. I don't think that's her role. I don't think that's how she views her role, and that'd be a really unfortunate role to have**.
EV: It'd be really unpleasant.
175: **Exactly. I think that her role is mainly as a resource to us and as a conduit to EH&S to answer questions about waste and compliance, and with her it's a matter of she's a resource for us, a designated resource for us**...

Typically, being the safety coordinator is a temporary position that is given to one of the grad students for one or two years. It is not an honorary task:

106: Yeah, everyone takes care of their own waste. I mean I've made my own waste tags for things that if I work specifically like beaker chemicals you can't put with some other beaker chemicals so I have my own B-waste for my experiment or for a lot of the like Glovebox [ph?] waste. Our waste person doesn't really work in the Glovebox. She doesn't really deal with it so if you work in the Glovebox you just kind of it's a special case. But general things that we just go through a lot of like the electrolyte is large volume, other solvents like L. [ph?] waste I guess, we go

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through a lot more and I guess she just takes care of making the bigger waste tags. And if you have a question about it like "I don't know how to dispose of this," that's kind of something she is supposed to look up an answer.

EV: How did you get this wonderful job?

106: My advisor appointed me.

EV: Okay, this isn't an honorary position?

106: No, no, no. Yeah, two years of servitude and then you're done and you hand it on to a younger student..

The fact that the job of safety coordinator is handed to "a younger student" is indicative of the importance the job is for the PI: it is a necessary but somewhat unpleasant task that is good to give to younger students. Of course, the chance that a younger student will tell an older post-doc that they are doing something unsafe is really quite small. However, this safety coordinator conceived her job to be larger than just an administrative function and did not care that the job of safety coordinator would make her less popular with her lab mates. She had such a difficult time to get her lab mates to comply with the rules that she instituted monetary fines for violations:

135: Yeah, it's, I think it was a learning process. In the beginning, I think I was being too concerned with making friends, because I had just sort of joined the lab. But in a way it's also just gaining the respect of your peers. It's not sometimes always just making friends, sometimes it's like, this is what we need to do, this is more about the safety and the concern of the entire lab, and not me just being friends with you and letting you slide on certain things. So we actually have instituted monetary fines for breaking any kinds of rules.

The money that was collected for violations was collected by the safety coordinator, and the group would have a pizza party every once in a while when there was enough money in the pot.

But Grad student 135 was very much an exception. Most safety coordinators take the job to be more administrative than anything else, and they are doing more compliance sort of tasks rather than overseeing safety, or whether people are using the appropriate PPE, for instance.

> *Safety coordinators are mostly concerned with compliance issues not with overseeing that the researchers work safely. They don't feel like they have the authority to check whether people are safe, and don't view it as their role. They can be helpful in compliance, but have little impact on the labs overall safety or the prevention of accidents.*

In short, the organizational structure of the laboratory has a massive impact on the day-to-day safety in a laboratory. While the safety coordinator is an important position, it is unlikely to have a major impact on how safe people are conducting their research, as safety coordinators do not view this as their job, and their peers would not accept the safety coordinators authority (note that the safety coordinator who instituted the fines had to institute them because her natural authority somehow failed to achieve the desired results!).

Group dynamics

In case where there is no authoritative presence in the lab to oversee the work of graduate students, there is little pressure stopping researchers from taking shortcuts, unless there is some kind of "social pressure" to behave safely.

Some researchers say that they would definitely speak up if they saw somebody being unsafe. For instance this post-doc in biology said:

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187: I think if anybody saw anybody doing something not safe, they would say something immediately. I don't think it would even be a 'we're going to report you to the lab manager or do anything'. Somebody would address it immediately. So, I think at that point, it's kind of self-regulated. But it would be definitely if the lab manager saw anything, she would say something immediately.

However, it depends on people actually noticing that something unsafe is being done and people are not necessarily aware of what the others in the lab are doing as they pay scant attention to other researchers' work. Here is a comment from a graduate student in Chemistry:

175: Everyone's kind of doing their own thing and moving along, and only in cases of rather extreme like "This could actually hurt you" will we actually kind of look over and say "Hey, you should probably do this differently." But if it's only little minor stuff, if it's like little minor stuff, like "Well, you should probably do that." **We generally don't really invade each other's kind of work.** It's only when it's something rather significant that can cause a more acute problem.

Another student said nearly exactly the same thing using different words:

Q: In terms of safety in the lab do you think that it's mostly a pull situation in the sense that you go when you have questions about safety, or are there other people that come by and say "Hey, you shouldn't be doing it like that"? Maybe it counts differently for yourself than for other people.
103: I would think that you would have to be doing something very unsafe to have somebody comment about it. It would have to be sort of a fairly major offense that might put the whole lab in sort of jeopardy or something like that. If I wasn't wearing gloves and I was doing something I wouldn't expect somebody to come by and say "Hey, you should probably be wearing gloves while you're doing that."

A post-doc feels similarly:

104: I'm responsible for my area. I mean I think technically we all should be responsible for the whole lab but I'm not going to get in peoples' faces and tell them how to keep their area, it's not my responsibility, technically it's not my responsibility, in spirit, it should be everybody's responsibility. We have a safety officer but also, she's not going to go around and order you how to keep your area.

Note how this post-doc thinks that the lab culture should be such that people check on each other, but in reality it isn't.

Overall, we found the culture in many labs to be like it is in this lab; researchers work fairly independently on their own research. This is especially so for post-docs and visiting faculty, who, because of their advanced degrees may get even less scrutiny than first year graduate students. Yet, pressure from lab mates is possibly the most effective driver of a safety culture. People will get a sense for "how things are done here" and also how things are not done. Interviewee-171 is a grad student in biology. He describes an incident in which a relatively new member of the lab had left some radiation on the bench. Note how the response to this incident came from all the researchers in the lab.

171: We have had one in which we found radiation on a bench and on pipettes after somebody had gone home and it was a pretty big deal in our lab. So, it was discovered by another lab member and **we had a chat about how we would talk to the person who had done this**.
EV: It was clear who had been?
171: Yeah, because it was localized to a single bench and a single set of pipettes.
EV: Okay.
171: So, we chatted among ourselves. **We brought it up to our PI and together the lab and the PI, we talked with this person about kind of how that was a near miss.** Somebody could've easily leaned up against the bench and then had lunch and then all of a sudden they've ingested some P32. **When this happened it was kind of a shock to**

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us so we all saw it as a sign that something had gone wrong in either this person's habits or communicating what's expected to this person. That happened once; it didn't happen again with that person. It hasn't happened since and I mean I think that if one of the implicit questions is how do we avoid that in the future. I don't know it's hard. If you've got somebody who is going to be sloppy then it's really difficult right.

EV: Yeah, so that's what you-- that could be one of the things that people are just sloppy. It could be an individual; it's not necessarily that it's a problem of the group or something.

171: You know, I think at the time we were still doing a good job. We had been doing a good job of people for how to use radiation properly.

EV: Was this a fairly new person or no?

171: Yes.

EV: Okay.

171: But, I think that we had been doing a decent job and certainly after that it made our radiation officer, of course be very serious.

EV: In dealing with it-- did look into it.

171: I mean not to imply that he was less diligent in the past because it wasn't my job and I didn't even use it at the time so I don't know what was going on. In general, our radiation safety officer is a very anal person, which is who you want for that type of job.

EV: Right.

171: I think what happened is that this person was just sloppy and when the person messed up the reaction from the lab was so serious that she understood that she has to actually do what we talked about in the training.

EV: Right.

171: Looking back, **a positive thing I can say is that the reaction was not just from this radiation safety officer**, it was from everybody and I think that was effective because I mean there's the consequences they are for everybody so I think that it was proper that everybody reacted strongly and negatively to the spill.

Labs differ in the level of cohesion in the group. The group that 171 worked in was relatively small, and they all worked around a few benches and hoods, so they were all within earshot and mostly wihin eyesight of each other. There was banter back and forth among the lab members and it was clear that there was some real camaraderie in the group. This can help lower the barriers for group members to talk to each other about their research. However, as we have seen, this is not necessarily the case in every laboratory, and such group cohesion is obviously dependent on such things as the lab layout and the personalities of the researchers, etc.

In one hopefully rather extreme case, the researchers don't even listen to the lab manager. This lab manager would say something to people who were using phenol and chloroform outside the hood, but to no avail:

181: Yeah, because if you don't have the space in the fume hood then you've got to find some other space to do your phenol and chloroform.

EV: Wow, now if you see that, do you say something?

181: I do, and I do tell them, "You know, for the personal safety of the people around you, they are kind of inhaling those compounds." But I also understand, "Well where do you want me to do it, that fume hood has no space?" "Yeah, that's true too. I don't know what to say, I just thought I'd tell you."

Unfortunately, this is not completely uncommon. When this safety coordinator tried to talk to someone who was using a dangerous chemical without the proper safety equipment:

113: I will hear from someone in the group say, "Oh, you should talk to someone, he's using aqua regia downstairs and without labeling it," something like that.

EV: Oh, okay.

113: And I'll try to talk to him but yeah, I will tell him…

EV: And what do they say, what did they say when you…

113: They say, "Okay, okay, I got it." And sometimes we ask him-- like the guy, there's someone in my group, he's also very concerned about safety, **he will ask the guy who's working on aqua regia to put on his mask and apron and also wear shoes, not sandals. But he didn't do it**.

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Peer pressure only works in case the members of a group have a strong enough social bond. If not, the PI or lab manager with greater authority must jump in and take action. A prerequisite for that to happen is, of course, that the PI must be notified in case there are safety violations. This is not always the case. Interviewee-113 describes what happened in the subsequent lab meeting:

EV: But like for instance, the issue with the experiments where you say, it's unsafe, that's not something that's brought up in the meeting, you wouldn't mention that there, is it awkward?
113: I didn't because I didn't see it. I normally work in another lab and they work downstairs in the lab, more chemicals there, I work upstairs, there's no chemicals. So I haven't seen it yet. I just hear…
EV: No, but the people that were concerned, you said there was somebody concerned.
113: Right, right. He won't bring it up in the group meeting because it's like making him…
EV: Talking bad about somebody else?
113: Yeah, right, feel like that way.

This is not an uncommon sentiment:

101: I don't think that there are any really major safety culture issues that I think need to change. I think my concern is primarily that people don't feel like it's okay to ask about safety or about- to express concerns to either our advisor or to other people in the lab about things that they think are unsafe.
EV: Give me an example.
101: I'm trying to think of.. Maybe there was maybe a concern about someone doing something that was in a way that another person in lab didn't think was safe and they had to come to talk to a couple of us in the lab about it. And I had mentioned well, why don't you just go talk to <PI>?
EV: Some person.
101: Yeah or talk to him about it or talk to the person themselves. But they didn't feel..
EV: Comfortable.
101: ..doing that.
EV: Because they're maybe an older..
101: Exactly. They've been here longer…. And I don't think anyone really wants to be the person to go into your boss and tattle on another person either. Yeah.

So while group cohesion can be very effective in instilling a culture of safety, many groups don't have this level of cohesion. Group cohesion is likely to be a dependent on a variety of factors, including the PI, the personalities of the researchers, the size of the group, the amount of turn over, and the labs infrastructure and layout. This grad student made the point that without group cohesion, the safety ideals that the PI strives for are not met:

175 … but as much as a principal investigator or a professor wants the students to do something, if you just tell us to do it we're probably not going to do it as much unless the culture in the lab is already for students to question other students. And that's definitely not the case in [PI]. Everyone's kind of doing their own thing and moving along, and only in cases of rather extreme like "This could actually hurt you" will we actually kind of look over and say "Hey, you should probably do this differently." But if it's only little minor stuff, if it's like little minor stuff, like "Well, you should probably do that." We generally don't really invade each other's kind of work. It's only when it's something rather significant that can cause a more acute problem.

Social cohesion can foster the safety culture and should be a goal for the PI

Of course, while group cohesion is important, we must acknowledge that even in groups where there is a lot of cohesion among many of the members, there may still be outliers: people that don't belong to the group or feel like they can do things in their own way. In those cases, social pressure may not be very effective in instilling a safety culture and more serious consequences for violations of safety procedures may be in order.

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Infrastructure

Infrastructure and space has a lot to do with safety culture. The way a space is designed can enhance social interaction among members. Also, the layout of the different lab spaces can impact such practical things as whether it is easy or difficult to open a door with gloves on.

Desks and benches

One of the differences between different buildings is whether offices and labs are separate or whether the desks are essentially in the same space as the labs. In quite a few buildings, desks are at the end of the bench, often separated by a piece of plexiglass, but sometimes even this minimal barrier is absent. In other labs, desks are a few feet away from the benches, while in yet others, students have offices in a completely different building. There are no doubt pros and cons of all of these set ups for both Safety and Research efficiency and effectiveness. From the standpoint of safety, having a desk right next to the bench encourages eating close to chemicals that may not be very healthy.

Another feature of building design and lab layout is whether it is easy to separate more dangerous activities from other more mundane activities. For instance, in one lab an area on a bench is marked off as the “radioactive area”, whereas in other labs there is a separate room for all radio-active experiments.

190: This is the radioactivity room. .... All isotopes are unloaded here into either the refrigerator, regular freezer or a minus 80. They are prepared here and they die here and go into the waste here. So radiation never leaves except if it’s like on a filter and it has to be taken to the dark room for the film to be put on it, right, but other than that no liquid radiation or radioactive material ever leaves that room except when the waste guy comes to take it away, okay? So that’s one of the other hazards.

Building design must take into account the practical realities of doing lab work, as careful thought must go into duct work. Installing a vented storage cabinet in a building not originally designed to accomodate it in that location can be expensive (and therefore does not get done)

Getting a permit to make alterations is also often very challenging: in one lab 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.

145: Right…. So, when our students need to go get solvent, they have to go walk across, over there, to another place, another room, down that hall. And they're carrying solvent back and forth, and that's not right. If you were going to have an accident with some solvent, it's when you're carrying a little jug of solvent, and you might trip. Meanwhile, after we moved in, you said, "Okay, we're going to be able to change things. We're going to be able to put our solvents right here, in this solvent cabinet," which we installed. And, to this day, this has never been approved. And it's, like, "How the heck do you get approval to actually put solvents? <inaudible>." For some reason, it's not approved; it's that someone from the County has to say, "Okay, you are in agreement, right now, with the requirements that were put in place when you moved into the building." That's number one. And number two: "This is an approved solvent cabinet. We're going to change now the classification of this zone, and you can put more solvent in this zone." We just can never-- <inaudible> didn't mention this to you.

Many labs are extremely crowded, as groups have continued to grow, but lab space hasn’t.

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In one lab, the hood is so full of stuff that some of the researchers have taken to do certain work on their bench that had better be done in the hood:

181: So we do life science/biology so we do a lot of, yeah, wet bench work here and we work with human and animal cells so there is a bio-safety level two concern here, we also work with human blood as well so there is those concerns. And then we do work with phenol and chloroform so there's that. So I think the problem really is convenience, because **our fume hoods are very crowded and so to work with phenol and chloroform in such a very tight space in the fume hood is extremely inconvenient, very uncomfortable. And so some of the times the post-docs will just work with the Phenol and chloroform on their open bench**.

This is not the only lab in which the lack of infrastructure led to some unsafe practices:

113: Right. And we start doing some chemical experiment in the group but we don't have a wet bench, it's not really convenient for people working on real chemical experiments.
EV: Oh, you don't have a hood?
113: We have a hood but it's not one you can put the sash down a lot, it just-- I don't know you've seen those kinds, it's only half.

Fixing infrastructural problems can be very expensive once a building has been constructed, of course. The researchers—always under pressure to produce results—will find a way to do the experiments, but in the process are likely to compromise safety.

Research changes over time and so does group size which can require infrastructure changes necessary to maintain safety. Stanford should look into its processes for retrofitting buildings, some labs grow to be unsafe.

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Infrastructure also has a palpable effect on safety practices such as the wearing of gloves when entering and exiting doors. In the Lorry Lokey Stem Cell research building for instance, researchers routinely open doors with gloves, even though this is prohibited. This graduate student explains why it is simply impractical to do otherwise:

164: I find that most people-- even though technically we're not really supposed to open doors with gloves, I find that often times, I just really can't help it. I don't want to have to constantly take off gloves and put gloves back on. It's the biggest pain to have to put on a pair of gloves when your hands are a little wet from being inside a previous pair of gloves. And I know that people sometimes will carry around a little piece of napkin to open doors, et cetera, but just the way that, for instance, this hallway is designed-- right-- our lab is on the left side. And then we have equipment rooms on the right side, and they are all handled doors. So we have to open the handle somehow, but I-- if I am-- say-- carrying something from my lab space to equipment room, I don't-- I have to wear gloves to carry it. Right? But then, that means that I have to use gloves to touch the door handle, and then who knows--

EV: So you-- yeah, okay.

164: -- how clean that pair of gloves were and then after a while, it's like, "Well, all these doors are contaminated, and so I'd rather just wear gloves and open them instead of taking my glove off and open-- and be the one person that don't wear gloves to touch the door handles."

The practical work of doing laboratory research work should always be considered whenever Stanford designs new research buildings that contain laboratory spaces.

In many chemistry labs, researchers each have their own bench (or part of a bench) so if they are messy it will not interfere much with the work of others.

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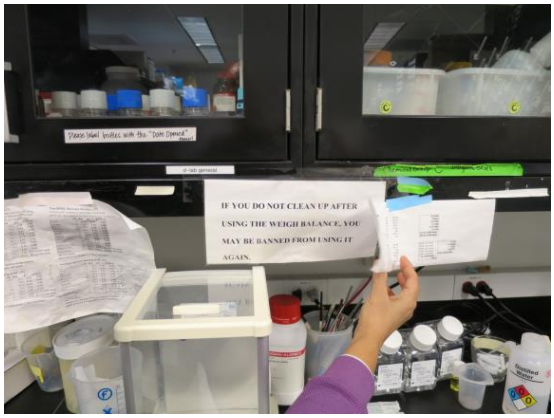
In other places, the lab spaces are shared so one person's mess means others have to clean up. That will usually come to a quick resolution, as people are loath to clean up after others.



Consideration for others is fostered when personal relationships within the laboratory are tight. As we have already seen there are many labs in which people work very independently, and this can be the source of a lack of consideration for other people's safety, as this safety coordinator in Physics points out:

113: We don't, we try to develop more procedures. For using vacuum chambers, I think each of the chambers has a procedure to follow what you have to do. **And for using chemicals, since we are not, we don't use a lot of chemicals and only one or two students have to use this kind of chemical and the other has to use like aqua regia to clean something. But sometimes what happens is that they are using dangerous chemicals but other people in the group don't know because each of us work on very different materials and very different topics so we don't really work together. It's like <inaudible> different places and you do reactions in different places, you're not there all the time to see what people are doing.** That's what concerns me.

There are many complaints about the layout of the labs in newer buildings. Lab rooms in which benches and desks are intermingled (Clark) or buildings in which the regular course of research requires the frequent opening of doors (Lorry Lokey) are examples. It appears that not enough input from PIs and research staff is collected and considered when designing new buildings.

One thing to consider when taking into account the design of the labs is the distance the PI must travel to visit the lab. In some buildings the PI's office is directly across the lab, which means that it is easy for the PI to visit on a regular basis as s/he will pass by the lab in the natural course of a day's activities. In other labs, the distance between the labs and the PI's office can be considerable, as when the lab is in another building and several floors away. On the one hand it is probably good for the offices to be away from the fumes produced by chemical benches, but on the other hand if PIs were closer to their labs they might have more influence over the day-to-day work in those labs, thus enhancing safety.

> *Stanford should investigate its current lab spaces—the advantages and disadvantages for research, collaboration, and safety—and create design principles that must be taken into account for all new construction.*

Training and learning

Safety training is an important part of instilling a culture of safety. There are three tiers of training, on-line training, classroom training, and hands-on training in the laboratory. To a considerable extent, the classroom training has been replaced by on-line training modules. These modules can be quite good.

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105: You know, it has to be also short. The blood borne pathogen training is quite long. It's a good one, it's really good.

But whether this information stays with people for long after they take it is perhaps questionable.

105: There's so many modules you have to take when you come in and they're all relevant, right? For example…
EV: Are they taught in a classroom style or are they…
105 Online training that you have to check off when you come here. One is chemicals, the other one is if you use compressed gas, if you're working with nonhuman primates or any type of blood, you have human blood borne pathogen training. Some of them are mandated to be done yearly, for example the blood borne pathogen training.
EV: Yeah. You have to redo them.
105: Others you just do it once. And in a way, when you first come in, there's so many things you have to learn, just walking around in the tunnels trying to get from A to B you have to learn. **So you have to do all of this training and I really question as to whether or not how much sinks in after you've taken it.**

The researcher seems to draw a contrast between the on-line training which happens in the virtual world and the very concrete practical realities of the work, which happens in real space, in this case "tunnels"; he questions the utility of the former for the latter.

After the training modules, there is often a lab training, but this varies a good deal from lab to lab. For instance, here is a safety coordinator who explains what she used to teach new incoming lab members:

35: <PI name> would e-mail me saying, post doc or graduate student X, Y, Z, are coming in on these days, and so we need to just get them trained. What I typically do is, then I have an e-mail that I've just used over and over again, the e-mail pretty much outlines the types of online courses that they have to take through Stars Training, [ph?] because that is just the mandatory training for our department. It's usually the compressed gas and air, it's general safety, and sorry, one other one. **Once they take those courses, then they come meet with me for an extensive, like, one-on-one or small group with me to go over our own safety lists and a safety tour of our labs**. So our—
EV: How long does that take? Like, an afternoon or two hours?
135: I would say at most probably between like, it's probably only 30 minutes. And so what I do is, we have this list that we have generated over the years, and a list, like a number of-- it reinstates a lot of things that you learned during those online courses, like, tanks need to be chained at two links, you know, at all times you must wear lab-- like, proper personal protective equipment, so goggles, this, this and this, so we go over a lot of those just to reiterate, but then we have other ones that is not necessarily in those online courses, such as any samples that you make must be labeled with your initials, the date and what the compound is. So so some of that stuff is not always outlined on those kind of courses, so we have our own expectations. So I go through all of these points with the person, and then at the end, I go through a tour of all of our labs, mainly pointing out where hazardous waste needs to go, where the safety showers, fire blankets, eye washes, fire extinguishers are in all the rooms, so I point out where the EAP, the MRC [ph?] assembly point is should the fire alarm go off. So yeah, I would say it takes between 30 and 45 minutes.

While this 30-minute training is very helpful, it is probably not enough for people to start working safely, as this grad student in material science explains:

113: I think we're all first year and we sit in a room and go through safety training. That's like the first or second week of the first quarter. So that's one I remember and the second one is you have to sit down with <facilities manager> downstairs and to go through some safety stuff in the building if you have to work in McCullough or in Moore, the one next-- yeah, that's the two trainings I had. And I have another training because I need to use x-ray diffraction machine downstairs so I have another x-ray training with EHS.
EV: Okay.
113: That's probably the three trainings I have so far.
EV: And after you had those trainings did you feel like, "Okay, now I can go and work on my own and be safe?"
113: Not really because you go to the lab and there are so many different things in the lab and it will be better if the senior students walk you through the lab and tell you what to do, what not to do.

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The walk through in the laboratories is something that is often done by the safety coordinator, but as the quote makes clear, these practices vary lab by lab.

> *While Tier one and two training is generally perceived to be quite good, Tier three training is deemed much more important, yet is inconsistently implemented in the labs. Stanford should investigate Tier three best practices and then spread these best practices throughout the labs.*

Because of the continuous turn over of personnel in the labs they need to have an effective way to introduce new members to the safety procedures in the lab. Some labs have a really good way of doing this.

102: Yeah, and I guess I started talking through what happens here, but you do a safety tour through the lab. You do a safety interview with that person that gave you the tour and then you do a formal safety interview with the PI, and he's very rigorous. It'll take more than an hour talking about the safety precautions and things like that, and only then after that can you start laboratory work.
EV: Yeah.
102: And then, from there you want to talk about some of the standardized operating procedures, so like you said the first reaction you want to set up he'll often go over it with you if you're new to the lab and you're not sure how things go. So, you would talk to somebody about what you'd want to do first, but then you'd go over it with him as well. So, it's very step-by-step for a new person to get really integrated into the lab, and it's a good system because you're going to avoid a lot. But, I think-- it varies lab to lab, but that's how it is in our lab. It's very regimented in terms of what you need to do to get your feet wet kind of.

As 102 rightly indicates, training practices vary from lab to lab. And ultimately, a lot is left to the researchers themselves: beginning grad students are expected to seek advice from older students.

101: So, personally, I'm not afraid of you know, being judged or being.. you know, going out and asking someone but I would say that they're.. **it is very person dependent and coming in as a first year graduate student, I think that you're expected to ask a lot of questions and you're.. you know, there's no shame in asking a bunch of questions and people are definitely watching out for you**. Maybe it's like a post doc or an older graduate student if they haven't done something before, **I'm not sure that everyone feels as comfortable asking anyone a question about it.**

Especially in areas like chemistry, where safety depends a good deal on the skills and knowledge of the researcher doing the science, the training can fall short, as the general safety rules will not keep you safe when researchers are trying new experiments:

104: Yeah, I think in general I feel like I'm provided with a sense of what the proper procedures are to be very safe. **The main problem is that when you're doing research, you're doing things that you don't necessarily know what the outcome is going to be and a lot of times you're setting up very specialized reactions that aren't covered in the general safety discussion. And so for those types of situations it becomes very tricky to assess whether or not you're actually working safely. And most of the time for those sorts of situations, my feeling of working safely didn't come from the safety training, it came from going to the literature and finding detailed experimental explanations of how to set up these things safely or in a way that should be appropriate**. So I guess, to answer your question, yeah, I mean I had a general idea of how to work safely in the lab but I don't think it was anymore than I had already had from when I was an undergraduate and you go to take your lab class and they tell you to wear your goggles and wear your gloves and wear your lab coat and this is where the waste goes and don't mix acids and bases and just very general things. So I didn't really feel like I had this extra safety understanding from this safety-- for somebody that's going to be now working in the lab over 60 hours a week, that probably was inadequate in terms of addressing some of the safety issues

Ultimately, it is only with experience that you really learn to be safe.

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EV: So where did that come from, how do you learn to be safe, if you will?
104: Just experience. I think I probably made a lot of stupid mistakes when I first started working in the lab and I didn't necessarily appreciate the activity of some of the chemicals that I was handling.

The reactivity of chemicals is one thing on paper, but it is another in practice. Consider what this researcher commented regarding her use of aqua regia:

106: **When we saw that the mixture reacted very mildly and was easily contained, I felt comfortable finishing the cleaning on my own**

Note that the knowledge "the mixture reacted very mildly" is something that is hard to glean from SOPs, but is something that could be conveyed in a well-shot video. We revisit this later in this report, when we look at SOPs.

Learning to be safe, then, depends on actual practical experience. This is one of the reasons why learning from accidents and near misses is so crucial.

103: I mean I think that yeah, every accident that happens is a great learning experience

104: But coming back to my point is that I think there are certain chemicals that I didn't necessarily appreciate how dangerous they could be. And I never had any serious accidents**, I had some minor things happen in the lab and I think those made me appreciate being as careful as possible when handling certain** <inaudible>.
EV: Yeah. They kind of set you back like, "Okay, this is not exactly what I expected," kind of thing?
104: Just kind of, you know, **I didn't really respect maybe how reactive certain chemicals were** or how much you have to respect certain chemicals and for their ability to undergo whatever process they're going to undergo. And I think that's something that comes with-- I think some people are very in tune with understanding that very quickly but I think also some of that just comes with experience and having seen a lot of that.

102: **I think from other people mostly and learning from other people's mistakes** is a lot of things. I mean if you see somebody do something you learn pretty quickly that that's not going to be a good thing. **If someone starts a fire with a certain chemical you're going to be very careful when you use it and have supervision. If something ever sparks when I use it, then next time I'm going to use it I'm going to have somebody over my shoulders watching and making sure that I'm safe and there're certain chemicals still to this day that if nobody is around the lab you won't use because you need to have that secondary supervision**.

Because incidents are such great learning experiences, some people do not feel that there is enough sharing of near misses and incidents.

EV: Right. And when there are incidents within the building, if you will, is that something that's widely shared so that everybody can learn, "Okay, this is what happened, this is how it happened, let's make sure that we put procedures in place or practices in place so that it won't happen again?" Do you feel that that's happening?
105: No. I'm a big fan of that because I think people learn from what happened to other people. For example, I can remember all the instances that happened at Boston University or MIT, UCLA.
EV: Exactly, yeah.
105: But there is also a culture and it depends upon where you go, they do or do not do that. Here I find the culture is it's all secretive. You don't hear about any of these things.

Being secretive is not a good thing, obviously.

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Stanford EH&S published a report on the large fire in Mudd Chemistry that destroyed a hood and posted it on its web-site for all to read. However, the report did not draw the right conclusion scientifically, and this has caused many people in the Chemistry department to raise their eyebrows. This is how one of the PIs addressed the issue in his lab meeting:

PI: I asked EH&S to put this document together to send out, and I asked them specifically to send it to me before they sent it out to everyone in the department and they did not do that. And they sent this out for Christmas, and EH&S wrote this up, and their argument that the cause was the incorrect lithium aluminum hydride THF ratio. Well that is not correct, okay? And so the-- the last couple of weeks, I've gone into a slow burn about this, **because this is really a bad idea when EH&S puts together a document that actually makes no sense**.

Obviously, the process by which EH&S creates these reports should be reviewed, as in order for them to be useful they need to be perceived that way by the research staff.

Stanford should investigate how it can implement a more effective way of learning from accidents and near misses; EH&S should involve independent researchers in the writing of the accident reports.

Training for PIs

One of the things we have already mentioned is that the way groups deal with Tier Three training varies widely. Some have mentoring programs others rely on new members to ask older members for help, some PIs do a long safety interview with new researchers, others let the safety coordinator handle the safety training entirely. Given these diverse practices, one must wonder whether Stanford provides any kind of training for new PIs on how to set up safety training in their group. Here's a PI's response to that question:

EV: Right, I'm wondering when we're talking about safety, when you became a PI, did anybody ever teach you this is how you run a safe lab?
127: I recall taking a lot of-- having to take a lot of modules online regarding safety issues.
EV: Yeah, but specifically on how to manage your group. That's more, I think, those train--
127: That, no. That, no. Absolutely not, that's a good point.

Stanford does not enforce a "Stanford" approach to safety training, and PIs don't get trained on how to instill a safety culture within their group. Stanford should investigate the ways in which new PIs are enculturated into Stanford and what kind of training they receive.

EH&S organization

When we asked researchers about EH&S, we received a variety of comments. Most seemed to indicate that researchers don't interact much with EH&S; many bench researchers have never interacted with Stanford EH&S, or did not know the name of the EH&S representative that served their group or building.:

103: Me, not personally. I've really never personally directly interacted with EH&S.

EV: Do you ever pick up the phone and call EH&S then?
101: No

EV: … Do you interact with them [EH&S]?
104: Not directly, I mean I do the safety trainings online and then we have our safety officer that interfaces with the department safety officer and then he interacts-- I guess he's part of EH&S.

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For most researchers, EH&S is not a common presence in their labs. This researcher commented that this is not like it was in another university where he worked:

EV: Yeah. So when you worked in a previous place was the EH&S there more visible to you?
105: Yes. They were more visible.

When people mention EH&S, they do so mostly in the context of waste pickup, chem tracker and inspections

EV: Okay, so talk to me about EH&S. Do you interact with them at all?
171: I do when it's time to dispose of our ethidium bromide waste.

EV: Sure, sure. But okay so then that's one way you interact with the EH&S, are there any other ways?
105: That's mainly it, mainly to regulatory. Every once in a while I would contact them about say, waste removal. I have not yet contacted them concerning drugs because they also handle the drug program.

That said, some researchers mentioned that EH&S personnel was very helpful and knowledgeable. Here is a lab safety coordinator:

106: … I think we also probably worked very closely with <EH&S employee name>. **He has made himself insanely available to us and he really stresses to people**. And I guess I don't know if everybody in the lab knows this or if I just know this from being safety chief and having met with him but everyone in the lab has seen him because he's done a lot of walkthroughs like practice safety checks in the lab, he's introduced himself to everybody in the lab. So everybody at least knows who he is I think but he's very available.

However, despite that positive experience with an EH&S employee, that same researcher did not contact EH&S when she needed help with a new procedure

106: I guess I didn't ask for EH&S help with that but I kind of chatted with people in lab, like have you used anything like this before.

Some researchers even express a certain reservation about EH&S, whom they regard a little bit like a policing organization:

EV: Yeah. And you don't have anybody at the EH&S that you can call?
180: **I mean I can call them. I haven't had the best experience, and then I'm always worried I'm going to call them and then our lab's going to get inspected and then, you know, we're going to have to make a whole bunch of changes** and it's going to be--

Generally speaking, then, EH&S is not a strong presence in Stanford's laboratories or even the organization that they would turn to for safety information. Relationships between researchers and EH&S are haphazard, not structural, in that EH&S folks do inspections, but they don't necessarily announce them to the labs and so whether they meet with researchers depends on whether they run into them. It appears that the EH&S reps have quite different ways of engaging with the research community. Some interface exclusively with the safety coordinators or lab managers of labs, others develop relationships with the research staff directly.

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Stanford EH&S is not an organization that takes an active part in the day-to-day safety practices in the laboratories; it is mostly compliance driven. EH&S may have to expand its role if it wants to instill a Stanford-wide safety culture.

We did hear some complaints about EH&S. These came mostly from folks in Chemistry. Interviewee 153 did not want to be recorded, but my notes from the interview indicate that she (a grad student) was quite unhappy with EH&S:

153: X is quite down on EH&S. **Why isn't there anybody on EH&S who actually knows chemistry**. At her previous school (ivy league) EH&S was better and more helpful. As an example, she mentions that she works with HF a lot. There is a gel (Hydrofluoric acid antidote gel) you can put on you're the skin of your arms that contains a lot of calcium and will protect you if you did have a spill. This gel should always be available when you work with HF; indeed it should be taped to the hood. At her previous school EH&S would provide it to all researchers working with HF. In Stanford questions are raised about money, and EH&S does not provide the gel. She believes that EH&S has not enough knowledge about chemistry, and that while they care about compliance, they don't care about much more dangerous chemical processes that they really should care about.

The role of the EH&S organization is rather ambivalent. On the one hand, EH&S is the only centralized safety organization on campus, so if there is a "Stanford" way of doing things, it can only be coming from EH&S. On the other hand, as we have seen in this report, EH&S is not terribly involved in the day-to-day research work, and therefore does not impact the way research is conducted very much. PIs and researchers like it this way because it gives them a lot of freedom, but it also gives them a lot of responsibility. While this model is probably common in academia, the question is whether this is an optimal way of organizing safety.

Personal Protective Equipment (PPE) & dress code

The wearing of PPE is an issue at Stanford in a way that it isn't in the private sector in which PPE is strictly enforced. Researchers at Stanford wear PPE inconsistently and some wear shorts and sandals to work in the labs. Mostly this is not because PPE is not available. Only in one, relatively new, lab the lab manager admits that he does not have safety glasses.

EV: Tell me a little bit about your PPE. Have you laid down the law when it comes to that?
193: That's another thing, and we talked about that at the lab meeting, that's another thing that we're very loose on. I almost never wear a lab coat, pretty much never. I wear it with ethidium bromide, and other people hadn't, and we don't sometimes, but that's now in the SOP, you must wear a lab coat. So that's one thing. Gloves are pretty standard, but again, that's to protect our samples. So when I was training everyone I said, "Look this is important because you can contaminate the samples, you put it in the incubator it contaminates everyone's samples." That's a huge problem. Now, again, we're not really working with too many hazardous things, so as far as it hurting you it's gonna be very low probability, but you gotta wear the gloves. And that's pretty easy and standard because it just seems like, yeah, you wear gloves. Goggles, we don't even have any.
EV: So when you're working with hydrochloric acid you're not wearing goggles? You're not worried about splashing or anything?
193: I am worried, but I don't have them so I don't wear them. I have, it's not even mine...
EV: They're not very expensive.
193: That's true. So I should get them. I guess people know about it. We never even really use it.

Some lab managers do not tolerate researchers that come to work in shorts and sandals:

174: I do wear eye protection in case there's a backsplash, and I'm fully gowned, double-gloved. **And then in fact if I see anyone even walking down the hallway in sandals or open-toed shoes I send them home**. So the rule in the lab

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is in the summer they can come into the lab in sandals, but they have to keep a set of closed-toe shoes here under their desk that they get into. **No shorts**.
EV: You enforce that.
174: I enforce it. No shorts.
EV: Because I saw sandals here.
174: No tanktops.

In another lab, there is a box of safety glasses next to the entrance door of the lab; you must put on safety glasses when you enter.

Other labs are much more loose about these matters and safety is left up to the individual; for instance, it is common to only wear safety goggles when there is a real splash risk. You can wear shorts into the lab at your own risk. This lab manager in the School of Medicine describes a pretty typical situation:

EV: Lab coats no?
189: Unless I'm doing radioactivity or unless I'm lysing a bacterial sample where I know it's under high pressure and it may then I'll put it on but no, I don't enforce it. It's a little different-- when we were-- I-- we used to be in Beckman, which is a different building on campus a few-- a bit over and they provided lab coats for people so you could just go in, use it and then they laundered it and it was back again but here they've never put a program like that in place. So unless somebody specifically needs it, they're doing virus work or radioactivity, we have a few that are laying around that people will wear but we don't at the bench wear lab coats here, gloves, yes. If we're using the liquid nitrogen, there is a face shield available and the thermal gloves to take things out with that. The DNA-- like I said things have changed. We're not-- our people aren't so much using exposure to UV light to look at ethidium bromide in a DNA job so that's another case in point where you would want to have some safety glasses, but then again even the equipment now is such that you put the gel into a device, close it and then put a UV light on so there's been some changes but there are still some things with ethidium that people really use that you need to put a special pair of glasses on just to be sure, but I mean all the stuff is there if people want to use it but—
EV: But it's not something that you--
189: It's not enforced, no.
EV: If you notice it you don't say, "You need to wear safety glasses with that."
189: If it was ethidium bromide and a UV light, yeah, I would, yeah, but closed-toed shoes I don't enforce that. People wear shorts in the summer.

Lab manager 189 describes a situation in which PPE is optional, largely because the work in the lab is not considered that dangerous. She also describes how part of the reason she does not wear a lab coat is that there is no program for washing the lab coats.

> *PPE is largely left to the researchers own judgment. They determine whether they need glasses or a lab coat*

The washing of the lab coats came up in other interviews as well. For instance, this grad student wanted to have her own lab coat, one that would be washed for her, but also returned to her once cleaned:

180: at UC Berkeley they gave everybody their own lab coats, like recently.
EV: Yeah. You don't have one?
180: Well, like I have a lab coat for the mice, but I mean it's like a department lab coat, so its one you would switch in and out. But I don't actually really like wearing lab coats.
EV: But if they gave one to you-- so do you want one or do you not?
180: I mean, you know, I kind of feel like if someone gave me a personal lab coat that I could give to the washing people and then I'd get back the same lab coat that might make me more excited about wearing one.
EV: Yeah, okay. It doesn't sound like it'd make you terribly excited about it.
180: No.
EV: Because you largely feel like you don't need it, right?
180: Yeah.

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There are some departments that use a lab coat washing service:

EV: So you just picked up lab coats that are cleaned?
164: Yes, so--
EV: Do you have a cleaning service here?
164: So actually this is part of the dev-bio department. That's-- oh, yeah, that's another thing that would be great. If we all had lab coat cleaning services, but the developmental biology department basically has a lab coat cleaning service for the graduate students essentially. And because we're-- our lab is under d-bio-- or graduate students and postdocs-- because our lab is under d-bio, we are able to go and just pick up lab coats and trade-- swap them out.
EV: Yeah, yeah. Okay, well, that's good. So you just picked up two for yourself there?
164: Yeah.
EV: And how long do they last before you want to wash them again?
164: Well, the last one I just dropped off. I-- lasted me quite some time. I probably should have changed it a long time ago, but I only recently-- on the weekend, I spilled beta dye all over it, so. Now, I needed a new one. And so maybe I'll change-- I would say-- on average, I'll change my lab coat twice a year maybe. So not very often.

Note how this grad student thinks that changing a lab coat half a year isn't that much. Contrast this with the situation in Chemistry, where there is no laundry service:

103: Gloves are totally fine. I felt in undergrad actually that it felt like gloves were in a shortage. Here, gloves totally fine. There's as many gloves as I would ever want that are available to me. So that's not a problem. Safety glasses, if you break a pair or something like that, it's no problem to go get another pair. A PI would never object to buying a pair of safety glasses or something. **The only thing that people have talked about and that I support as being something that we could work on is lab coats. So currently lab coats are not required parts of your personal protective equipment.**
Q: Really?
103: Really.
Q: Even after the UCLA thing?
103: Even after the UCLA thing. We're not required. We're sort of encouraged to wear lab coats and I try and always wear long pants and close-toed shoes are necessary, but I try and wear long pants and if I can, long sleeves, but we're not required to wear lab coats and part of the sort of discouragement from that is that you work with a lab coat and it gets dirty over time. You spill things and maybe you brush your elbow in something or something like that and there's no mechanism for cleaning the lab coats or anything like that. If I had been working with chemicals, I don't exactly want to take my lab coat home and throw it in my normal washer with everything that I always wear. A lot of other universities have sort of laundry services set up specifically for lab coats and I know those services are available. I think the money of where that's going to be funded is the problem in those cases, but I think that would be something that would be very valuable and like you said, really, we don't wear lab coats, and a lot of that has to do with the fact that they're not required and there's no sort of infrastructure set up to encourage us to wear them. We could go get a lab coat if we wanted and the PI would probably pay for it, but again, washing it or whatever. If we had--
Q: That becomes your responsibility to deal with.
103: To take care of it, yeah. Professor <name> actually bought everybody in the lab one of the flame retardant lab coats, which I think was a good gesture. Again, though, they get dirty and there isn't a sort of department-wide laundry service set up for dealing with those which would be something that if the money could be found I think would be highly valuable.

Note how this grad student has given the matter some thought and can see that to an outsider it must appear rather ridiculous that there is no requirement that the researchers in Chemistry don't wear lab coats.

One lab manager in the school of medicine told me she washes her own lab coats. Since she wears one when she does work with radio-active materials she notes on the coat the half-life of the materials she used and waits until that has passed before she takes them home. Not an ideal situation.

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Stanford should create a centralized lab coat laundry service—it would send a message to all researchers that they are expected to wear them and that Stanford takes this requirement seriously.

One of the dangers with leaving PPE usage entirely up to the individual researcher is that people will have different comfort levels with risk and may thus put themselves (and others) in danger. If PPE is simply required as a standard step in entering the lab, there is less concern about people being unsafe.

A new lab manager's comments show how, as a new lab manager, he is just developing his protocols and standards for PPE in his lab. Note how he is making up the rules, and clearly they depend on his own preferences. For instance, he admits: "I like to wear shorts".

193: …. And then occasionally we'll wear shorts on summer days.
EV: Summer day?
193: Yeah, and I do, but I do emphasize that that's not safe, and we talked about that at the lab meeting. How are we supposed to deal with that? **EH&S told me a similar thing, you should not wear them [shorts], but it's not gospel for EH&S. It's not a part of their strict regulations. But they highly recommend that yes, it's okay to wear that if you're not gonna do bench work that day. So sometimes I wear shorts.** Most of the time I don't though, I'll have jeans or these sweat, and most of the other people as well. So we try to just say minimize that. If it's a really hot day, or if you're only gonna be here for a little bit, if you're not gonna do any bench work you might be okay.
EV: So do you make sure that when you go in shorts you don't do any bench work, or are you not strict about that?
193: I'm not strict about that.
EV: So is that something where you think that will stay that way, or is it one of those things where you're still in developing your protocols?
193: Yeah. I don't know to be honest. I don't know how it will develop in the near future, far future even. And I guess I like to wear shorts, it's probably why I'm on the fence about it. And I see what we have in the lab, and I'm not too worried about the hazards. The hydrochloric acid is a very good point, but other things I don't see. Bleach would be it, and that's bad for my clothes. Considering what type of clothes I wear if I wear a nice shirt or not is it gonna get touched by the bleach, so that's even just a consideration for my style not for the safety necessarily. And then if we're working with blood that day I should probably not wear shorts. So, again, if you are gonna work on the bench is it okay to wear shorts? And I would say generally "yes" in our lab because you're just gonna work with saline buffered solutions, the cells have been lysed, and even if you get the cells out of the incubator and lyse them out here that's a pretty quick operation, the probability of that happening is low. But it still could happen, and the fetal bovine serum is around, and that could get on your legs. And I guess the other reason why I don't think about it so much is because I don't wear the lab coat either, so my forearms are exposed, which are much more likely to get splashed on rather than my legs that are way down below, and I'm wearing shorts, so it's when I <inaudible> and stuff.

Note how lab manager 193 appears to receive little guidance about the safety rules when it comes to PPE, he is making up his own rules. It demonstrates, again, the independence of the laboratories when it comes to safety practices.

If the rules about PPE were clearly stated, lab manager 189—who said she did not enforce a dress code in her lab—said that she would enforce them in her lab:

EV: Clearly, you don't feel that [not wearing lab coats, safety glasses] affects safety. Would it be something that you think would be regulation overreach if they said this is what--
189: No, 'cause I-- in industry it's totally different; it's what's accepted and that's just what you have to do. No, I don't think it would be an overreach but I think if they wanted that for sure they'd have to come down and make it a real—
EV: Push for it.
189: Yeah. You have to put a poster up and say, "This is the way it is" and then **if I get that kind of backup then I will enforce it**.
EV: Okay.
189: Yeah, but-- yeah, it's a pretty <laughs> flexible environment and it's probably like anything. It takes unfortunately a really nasty incident and then everybody does it but we've never had that—
EV: Right.

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The only thing we can conclude, then, regarding PPE, is that

> *Stanford's rules concerning PPE are not very well communicated to the laboratories and researchers*

Standard Operating Procedures

Safety in the doing of research requires planning and care, and Standard Operating Procedures can help. Standard operating procedures are documents that are written by researchers and vetted by EH&S staff. They are a great way for researchers to think through the doing of new experiments and the safety precautions they should take.

However, SOPs are often not written for many of the new experiments that are being conducted in the laboratories. Nor are they shared between labs. SOPs are developed within the lab and stay there. For instance, when a researcher in Chemical engineering needed to clean something with Aqua Regia, she had to develop her own SOP, even though there are SOPs for Aqua Regia in many different places.

SOPs have limitations in their applicability. While they are good documents to write up, the SOP does not necessarily have a lot of practical information. Researchers would prefer to talk to someone who has done the same or similar experiments.

EV: If you were to do it would you go and read the S.O.P. or would you go talk to them?
106: I would ask around and see who it is because I think it was <name> but at some point the original person is going to graduate so they won't be around anymore. So I would read the S.O.P., ask around. If they are not around I'd probably- so I want to do I think I need to use piranha next week and I don't think the person who made that S.O.P. is around anymore. So I'm going to look it up on my own because I don't want to mess with it that much.

One researchers mentioned that what would be nice is if there were videos on-line that showed how to use certain dangerous materials. SOPs in video form, containing researchers actually performing certain experiments and explaining how they did them, and how they stayed safe. He explained why:

152: I think there's just much more that's captured when you-- so, for a couple of reasons. One is you can capture a lot more information by doing a video and observing somebody else who's an expert in the procedure do it than you can by just reading a document. Part of that is because the person who's the expert who's going to prepare the document is so accustomed to doing it that something that's obvious to them might not get included when it's not obvious to a new user. And so, having the video there you see what they're doing and so you can see. "Oh, I want to make a dilute acid, dilute the perchloric acid from concentrated to .1 molar." That's something now that I've done many times. The first time I tried to do it, it took me forever because I couldn't figure out what pipette do I use. I can't use a plastic pipette. I didn't know that we had disposable glass pipettes in the lab. It's not something we had in our other lab, so I just didn't know about it. I didn't think to have a beaker of 50 mls of pure water there so that after I've added the acid to the dilute solution that I could just rinse the glass pipette with that fresh water a couple of times to dilute any drops that might be left in there. It's just really small things that--

One researcher liked the idea:

185: I think the benefit to doing it that way [video] is it'd almost make it a little bit less formal where if someone was demonstrating a procedure and then commenting this and that about what they're doing they might be more likely to describe something small or minor that could be omitted from a more formally written article, whether it be something that is just a personal observation they have about what works better than something else or--

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But some researchers have reservations because they think there would be too many liabilities associated with the publication of videos.

EV: Okay, would it be helpful when you look for things like that if these procedures were in a video library.
171: For sure, but it's hard because when you publish something unless you take the most conservative approach to it, you put yourself in a hard position if someone has an incident and they go back to the video, for example, and they say well I did what the video said and they still had a problem. You know, there's variability in any technique right, so I think when you-- so here's the impression...

And other researchers were concerned that having these videos available to the public might create trouble as not everybody has access to the same equipment

175: Yeah. It's interesting, because I watch homebrewing videos on YouTube to help me figure out how to do particular procedures, but for some reason I'm hesitant to say yes for chemistry, and I'm trying to figure out why. I think in general that would be good, but, I mean, if the person watching it is knowledgeable in the field, they're not just kind of trying to do something backwater that they don't really understand, it should actually be a great resource. **I think the hazard that you run into is that the equipment that each person uses or each lab uses is incredibly diverse**, and so the...
EV: You might not have the thing that they have.
175: Right, or they don't have something that you have that makes your job a lot easier. And if done correctly I think that could be dealt with, where you can during the video say "Well, if you don't have an argon line this is what you need to do instead" and stuff like that. I think there's potential applications, but whoever's creating those videos would have to be just kind of careful...

Stanford should consider building a library of SOP videos made by researchers which can be accessed by Stanford researchers and are considered best practices for doing research.

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Appendix D-3-A: Accidents

We already encountered accidents in two different contexts. In the section on consequences we looked at how some PIs and lab managers deal with safety violations. Not all of those were accidents, but some were. And, in the training and learning section we discussed that accidents are a great opportunity for learning. Accidents demonstrate to researchers that certain rather invisible dangers are very real and that proper precautions must be taken. Accidents are useful as they can be great learning experiences, so we provide a long list.

Here is a sample of some of the accidents we heard about in our interviews.

168: She dropped a bottle of flammable chemicals and it broke and it spilled all over the floor, about 500 ml. So I mean it was a problem, she shouldn't 've dropped it, but she did and I don't think that she reacted poorly.

103: I mean I think that yeah, **every accident that happens is a great learning experience** for it and one of the problems with the accident a couple months ago down the hall was that someone was using sort of a flammable solid and also had flasks of flammable solvent in the same area and so one sparked and then that started the secondary fire that ended up making it a lot more dangerous of a situation and so now that actually was **a good takeaway message for me that be aware of what else is in my hood while I'm working and that that could potentially go bad if something that I'm actually working with now goes bad and so keeping things sort of more tidy in that respect I think is a good takeaway message**. Unfortunately, we can't always have that safety net of learning from our mistakes because sometimes those mistakes are going to be bad enough that you might not be able to learn from them if something really bad happens.

101: …we did recently unfortunately have a fire incident, so that's the only incident we've had since I've been here that I can sort of relate to. So there are a couple of things that we had.. so it was extinguished and the damage was... no one was hurt in the incident but it was definitely I think being one of the more major incidents that anyone in this lab has experienced but **immediately following that we had at our group meeting essentially a breakdown of what exactly had happened and that was led by our PI and then.. so it was a very analytical discussion about the specifics of what had gone wrong in that specific incident and then just in general, reminders about the types of things that we should be aware of when we're doing that reaction or just in general when we're setting something up with a particularly dangerous chemical as well as reiterating to us that he's.. that we shouldn't hesitate to go talk to him if we're uncomfortable doing something**..

104: For instance what happened at UCLA with that girl, I mean, I knew she was involved in an accident with t-butyl lithium and I knew t-butyl lithium was very reactive and dangerous but-- I was just a grad student, people that were post docs in my lab or even my professor was like-- he'd never heard of something like this happening before. And so **nobody was fully prepared for how dangerous that could be. I think especially a lot of the grad students or even post docs you're used to handling maybe like a milliliter of t-butyl lithium or something like that and it was different if you're trying to handle-- she was trying to handle like 150 milliliters of t-butyl lithium**.
EV: During the accident you mean?
104: During the accident, yeah. But coming back to my point is that I think **there are certain chemicals that I didn't necessarily appreciate how dangerous they could be**. And I never had any serious accidents, I had some minor things happen in the lab and I think those made me appreciate being as careful as possible when handling certain <inaudible>.
EV: Yeah. They kind of set you back like, "Okay, this is not exactly what I expected," kind of thing?
104: Just kind of, you know, I didn't really respect maybe how reactive certain chemicals were or how much you have to respect certain chemicals and for their ability to undergo whatever process they're going to undergo. And I think that's something that comes with-- I think some people are very in tune with understanding that very quickly but I think also some of that just comes with experience and having seen a lot of that.

113: There's one accident happen when I-- I think the first year or second year when I joined the group, I didn't pay attention carefully because we used vacuum system and if you need to open it up you have to fan the chamber with argon [ph?] and then I forgot to like boost [ph?]-- there's a screw on the door so I didn't loosen [ph?] it then it's over pressured and one of the windows just exploded.
EV: Explode?
113: Yeah.

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EV: Oh my.

113: But the good news is I was in a group meeting, I wasn't there. Yeah, I was like rushing to the group meeting and I turned the gas on, I forgot to open the door, so I locked the chamber, I forgot to open it, then the door breaks. And when I went downstairs there was like pieces everywhere.

105: …Like I said, I remember things where there's a fire alarm and the reason why we got a fire alarm is because one lab was spraying down their table top with alcohol to clean it off, everybody uses 70 percent alcohol to clean things up, and forgot they had a Bunsen burner at the end, so the whole building had to evacuate. But I've never seen an official, and this wasn't here, I never saw an official notice going out saying, "Don't do this because this is what can happen," you know, it's none of that. There's probably instances where a Bunsen burner in a biosafety cabinet, which they use a lot because they want to disinfect the tissue culture and certain things and they also use alcohol so it's like a bad combination, and there's cases where the biosafety cabinet got burned because you have alcohol and the flame.

118: I mean, the only incident, one student cut his hand, not real bad. I think he did need stitches, but, like, three stitches. He was screwing two pieces of glass together and, I guess, was pushing too hard and not quite in a straight line. And one of the pieces of glass broke.

106: We only had one that I know of in lab and I was the safety chief for it. A girl cut herself with just a straight razor blade. She was trying to cut something else and it went through her finger and it actually cut pretty deep. And I didn't really know what you were supposed to do about it. So she walks into the office with like her finger wrapped up in a bloody thing like what do I do about this? And I was like, go clean it up. So I just started looking online on the EH&S website and everything like who do I report this too, because it turns out there's a bunch of forms you have to fill out. And she can't just go to the student hospital on campus. She has to go to the EH&S or an actual hospital.

135: Sure. So one instance is, we came into lab, and someone opened the flammable cabinet and found that one of the bottle taps had blown off the top of this chemical. So the inside of the flammable cabinet was, like, splattered with all kinds of, whatever this chemical was. The cap was just laying on the side, and so obviously there must have been some kind of buildup with this chemical, or whatnot, and what we did was, I think this was, I recall, late at night, or no, it was early in the morning, someone was trying to get a chemical and they noticed this, so then what they did is they then talked to me, and we called EH&S and dealt with it.

135: They were carrying a four liter bottle, I mean, I'm thinking it's THF, and—

EV: Some solvent, right?

135: Yeah, and they didn't use the proper carrier, so they were just carrying bottle alone, and we have basement. They were carrying from one room to other, and they set it down and in some way or fashion, the bottle on the bottom broke. So I don't think the four liter bottle was completely full, but it was quite a lot. So then he came out of the room, I don't recall if I was safety chief at the time, but we basically closed that off, had EH&S come and yeah. And it was just basically like, you knew, you should have known to use a solvent carrier, for the instance that if you had put it down with the solvent carrier, at least the solvent would have been contained in the carrier, and this is why we don't do this. So a lot of the stuff is just very stupid, almost, I would say like, laziness. Yeah.

137: let's see. I think we wrecked the surface of a bunch of tile in our GC room by breaking a jug acid nitric [ph?] on the floor. No one was hurt. You know, it was cleaned up without incident.

136: Okay, so in our lab probably the most serious incident-- and this is, like, the one time I actually went to <PI name> about it-- was **a couple of students work quite a bit with selenium, elemental selenium, for some of their experiments. And around their work area we were concerned that the way in which they were running experiments, a lot of things were getting selenium contaminated**.

136: Two or three years ago that-- because I believe they were sputtering off of a selenium target on it?

PI: It wasn't pure selenium. It was a selenide, though.

136: It was a selenide target—

PI: Containing material.

136: And after some time they noticed that there was a very distinctive smell coming from it. And it wasn't one hundred percent sure that it was selenium, but it was something that wasn't supposed to give off an odor.

EV: Oh, okay.

PI: In fact, we brought EH&S in on this and asked them what the smell was and they brought all their sensors over and they could never find anything.

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EV: Okay.
PI: So they looked for H2Se, which is the toxic selenium-containing gas. That's the gas I mentioned in today. So I knew I didn't want to have H2Se in the lab. But they never found any-- I mean it was below the detectable--

161: Well, I had somebody a while back who dropped some glassware uh.. and cut his hand and he went to the-- he got to the ER, whatever, yeah. Got it taken care of, but that was a while ago.

161: Uh.. you know, I don't know. I don't remember what we did. Uh.. somebody contaminated one of the ovens with some radioactivity recently and basically sent an e-mail out that "I realize it's not -- I don't use this. I'll be in- in the morning and clean it up." But it was within a contained region within the P-32. So I thought that was fine, and he sent back an e-mail the next day that he's decontaminated the- the instrument.

EV: Yeah, yeah. Okay, so what kind of accidents have you seen?
181: Oh, the TRIzol on the neck. The mercury on the floor.

175: So, let's see. Probably I stabbed myself a couple times with needles. Luckily, they were generally clean. So, I didn't have to worry too much about that just because we use syringes to transfer reagents a lot. So, I'd stab myself with a clean needle every once in a while, but luckily it's always been clean. **I had a small H2 flam, hydrogen flame in my hood once when a particular reaction, which had a catalyst that I didn't realize was quite so flammable under these conditions ended up spontaneously igniting. And so, I just kind of closed my hood sash, stood back, and let it burn out. But that was-- it was fairly well contained. It didn't spread to anything. I didn't have any solvent or papers around because I knew I was working with hydrogen**. Anything truly—
EV: You knew that in that case that it was just something that would burn itself out and it wouldn't spread to other things?
175: The H2 balloon would empty eventually.

175: Let's see, I think the people that do-- well what's unfortunate is that the people that probably do report those things are the people that have the least number of problems because they're the people that are paying the most attention and actually kind of care about those sort of stuff. It's also not clear to me exactly what constitutes a reportable incident. When do we cross the threshold between this was contained, I don't need to worry about it, and this is something that we need to self-report. And so my general approach has been to send <PI> or the group an email when something happens. Like in the case of that meeting, I had-- at one point in time, I'd pulled some what amounts to tissue papers out of an inert atmosphere glove box, and they had spontaneously ignited. And I just let them burn out. And so, I sent <PI> an email and an email to the group letting people know about-- and it was unexpected to me that that would happen, about what had happened. And sort of if <PI> didn't tell me to fill out an incident report form, so I didn't. This is one of those things where if I had something happen, I just let him know. And if he says fill out an incident report form, I will. I think other people kind of go ahead. The people that have filled it out kind of went ahead and did it on their own, not necessarily without <PI>'s prompting. Whether or not if <PI> was thinking about it, he would have told me to do it, or if did make the clear decision not to have me fill it out, I don't know.

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Appendix D-3-B: EH&S web-site

The EH&S web-site was often criticized in the Task Force town hall meetings. In the interviews too, people complained about it frequently.

135: I think EH&S website is like, not very well organized, so instead of spending time trying to figure out what links to get to, sometimes I'll just ask Trevor, like, what is the proper protocol for surplus chemicals and where can we send them?

EV: EH&S Web site?
175: I never access it really.
EV: You never access it.
175: Yeah. I struggled with it when I was a first-year and kind of gave up on it and don't really use it.

180: Yeah. I mean I guess if they had a better website maybe I would go there more.

EV: Okay, okay. So I'm wondering a little bit about what resources you use to find safety-related information. Where do you go if you need to--
164: Other people. I am told often that the EH&S website has information, but the few times that I've tried to use the EH&S website I've been frustrated. I sort of-- I think it's one of those things where people-- where-- for me, I just want to find the information fast. I wish if I'd go to the EH&S website, there's one, two, three-- where's your chemical inventory storage directory? Click that if that's what I want. Toxic waste pickup request. Click that. Something easier because I find that the website-- things just seem to be buried in the website, and I have to dig through it to try to find any useful information. So then I just don't bother, and I ask other people.

Mostly people would look at the EH&S web-site to look for Stanford specific—not general--information:

EV: Do you ever visit the EH&S website?
105: I have. They need to upgrade it further I think, it's a little difficult to…
EV: What would you look for, what did you go look for?
105: What did I go and look for recently? I was looking for a policy on the use of, I think viruses, or tissues, what the policy was in terms of inoculating human tissues into immuno-compromised mice. And I probably [ph?] they have a policy that's sort of not official yet so I couldn't find it. So I had to ask them and they told me, "Well, it's not official yet," so that's the last time I did it.

EV: So, do you go on their website?
171: I have been on their website to find the number for the person to call to pick up the bromide waste.

The more common pieces of information people look for is information regarding Chem Tracker, the Waste Tags, Waste pickup, ordering chemicals, etc.

EV: Okay. Okay. What about the website, do you go on that?
118: **Just for the ChemTracker**, the chemical...
EV: Oh, yeah, ChemTracker.
118: ...inventory and for the waste pickup. I think yeah, that's pretty much the only times I go on the website...
EV: Do you have links to those? Or do you Google search it? Or do you...
118: I think I always Google search "ChemTracker."
EV: Stanford EH&S.
118: Stanford, yeah. And then, I just remember "wastetag.stanford.edu" takes me to their waste label site.

EV: Okay. I think we're almost done. Yeah, so I need to ask you about the EH&S website. Do you go there?
188: Yeah, sometimes.
EV: What do you go there for?
188: Sometimes to look things up or to look for the **hazardous material disposal form**. And to look up the…
EV: Do you mean waste tags?

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188: Yeah, waste tags.

EV: ... Do you ever go on the EH&S website?
101: Occasionally. Usually just to download forms to be filled out if I need more copies, to find out about..
EV: Forms of what?
101: Yeah the quarterly forms, the waste tag online generator, you can access this through theirs. I've used their website to look up where you can find a batteries disposal on campus, things like that. I don't frequently use it. One of the town halls, I think I was surprised to learn about certain features that they have on the website. It's not the easiest to navigate.

EV: What do you actually use?
135: I guess just waste tag and surplus.
EV: Chemtracker?
135: Chemtracker, I have my own bookmark for.
EV: But you use it.
135: Yeah. EV: Isn't that-- you don't consider it EH&S?
135: **No, I consider it its own separate entity**. If that makes sense. I go, like, actually if I go and try to use Chemtracker, I-- and forget what the bookmark website is, **I just go and Google, like, Chemtracker, Stanford, and I think maybe that puts me at EH&S website, perhaps, I don't recall**. But I guess I know they help with chemical inventory, but I see them as two separate entities.

EV: What parts of the EH&S website do you use?
136: The waste removal system.

EV: … So is there anything that you go to the EH&S website for?
180: Well, yeah, looking up if I have a chemical disposal question.

EV: How about EH&S website? Do you use that at all?
185: I do use that to check what they consider hazardous chemicals. I think that is a very useful list, and I think that the way they have that set up is better than at other places I've worked. So actually I do go to their website fairly frequently.

EV: Okay. What other parts of the EH&S website do you use?
136: So they have an SOP template as a word document for download, so when I was creating all the SOPs for the ammonia furnace, I downloaded that template and created all my SOPs from that. Apart from that, I don't really use the EH&S website that much.

EV: Do you go on the EH&S website?
193: Mm-hmm.
EV: What do you look for there?
193: **What I do there regularly is waste pickup**. I have to request it through a form.
EV: Is it easy to use?
193: It is very easy, yeah. It's a form, it just pops up, you fill in the blanks, and then submit. And then I just leave it there, and the guys come, and then they've come often enough clearly because they know where it is. I've never even interacted with them. They come when I'm not here. So it's a pretty, as far as I can tell, seamless.
EV: What else for EH&S website?
193: And then, as I mentioned, **dry ice occasionally I have to do that again, so I go there to remind myself how to do that**. I mentioned that we're gonna start using lenti or the viruses for recombination probably in the near future so I've gone to the website to see about that, what do I have to do for that? What are the physical things I have to do for it? What are the paperwork things I have to do for it? When I was giving the lab presentation I went on there to get a couple resources, so just lab safety resources.

EV: How about, do you ever go to the EH&S website?
113: Yeah, I do very often because I have to fill out the ChemTracker.

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EV: Okay.
113: Yeah, I do ChemTracker, waste pickup and yeah, a lot of things there. Yeah, if I need some information, then I'll go to the EH&S website.
EV: Okay. So what is the kind of information you look for?
113: Like the storage group stuff, what kind of new chemicals, how we put them in a group, like different storage groups.

MK: Have you ever used EH&S website?
115: Yeah, regularly.
MK: Yeah, so what do you use it for?
115: Resources. There's a lot of resources. Hazardous waste program. Information, whatever they have available in there.
MK: Under what circumstances do you go to the EH&S versus say googling a question.
115: Probably an MSDS [ph?]. Because I think the EH&S MSDS system it's like you have to do three steps before you can get there as opposed to google it…
MK: Google you just type it in and…
115: …and it's there, you get it back. So I don't know if there's anything you can do better than that. Chemical inventory, they want to make sure the chemical-- if the chemical is new or someone is ordering chemicals that's not on the list. They just sort of link-- because I have global access for the chemicals being used here. You know, the university has this chem tracker so I can consult that if someone is ordering chemicals that's not on the list.

EV: Anything else you use on the Web site? So you do ChemTracker and the electronic waste tags. What else?
174: And then **just generally look up once in a while how to get waste picked up**. We had some mercury lamps, so we were looking up how to dispose them of [sic] from microscopes. Now we've gotten away from using mercury lamps altogether because they are a pain to get rid of, the lamps, when they burn out. We just use the LED-based system, so there's no more mercury lamps. But **it took us a while to navigate through the whole Web site to find out how to label them, what kind of waste and how to get it picked up**.
EV: You're saying it's hard to navigate?
174: Yeah, just to get information. I think now they've put in a search in the EH&S Web site. I recently looked at it, that you can put in some keywords and it'll pull it up, but there didn't used to be a search function on it, so yeah.
EV: What other information sources do you use for safety?
174: So sometimes you just need an MSDS of something, and that's...
EV: Do you just use Google?
174: Yeah. Yeah, I just go to Sigma and get the MSDS from the Sigma site. That's about it. And then shipping with dry ice, that's a big FAA violation if you don't do it right, so the training on that is I think quite useless, the online shipping, but I guess people need to do it because...

Sometimes people mention that they use the Stanford EH&S web-site to find more general safety information.

101: Yes. Yeah, I might have used it a couple of times to look up MSDS sheets for chemicals.

EV: Okay. Do you go on their website?
106: I do a lot. Mainly I'll use chem tracker. And I use the chemical safety database to look up what storage groups chemicals are. I've been starting a bunch of new synthesis for new materials and I'm ordering all of these precursors and I don't know what they are. I mean I've looked them up online to make sure A, that they exist because I'm making up a new synthesis. I didn't know if you could buy iridium acetate or not, for example.

EV: Where do you go for safety information?
175: So mostly what I would access would be MSDSs, and those would generally-- either from the commercial supplier or the-- and I guess I perhaps-- let me see. It depends. **I probably link through the EH&S Web site to find MSDSs just because they've got a link through to the MSDS Web site. I think that's about as much as I would do. And then otherwise if it's a fairly well-known reaction and I feel like I would learn something by it I would kind of Google search for chemical forums and blogs and information of that type if it's something common I feel like that that information would be out there**.

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EV: ... The EH&S Web site is the only thing. Do you ever go there?
152: So, I think I utilize some of the resources, but **I don't go to the homepage, but I do use like the chemical safety database**, which is something that I wasn't aware of in my old group, but other people, as part of a different outlook on safety, made me aware to sort of look up a chemical. What storage group does it go with? I don't know if that's a universal thing, or just something at Stanford, but they have different compatibility storage groups, and **then occasionally to use like the MSDS or ChemTracker a little bit**.
EV: Okay, and those are easy to find?
152: **Harder than they should be I would say**. Now that I know they're there, I--
EV: You found it a few times and you liked bookmarked the pages you need to go.
152: Yeah. I haven't bookmarked it, but I'll do a Google search, but then it still usually takes me a couple of clicks to say, "Oh, no. That wasn't the right link. It was this one." But, I know it does exist. So, I know I just have to find the right link, but it's not usually the first one that I click on.

Sometimes people mention that it would be great if Stanford EH&S would provide more *practical* safety information on the web-site. The material safety data sheet (MSDS) for chemicals is so full of hazards that it is hard to see how one is to use a substance safely.

EV: Yeah. What else would you go there for, then? What other safety stuff would you be interested in looking at? We're doing the redesign.
180: Yeah, I don't know. I feel like if I could go there and easily find information then maybe I'd be more interested. You know, if I could type in a chemical name and it would say, "Okay. This is why it's dangerous." And then if it had some kind of comparison, like a low pH is dangerous, but like orange juice has a low pH or I have low pH in my stomach acid, which would be very toxic if it wasn't in my stomach. But, okay, so is it dangerous like orange juice or coffee, or is it dangerous like something--
EV: Like HF and it will eat my bones.
180: Yeah, I mean just some practical information.

103: Yeah. Yeah, they skew it towards "This is really dangerous" even on things that you wouldn't think of that are dangerous. A lot of times it'll sort of sadly end up being looking on-- **Wikipedia has a lot of information about chemicals, and it'll say "This is a highly toxic chemical in humans" or something like that. Other than that there's not all that much that I would sort of know to look at.** We've had a couple of open houses as part of this sort of safety taskforce, and something that's been brought up a couple times is there should be resources for things like that on the Health and Safety Web site. **The EH&S Web site should have those kinds of things available in a sort of down-to-Earth, practical sense. I think one of the problems often with that is that once you have an organization like EH&S that's labeled as "They are here protecting us" they have to worry about liability as well just like the MSDS people do, and so they're going to sort of tend to skew things towards "This is really dangerous" as well, and it's not going to give us what's sort of really practical to do.**
EV: Interesting.
103: Someone gave an example at a meeting I guess it must've been last week that this chemical is kind of reactive with water, and so instead of putting your reaction in an icebath to cool it down, you should use a chilled oilbath. And a chilled oilbath is not something that any of us had ever heard before as being something that's actually used. That was just probably what some sort of lawyer or lawyer in combination with a sort of higher-up chemist decided that that was what the safe practice for using this type of thing is. But, I mean, that's not practical, and that's not going to get...
EV: You don't have a cooled oilbath.
103: Exactly. That's not what's going to get followed sort of on a practical sense.

175: One that has the exact information that I need at that point in time, really easy, quick. <laughs> EV: Google.

175: I know. I've thought about that, because I always get frustrated when they say "Oh, it's a great Web site, go here, find this out," and then you go there and you're frustrated, "Oh, this should be better," but it's hard to find what would make it better. One personal annoyance that I've had is that a lot of the time the way that you go through-- **when I've personally looked for something on there, say, in this case glove safety, like what gloves should I use with what compounds, what I would do is I could say, okay, go to the EH&S Web site, spend some time searching around the Web site till I finally find their information for how to make glove choices. And what they have is instead five different links to five different commercial suppliers of gloves, that then I need to go**

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to there and look at how this particular company's formulations of different gloves are recommended. And each different company has a different way of presenting information, and on the fourth one down I finally find a table that I deem to be reasonably accessible to get the information from that I'm looking for. It would be better I think for-- and I would imagine the issue is a liability sort of problem-- is for me **I would feel better if EH&S would be able to take a stance and say "This is our recommended guidelines for gloves" and have their own table that I could just easily access instead of just kind of porting us to all these other resources and forcing us to then just do what we could've done originally, which is just fricking Google it, right**? But if they could take a stance and say "This is our recommendations, here are the resources" I think that would be useful, but, I mean, then item-by-item for every potential hazard they would have to go through that, choose what their stance is and open themselves to all sorts of liability potentially, so...

MK: So do you ever use the EH&S website as a source of information?
PK: **I use it for inventory control**, yeah, I use their inventory system. And I use the…
MK: Like chemical inventory?
PK: Yeah, we have a chemical inventory. ES&H maintains their website; all of our chemicals go in and out of that so I use that. I use the first version of it because that's the most convenient one. I think it's gone through three or four versions <inaudible>. I've accessed the ES&H website for chemicals that they store, excess chemicals that they give away for free from if <inaudible>.
MK: Right.
PK: Occasionally other <inaudible>. There is a commonality of permitting regulations and they have some documentation there that I've pulled out occasionally for use [ph?], to understand what's going on at SLAC for example. That kind of information would be actually very useful if it were made more obvious where you could find it, you know, what are the federal regulations, is there a summary of them and how does the law apply? Sometimes these things become important. For example, waste treatment in the laboratory is a big deal.

MK: Let me see. Have you used Google or gone on the Internet for kind of safety related information in the recent…
120: All the time.
MK: Okay.
120: All the time. The flux of requests from <name> or from <name> is pretty constant. So I might get a couple of week.
MK: And are there specific websites you go to or do you Google for MSDSs?
120: Google for MSDSs, I also go to Google Scholar and look up scientific peer review literature on materials that are being used. I also do that on the Chem Abstracts website. I've found that very useful.
MK: Okay. If the EH&S site had an MSDS repository, I think it does but would you go there or do you just prefer going to Google for it?
120: You know, if you're looking for an MSDS, actually I usually go to Google and if you Google MSDS, you know, chemical X, you get ten MSDSs from <inaudible> Aldrich and you might find one from Princeton, other chemical companies. I look at several of them to see what they all say. And sometimes you find contradictions, you find different hazard classes. It's important to know that because some of that might be more pertinent or not to the users that you have in mind as you're doing this search.

Interviewee-137 was looking for simple-to-consume information about how to fill out the forms for radioisotope use:

137: No. No. It is-- there is some. It takes some time to learn all of the requirements about-- to learn about quarterly surveys that you have to do. And just as an example if you have CRA, a permit for radioisotope use, there are some forms that you have to file quarterly and some training requirements for those. And it takes a while to learn those requirements. If you search at EH&S's website you can usually find the information that you need but it's not like someone hands you a simple little manual that you can read and find all the rules. Stanford is more disbursed than that so there's a lot of kind of learning on the job.

With interviewee 121, we looked on the EH&S web-site, but we could not find the information easily. Interviewee_121 said that he could not find it because usually he uses another computer, where he has the link stored. We could not find the Chemical Inventory when we went to: Chemtracker.stanford.edu. Note that it is not clear how to add inventory, which is what you want to do.

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But if you click on the first search item that comes up in google when you search for “Stanford chemtracker”, it does come up with a page from which you can find Chemtracker in the middle of the page.

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Researchers who are not the safety coordinator of their group report visiting the web-site only rarely or not at all.

EV: ... Do you go on the EH&S Web site?
154: I do not.

EV: ... Do you ever go to the EH&S website?
162: I feel like I've been incidentally for something, but I don't even know what. Not habitually.

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EV: Have you ever gone on their website?
102: Yes.
EV: To do what?
102: To get trained, and that's it.

EV: Yeah. Yeah. Do you ever go on the EH&S website?
138: I have gone on the EH&S website and looked over information about the chemical handling. And they also have the training courses on their website. So I've gone through the compressed gas training, the chemical handling, the general safety training. And they also have another training being developed if memory serves for PIs for labs. So it's been a while, to be honest, since I browsed through the website. Probably over a year, but I have been to the website.
EV: Yeah. What did you think?
138: I mean, everything is there. It's not always--
EV: Easy to find?
138: Not necessarily easy to find. Sometimes I don't know where to click. And it could be in or in effect [ph?] I don't know what I'm looking for too. But I've always been able to find anything that I needed to know on the website

EV: And do you ever go on their website?
111: Yes, yes, yes, I do.
EV: For what?
111: I went like for sometimes to look at, you know, if I'm not sure about something.
EV: If you're what?
111: I'm not sure about something so like, you know, go to training, you know, and look maybe for other material, what you have to do, what you have to deal so typical I do that.
EV: Yes, yes.
111: And I think it's very well, you know, I really like it because it's well organized in the parts whatever, you know, it's like for material, you know, for people, and it's like for extra [ph?]--, you know, I really like it, yes.

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Appendix D-3-C: Interview Guide

Note: All interviews were conducted as ethnographic interviews, that is semi-structured. Below we provide the interview guide we developed, but the actual interviews followed this structure only loosely.

Background (10m)

- Tell me a little about yourself, your studies/work and career?
- In what labs do you do most of your work?
- Can you tell me about the structure of your lab? What are the different roles of people in the lab? How does communication happen? [Perhaps ask to draw a diagram showing the roles of people with arrows about how communication happens]
- Do you prepare for working in the lab in any way? How?

Lab safety (15m)

- Do you consider your research/work hazardous? If so, what aspects of the work make it dangerous?
- If you have a question about safety (e.g., how to do something safely), who or what do you consult?
- Have you ever experienced an incident? (How did you know it was an incident?) What happened?
- Did you or someone else communicate the incident? (and if so how) (If not, why not? Is such reporting encouraged/discouraged?)
- [If yes] Were there any consequences as a result of the incident? If so, what? Were there any consequences as a result of reporting the incident?
- How closely do you feel your supervisors monitor safety in the lab? How would you compare their attitude toward safety to yours?
- Does the lab do safety inspections? Are you involved? [If so] Can you give me some examples of results that came out of the last safety inspection?
- Do you think the safety in the lab can be improved? If so, how?
- How much of a priority is safety in your laboratory relative to other activities? (Can you give examples of why you feel that way?)
- Do you think this lab/workplace is safer than others you may have worked in before you started working here?
- When you compare your current work practices to the way you worked when you first started, are you safer now, and if so in what way? What did you learn, and how did you learn it?

Safety training (5m)

- Can you tell me a bit about the safety training you received? How was it delivered (on-line, supervisor, etc.)? Did you get additional training at any point?
- Do you feel you received enough training about the dangers in the work you do and how to avoid them, or manage them when something happens?

Safety Information (15m)

- Under what circumstances have you looked for safety-related information?
- Can you give me an example of the last time you looked for safety information? When did it happen? What were you looking for? Can you walk me through the process you used to find that information? Is this a typical process for you?

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- Are there times when you wanted information about how to do something safely, but couldn't find it? Can you give me an example of what happened?
- What kind of information have you looked for in the past? Are there different categories? [prompt if necessary: material safety, process safety, device use, etc.]
- What resources do you use to find safety information? [prompt for; books, Google, other people]

EH&S Information and Site (15m)

- What would you expect to find on an Environmental Health & Safety site?
- In what circumstances would you expect to go there?
- Have you ever gone to Stanford's EH&S web-site? If so can you describe the circumstances? If so: What did you like about it? What did you not like?
- Can we run through what you last looked for and how you navigated the EH&S web-site to get to the information you need?

Technology use (10m)

- How do you normally search the Internet for information? [prompt: laptop, phone, tablet]
- When you are working in the lab, do you often search the internet? What do you use?

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D-4: Survey Form (for Principal Investigator)

Default Question Block

Stanford Laboratory Safety Culture Survey

Thank you for participating in this survey about the laboratory safety culture at Stanford. The goal of this survey is to get your opinions about the safety practices of your lab so that we can determine how we can help make Stanford a safer place to conduct research. This survey has 46 questions and will take approximately 10-25 minutes to complete. Your responses will be kept anonymous and confidential.

This survey is being administered by Erik Vinkhuyzen and Mike Kuniavsky of the Palo Alto Research Center (PARC) for Stanford's Task Force on Advancing the Culture of Laboratory Safety. You may contact us at lab_safety_survey@lists.stanford.edu.

Please return the survey as soon as possible but NO LATER THAN MARCH 5, 2014. We are on a tight schedule and appreciate your early participation. (a1)

How potentially hazardous is your laboratory research work?

	1	2	3	4	5	6	7	
Not at all hazardous	○	○	○	○	○	○	○	Very hazardous

Please rate your agreement or disagreement with the following statements

	Strongly Disagree	Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Agree	Strongly Agree	Not applicable
The people in my lab understand the potential hazards associated with their work in the lab	○	○	○	○	○	○	○	○
I know what my responsibilities are when it comes to safety in my lab	○	○	○	○	○	○	○	○
The people in my lab have the necessary tools, supplies, and equipment to work safely	○	○	○	○	○	○	○	○
The people in my lab know what to do in case of an emergency	○	○	○	○	○	○	○	○
The people in my lab know their responsibilities when it comes to safety	○	○	○	○	○	○	○	○
Compared with similar laboratories, my lab group is more focused on safety	○	○	○	○	○	○	○	○
My lab has a clearly defined process for teaching new researchers the safety procedures	○	○	○	○	○	○	○	○
	Strongly		Somewhat	Neither Agree nor	Somewhat		Strongly	Not

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	Disagree	Disagree	Disagree	Disagree	Agree	Agree	Agree	applicable
The safety procedures in our lab are adequate	○	○	○	○	○	○	○	○
The people in my lab maintain a clean and uncluttered facility	○	○	○	○	○	○	○	○
The researchers in my lab encourage each other to work safely	○	○	○	○	○	○	○	○
In our lab safety-related mistakes are swiftly corrected	○	○	○	○	○	○	○	○
In my lab it is rare for people to disregard safety procedures	○	○	○	○	○	○	○	○
In our lab, there are well understood consequences for intentionally violating safety procedures	○	○	○	○	○	○	○	○
If there are safety issues, we discuss them in our group meetings	○	○	○	○	○	○	○	○

	Strongly Disagree	Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Agree	Strongly Agree	Not applicable
When individuals in my group start a new research procedure we discuss the risks and safety implications	○	○	○	○	○	○	○	○
People in my lab sometimes feel pressure to finish a project even though safety may be compromised	○	○	○	○	○	○	○	○
The people in my lab feel comfortable refusing a task they think cannot be done safely	○	○	○	○	○	○	○	○
If a researcher in my lab sees another person doing something unsafe, they feel comfortable addressing the individual directly	○	○	○	○	○	○	○	○
People in my lab feel comfortable asking for help when asked to perform a task for which they don't know the proper safety procedure	○	○	○	○	○	○	○	○
When the people in my lab accidentally do something unsafe they share it with the group to prevent future incidents	○	○	○	○	○	○	○	○
People in my lab always report safety problems to me	○	○	○	○	○	○	○	○

	Strongly Disagree	Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Agree	Strongly Agree	Not applicable
When a safety-related incident occurs elsewhere	○	○	○	○	○	○	○	○

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on campus, I communicate it to my group	○	○	○	○	○	○	○	○
I am personally involved with the day-to-day safety practice in our lab	○	○	○	○	○	○	○	○
In our lab safety is the highest priority	○	○	○	○	○	○	○	○
I always report safety violations	○	○	○	○	○	○	○	○
Reporting a safety incident or concern will not result in negative repercussions for the person reporting it	○	○	○	○	○	○	○	○

Rate how useful you found the following safety training.

	Very Useless	Useless	Somewhat Useless	Neutral	Somewhat Useful	Useful	Very Useful	Not applicable
EH&S On-line training	○	○	○	○	○	○	○	○
EH&S classroom training	○	○	○	○	○	○	○	○
Hands-on training in the lab	○	○	○	○	○	○	○	○

How safely do people your lab carry out their work?

	1	2	3	4	5	6	7	
Extremely unsafely	○	○	○	○	○	○	○	Extremely safely

I don't always report safety violations because: (check all that apply)

- ☐ It would reflect poorly on me
- ☐ I don't know to whom I should report or how
- ☐ There may be negative repercussions from reporting a safety violation
- ☐ It would not matter anyway
- ☐ Other (please specify)

When I report a safety problem there is appropriate follow-up.

Strongly Disagree	Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Agree	Strongly Agree	Not applicable
○	○	○	○	○	○	○	○

In the last year how many safety incidents and/or near misses have been reported to you by lab researchers?

- ○ None
- ○ 1 to 2

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- 3 to 5
- More than 5

Please briefly describe an incident you experienced. (optional)

How often do you visit the lab?

- Daily
- 2-3 times a week
- Once a week
- 2-3 times a month
- Once a month
- Less than once a month
- Never

The following questions concern EH&S. If appropriate, you may substitute EH&S with another Stanford health and safety organization that serves as a primary source of safety contact and information (e.g. University Safety Partners).

How often do you interact directly with EH&S personnel?

- Daily
- At least once a week
- At least once a month
- Less than once a month
- A few times a year
- Less than once a year
- Never

Please rate your agreement or disagreement with the following statements.

	Strongly Disagree	Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Agree	Strongly Agree	Not applicable
I find my interactions with EH&S personnel very helpful	○	○	○	○	○	○	○	○
I feel comfortable reporting safety concerns to EH&S	○	○	○	○	○	○	○	○

How often does EH&S visits your lab?

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- ◯ Never
- ◯ Less than once a year
- ◯ A few times a year
- ◯ Monthly
- ◯ More than once a month
- ◯ I don't now how often

Please rate EH&S as an organization.

	1	2	3	4	5	6	7	
Very incompetent	◯	◯	◯	◯	◯	◯	◯	Very competent

How familiar are you with the EH&S web-site?

- ◯ Unaware
- ◯ Aware but never visited
- ◯ Visited once
- ◯ Visit regularly

	Strongly Disagree	Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Agree	Strongly Agree	Not applicable
I find the EH&S website very helpful.	◯	◯	◯	◯	◯	◯	◯	◯

Tell us how the EH&S website should be changed to make it more helpful. (optional)

Please describe how EH&S can improve. (optional)

Please tell us a little bit about yourself. We will NOT use any of this information to identify you.

In what school do you work? (If more than one, select primary)

- ◯ Earth Sciences
- ◯ Engineering

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- ◯ Humanities and Sciences
- ◯ School of Medicine
- ◯ Would rather not say
- ◯ Other (please specify)

What is your role?

- ◯ Faculty/PI
- ◯ Lab Manager
- ◯ Other (please specify)

How many people are in your research group?

- ◯ 1-5
- ◯ 6-10
- ◯ 11-15
- ◯ 16-20
- ◯ More than 20

Block 1

How many years have you been at Stanford?

- ◯ 0-3 years
- ◯ 3-5 years
- ◯ 5-10 years
- ◯ 10+ years

If you would be willing to answer further questions about safety on campus, please provide your e-mail address: (optional)

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D-5: Survey Form (for Laboratory Researchers)

Default Question Block

Stanford Laboratory Safety Culture Survey

Thank you for participating in this survey about the laboratory safety culture at Stanford. The goal of this survey is to get your opinions about the safety practices of your lab so that we can determine how we can help make Stanford a safer place to conduct research. This survey has 46 questions and will take approximately 10-25 minutes to complete. Your responses will be kept anonymous and confidential.

This survey is being administered by Erik Vinkhuyzen and Mike Kuniavsky of the Palo Alto Research Center (PARC) for Stanford's Task Force on Advancing the Culture of Laboratory Safety. You may contact us at lab_safety_survey@lists.stanford.edu.

Please return the survey as soon as possible but NO LATER THAN MARCH 5, 2014. We are on a tight schedule and appreciate your early participation. (b1)

How potentially hazardous is your laboratory research work?

	1	2	3	4	5	6	7	
Not at all hazardous	○	○	○	○	○	○	○	Extremely hazardous

Please rate your agreement or disagreement with the following statements.

	Strongly Disagree	Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Agree	Strongly Agree	Not Applicable
I understand the potential hazards associated with my work in the lab	○	○	○	○	○	○	○	○
I have the necessary tools, supplies, and equipment to perform my work safely	○	○	○	○	○	○	○	○
I know what to do in case of an emergency in my lab	○	○	○	○	○	○	○	○
My responsibilities for lab safety were clearly communicated to me	○	○	○	○	○	○	○	○
Our lab does a good job of teaching safety procedures to new researchers	○	○	○	○	○	○	○	○
My lab colleagues are at least as conscious about safety as I am	○	○	○	○	○	○	○	○
The safety procedures used in our lab address the risks in our work	○	○	○	○	○	○	○	○
Our lab is clean and uncluttered	○	○	○	○	○	○	○	○

	Strongly Disagree	Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Agree	Strongly Agree	Not Applicable
My lab colleagues exert								

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	Strongly Disagree	Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Agree	Strongly Agree	Not Applicable
strong peer pressure on me to work safely	○	○	○	○	○	○	○	○
In our lab safety-related mistakes are swiftly corrected	○	○	○	○	○	○	○	○
In our lab it is rare for someone to disregard safety procedures	○	○	○	○	○	○	○	○
In our lab there are well understood consequences for intentionally violating safety procedures	○	○	○	○	○	○	○	○
In our regular lab meetings, we discuss all safety issues	○	○	○	○	○	○	○	○
When individuals in our group start a new research procedure we review the risks and safety procedures	○	○	○	○	○	○	○	○
In our lab there is pressure to finish a project even though safety may be compromised	○	○	○	○	○	○	○	○
I feel comfortable refusing to do a task I think cannot be done safely	○	○	○	○	○	○	○	○

	Strongly Disagree	Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Agree	Strongly Agree	Not Applicable
If I see a person in my lab doing something unsafe, I feel comfortable addressing the issue directly with the individual involved	○	○	○	○	○	○	○	○
If someone asks me to perform a task for which I don't know the proper safety procedure, I feel comfortable asking for help	○	○	○	○	○	○	○	○
If I accidentally do something unsafe, I share it with my group to prevent future incidents	○	○	○	○	○	○	○	○
When a safety-related incident occurs elsewhere on campus, it is communicated to me with a causal analysis	○	○	○	○	○	○	○	○
My PI or lab manager is concerned about my safety in the lab	○	○	○	○	○	○	○	○
My PI or lab manager has clearly delegated lab safety responsibilities	○	○	○	○	○	○	○	○
My PI or lab manager visits the lab regularly	○	○	○	○	○	○	○	○
My PI or lab manager visits, he or she looks at safety issues	○	○	○	○	○	○	○	○

	Strongly Disagree	Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Agree	Strongly Agree	Not Applicable

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	Disagree	Disagree	Disagree	Disagree	Agree	Agree	Agree	Applicable
My PI or lab manager fully understands the risks of the research in our lab	○	○	○	○	○	○	○	○
In our lab, safety is the highest priority	○	○	○	○	○	○	○	○
Compared with similar laboratories, my lab group is more focused on safety	○	○	○	○	○	○	○	○
I always report safety problems	○	○	○	○	○	○	○	○
Reporting a safety incident or concern will NOT result in negative repercussions for the person reporting it	○	○	○	○	○	○	○	○

Rate how useful you found the following safety training.

	Very Useless	Useless	Somewhat Useless	Neutral	Somewhat Useful	Useful	Very Useful	Not applicable
EH&S online training	○	○	○	○	○	○	○	○
EH&S classroom training	○	○	○	○	○	○	○	○
Hands-on training in the lab	○	○	○	○	○	○	○	○

How safely do people in your lab carry out their work?

	1	2	3	4	5	6	7	
Extremely safely	○	○	○	○	○	○	○	Extremely unsafely

I don't always report safety violations because: (check all that apply)

- ☐ I feel peer pressure to not report
- ☐ I feel pressure from my PI to not report
- ☐ It would reflect poorly on me
- ☐ I don't know to whom I should report or how
- ☐ There may be negative repercussions from reporting a safety violation
- ☐ It would not matter anyway
- ☐ Other (please specify)

When I report a safety problem there is appropriate follow-up.

Strongly Disagree	Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Agree	Strongly Agree	Not applicable
○	○	○	○	○	○	○	○

In the last year how many safety incidents and/or near misses have you witnessed?

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- ◯ None
- ◯ 1 to 2
- ◯ 3 to 5
- ◯ More than 5

Please briefly describe an incident you experienced. (optional)

The following questions concern EH&S. If appropriate, you may substitute EH&S with another Stanford health and safety organization that serves as a primary source of safety contact and information (e.g. University Safety Partners).

How often do you interact directly with EH&S personnel?

- ◯ Daily
- ◯ At least once a week
- ◯ At least once a month
- ◯ Less than once a month
- ◯ A few times a year
- ◯ Less than once a year
- ◯ Never

Please rate your agreement or disagreement with the following statements.

	Strongly Disagree	Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Agree	Strongly Agree	Not applicable
I find my interactions with EH&S personnel very helpful	◯	◯	◯	◯	◯	◯	◯	◯
I feel comfortable reporting safety concerns to EH&S	◯	◯	◯	◯	◯	◯	◯	◯

How often does EH&S visits your lab?

- ◯ Never
- ◯ Less than once a year
- ◯ A few times a year
- ◯ Monthly
- ◯ More than once a month
- ◯ I don't now how often

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Please rate EH&S as an organization.

	1	2	3	4	5	6	7	
Very incompetent	○	○	○	○	○	○	○	Very competent

How familiar are you with the EH&S website?

- ○ Unaware
- ○ Aware but never visited
- ○ Visited once
- ○ Visit regularly

	Strongly Disagree	Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Agree	Strongly Agree	Not applicable
I find the EH&S website very helpful.	○	○	○	○	○	○	○	○

Please tell us how the EH&S website should be changed to make it more helpful. (optional)

Please describe how EH&S can improve. (optional)

Please tell us a little bit about yourself. We will NOT use any of this information to identify you.

In what school do you work? (If more than one, select primary)

- ○ Earth Sciences
- ○ Engineering
- ○ Humanities and Sciences
- ○ School of Medicine
- ○ Would rather not say
- ○ Other (please specify)

What is your role?

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What is your role?

- Graduate student
- Post-doctoral fellow
- Research Associate
- Research Assistant
- Office and administrative staff
- Undergraduate student
- Would rather not say
- Other (please specify)

Do you directly supervise others?

- Yes
- No

How many people do you supervise?

Block 1

How many years have you been at Stanford?

- 0-3 years
- 3-5 years
- 5-10 years
- 10+ years

If you would be willing to answer further questions about safety on campus, please provide your e-mail address: (optional)

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

Attributes of a Positive Research Laboratory Safety Culture at Stanford University

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:

Attribute	Positive Safety Culture *(Principles, Characteristics, Traits)*
Research Group *Organizational Dynamics*	1. 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. 2. Faculty-PI/laboratory manager and laboratory research personnel demonstrate ownership for safety in their day-to-day research activities. 3. Decision-making reflects that safety is a priority over research production and is compatible with good research science. 4. 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. 5. 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. 6. 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*	7. Laboratory members are considerate of others working in the laboratory and maintain a laboratory environment where safety and laboratory housekeeping are very important. 8. Laboratory members openly discuss laboratory safety concerns and prioritization regularly. 9. Laboratory members identify and manage their own safety environment and are receptive and responsive to queries and suggestions about laboratory safety from their laboratory colleagues. 10. Laboratory members conduct their research using protocols and procedures consistent with best safety practices in the laboratory. 11. 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.

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(Appendix E continued)

Attribute	Positive Safety Culture *(Principles, Characteristics, Traits)*
Communication *about safety within the laboratory*	12. Communication about safety within the laboratory 13. The laboratory group ensures that issues potentially impacting safety are identified and appropriately communicated commensurate with their risks and potential consequences. 14. The laboratory supports a continuous learning environment in which opportunities to improve safety are sought, communicated and implemented. 15. The feedback loop on identified safety issues (bottom-up and top down) is closed (addressed) at the faculty-PI/laboratory management level. 16. 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	17. EH&S provides easily accessible laboratory safety information. 18. EH&S staff promotes laboratory safety improvement while trying to reduce the inconvenience to laboratory members. 19. EH&S staff is involved in the early stages of laboratory and experimental design and provides technical consultation and safety support. 20. EH&S supports adaptation and localization of safety procedures by laboratory members so long as they meet the intent of the safety requirements. 21. 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 *towards Safety*	22. Roles, responsibilities, and authorities for safety in academic research laboratories are clearly defined and reinforced. 23. The organization's decisions ensure that safety in academic research is maintained as a priority and supported. 24. The organization ensures that the facilities, infrastructure, programs and other resources needed to ensure safety in academic research conducted at the institution are available. 25. Management acknowledges and rewards exemplar laboratory safety experiences and promotes as examples to other laboratories.

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Appendix F:
Health & Safety Policy at Stanford

Principles, Responsibilities, Practices
October 2012

Principles of Health & Safety

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 and safety laws and regulations.

Stanford University makes all reasonable efforts to:

- Promote occupational and personal safety, health and wellness;
- Protect the health and safety of Stanford University faculty, staff and students;
- Provide information to faculty, staff, and students about health and safety hazards;
- Identify and correct health and safety hazards and encourage faculty, staff, and students to report potential hazards;
- Conduct activities in a manner protective of the environment, and inform the Stanford community regarding environmental impacts associated with institutional operations; and
- Maintain a risk-based emergency management program to reduce the impact of emergency events to the Stanford community.

Responsibilities

Adherence to good health and safety practices and compliance with applicable health and safety regulations are a responsibility of all faculty, staff, and students. Line responsibility for good health and safety practice begins with the supervisor in the workplace, laboratory or classroom and proceeds upward through the levels of management. For detailed guidance on individual safety responsibilities under Cal/OSHA, refer to the University's Illness and Injury Prevention Program (IIPP).

Overview

In academic areas, supervisors include faculty/principal investigators, laboratory directors, class instructors, or others having direct supervisory and/or oversight authority. Academic levels of management are the department chairperson or Independent Lab director, dean, the Dean of Research, and the Provost. Administrative levels of management include managers, directors, and vice presidents. **Final responsibility for health and safety policy and programs rests with the President of the University**.

The **Associate Vice Provost for EH&S** and the University Committee on Health and Safety are responsible for recommending University-wide health and safety policies to the President.

The **Associate Vice Provost for EH&S** is responsible for ensuring overall institutional compliance with applicable policies, statutes, and regulations; monitoring the effectiveness of the safety programs; and providing central health and safety services and support to all areas of the University.

Safety Performance

Each individual at Stanford is expected to perform all work safely. Managers and supervisors shall establish and maintain a system of positive reinforcement and escalated discipline to support good health and safety practices. Safety performance shall be a part of every individual's role and responsibility as well as performance expectation and evaluation.

Providing a Safe Workplace

Stanford's program for providing a safe workplace for faculty, staff and students includes: facility design; hazard identification, workplace inspection and corrective action; shutdown of dangerous activities; medical surveillance: and emergency preparedness.

In addition to this general institutional health and safety policy, additional hazard specific policies and requirements may apply to different work and learning environments at Stanford and will be found in the Research Policy Handbook and at the EH&S Website.

Facility Design

Facilities will be designed in a manner consistent with health and safety regulations and standards of good design. Those University departments charged with primary responsibility for the design, construction, and/or renovation of facilities, together with EH&S shall ensure that there is appropriate health and safety review of facility concepts, designs, and plans.

In case of disagreement between EH&S and the cognizant facilities department, the conflict shall be resolved by the Vice Provost and Dean of Research in consultation with the cognizant vice president or dean and the Provost (or designate). The determination of the Vice Provost and Dean of Research may be stayed by the Associate Vice Provost for EH&S pending a prompt appeal to the President.

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Principles, Policies, and Procedures: Roles and Responsibilities

Role	Responsibilities
Managers	**University managers, academic and administrative, are responsible for ensuring that:** • Individuals under their management have the authority to implement appropriate health & safety policies, practices and programs; • Areas under their management have adequate resources for health & safety programs, practices, and equipment; and, • Areas under their management are in compliance with Stanford University health & safety policies, practices and programs.
Supervisors	**University supervisors, including faculty supervisors and Principal Investigators (PIs), are responsible for protecting the health & safety of employees, students and visitors working under their direction or supervision. This responsibility entails:** • Being current with and implementing Stanford University health & 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	**Faculty, staff and students are responsible for:** • Keeping themselves informed of conditions affecting their health & safety; • Participating in safety training programs as required by Stanford policy and their supervisors and instructors; and, • Adhering to health & 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	**Environmental Health & Safety (EH&S) is responsible for:** • Reviewing legislation, recommending policies, and monitoring compliance with environmental and health & safety statutes and regulations and University health & 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 & 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. *While EH&S is responsible for developing and recommending relevant health & 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.*

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Hazard Identification and Correction

Stanford University encourages employees and students to report health and safety hazards to their supervisors, managers, or EH&S. Employees and students shall not be discriminated against in any manner for bona fide reporting of health and safety hazards to Stanford or to appropriate governmental agencies. Supervisors shall inform students and employees of this policy and encourage reporting of workplace hazards.

Supervisors, both faculty and staff, shall assure that regular, periodic inspections of workplaces are conducted to identify and evaluate workplace hazards and unsafe work practices.

- The frequency of inspections should be proportional to the magnitude of risk posed in the particular workplace.
- Means of correcting discovered hazards and/or protecting individuals from the hazards shall be determined and implemented appropriately.
- Unsafe conditions which cannot be corrected by the supervisor or manager must be reported to the next higher level of management. Any individual, supervisor or manager who becomes aware of a serious concealed danger to the health or safety of individuals shall report this danger promptly to the Department of EH&S and to the faculty, staff and students who may be affected.

Shutdown of Dangerous Activities

The Associate Vice Provost for EH&S has the authority to curtail or shut down any University activity considered to constitute a clear and imminent danger to health or safety. In the event of such curtailment or shutdown, the cognizant dean, director or vice president and the Provost (or designate) shall be immediately notified.

In cases of dispute, an order to curtail or shutdown will remain in effect until the Provost or the Vice Provost and Dean of Research (or their respective designates) determine in writing that the danger has passed or been mitigated or that the order should be rescinded for other reasons.

Should the Associate Vice Provost for EH&S disagree with a determination to restore a curtailed or shutdown activity, the Associate Vice Provost for EH&S may promptly appeal the matter to the President. In the event of an appeal, the order to curtail or shutdown shall be in effect until the President determines otherwise

Medical Surveillance

Stanford University shall evaluate and monitor, through a program of medical surveillance, the health of Stanford University faculty, staff and students who are exposed to certain hazardous materials and situations as defined by law or University policy. Each supervisor is responsible for ensuring that employees and students under their supervision participate in the medical surveillance program as required by University policy. EH&S will monitor medical surveillance program participation. Each University department/school shall administer the program for faculty, staff and students covered by University policy.

Emergency Response Plans

EH&S coordinates overall emergency response planning for the institution and provides guidelines for departmental emergency response plans. Every department shall have an individual emergency response plan and shall develop business continuity and contingency plans and implement appropriate mitigation programs to reduce the impact of emergency events.

Schools and departments shall maintain local departmental emergency operations centers and communications capabilities according to guidelines in the campus emergency plan. Multiple departments located within individual buildings will jointly develop comprehensive building-based life safety response plans.

Emergency plans shall include evacuation and assembly procedures, posted evacuation maps, reporting and communication practices, training, and drills.

Safety Communication and Training

Safety and compliance required training shall be communicated in a manner readily understandable to faculty, staff and students, in accordance with the communication policy outlined below.

Systems of Communication

Managers and supervisors, both faculty and staff, shall establish, implement and maintain a system for communicating with employees and students about health and safety matters. Information should be presented in a manner readily understood by the affected employees and students. Due attention must be paid to levels of literacy and language barriers. Verbal communications should be supplemented with written materials or postings if appropriate. Whenever appropriate, statutes and policies affecting employees and students shall be available in the workplaces.

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Communication about Hazards

Faculty, staff, and students who may come in contact with hazardous substances or practices either in the workplace or in laboratories shall be provided information concerning the particular hazards which may be posed, and the methods by which they may deal with such hazards in a safe and healthful manner. In areas where hazardous chemicals or physical agents are used, handled, or stored, communication about these hazards shall conform to the Research Policy Handbook EH&S Requirements for laboratory facilities and the Hazard Communication Program for all other campus workplaces.

Training

Supervisors, including faculty, shall be experienced, trained or knowledgeable in the safety and health hazards to which employees and students under their immediate direction and control may be exposed, and shall be knowledgeable of current practices and safety requirements in their field.

Faculty, staff and students shall have or be provided the knowledge to protect themselves from hazards in their working and learning environment. Supervisors, both faculty and staff, shall ensure that employees and students have received appropriate training and information regarding:

- General health and safety practices of the workplace or laboratory, including emergency procedures;
- Job-specific health and safety practices and hazards;
- Recognition and assessment of health and safety risks; and,
- How to minimize risks through sound safety practices and use of protective equipment; and,
- Awareness of appropriate practices to protect the environment.

Training shall occur when:

- An employee is hired or student is new to the laboratory;
- An employee or student is given a new assignment for which training has not previously been received; and
- New hazards are introduced by new substances, processes or equipment.

Faculty, staff and students should, periodically, be retrained or demonstrate an understanding of current standard safety practices and requirements for their areas.

Documentation and Recordkeeping

Documentation and records as required by regulation shall be kept to demonstrate compliance with applicable statutes, regulations and policies. Requirements and procedures for such recordkeeping can be found in the Research Policy Handbook and at the EH&S Website.

APPROVALS

REVISIONS

Revision v2.0 Approved and Adopted by Stanford University President (October 2012)
Revision v2.0 Recommended by University Committee on Health and Safety (June 2012)
Original Approved and Adopted by Stanford University Cabinet (April 1991)

Health and Safety Policy at Stanford: Principles, Responsibilities and Practices was developed by Environmental Health and Safety (EH&S) at Stanford University with input and feedback from the campus community. Please direct all questions and comments to EH&S (650) 723-0448 http://ehs.stanford.edu.

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