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Safe Science: Promoting a Culture of Safety in Academic Chemical Research

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Celebrating 50 Years 1964-2014

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Study Sponsors

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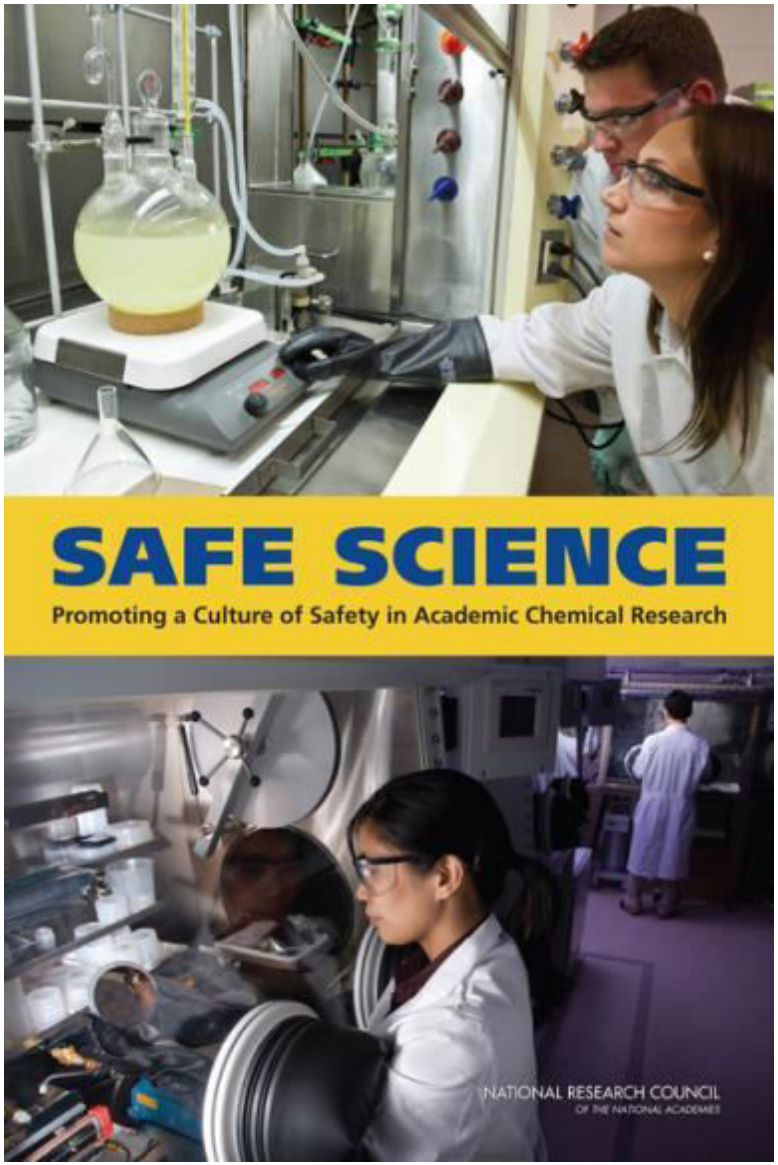
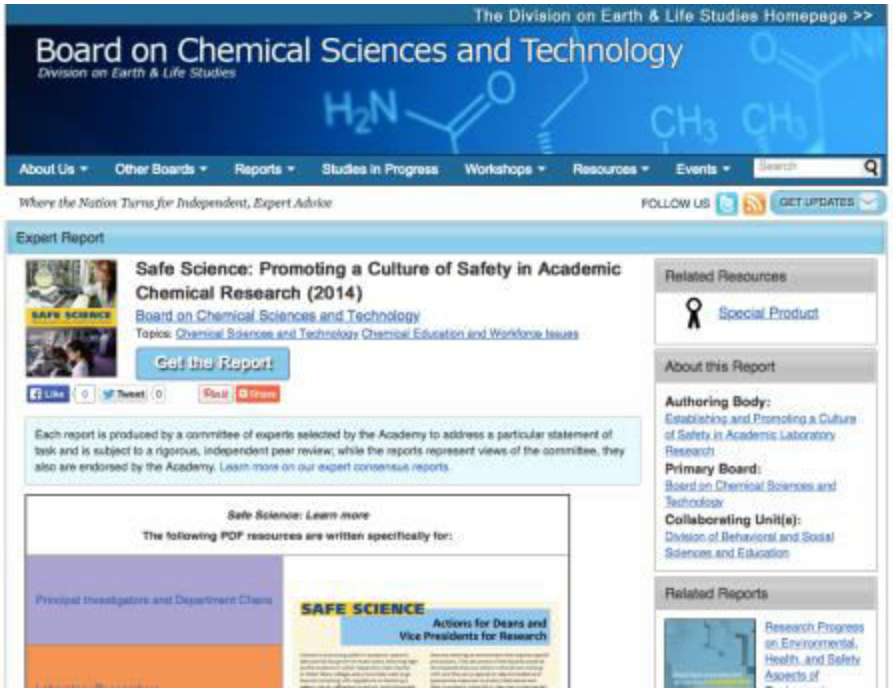
Full Report Available



Download PDF and other materials at:

http://dels.nas.edu/safescience



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History

U.S. National Academy of Sciences Charter (1863)

"And be it further enacted, That…the Academy shall, whenever called upon by any department of the Government, investigate, examine, experiment, and report upon any subject of science or art, the actual expense of such investigations, examinations, experiments, and reports to be paid from [funds] which may be made for the purpose."

- Unbiased, authoritative advice
- Evidence-based recommendations
- Committees composed to avoid conflicts of interest
- Neutral venue for open dialogue and discussion
- Honorific organization

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Motivation for the Study

- Rise in the incidence of serious and sometimes fatal accidents in university chemistry research laboratories, particularly over the past two decades
    - Notable incidents
        - Dartmouth University – 1996
        - UCLA – 2008
        - Texas Tech University – 2010
        - University of Hawaii – 2016
- Serious accidents in research labs are not limited to academia
- These incidents have evoked a broad range of institutional responses
- *Deficient safety culture identified as a primary cause*

Process for the Study

The National Academy of Sciences is an independent, nonprofit organization that works outside of government to provide unbiased and authoritative advice to decision makers and the public.

Goals for the Study

- Examine laboratory safety in **chemical research in non-industrial settings**.
- Compare practices and attitudes in these settings with knowledge about promoting safe practices from the **behavioral science** literature.
- Describe, identify the strengths and shortcomings of, and provide guidance on, the roles of the current **hierarchy of actors** responsible for laboratory safety in U.S. education.
- Examine knowledge from the behavioral sciences and experience with **safety systems from other sectors** (such as industrial research facilities, nuclear energy, aviation, and health care) for key attributes of successful safety systems and cultures.
- Provide guidance on **systems and tools** that might be established, maintained, and utilized to raise the overall safety performance.

Study Committee & Staff: Broad Engagement

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What is Safety Culture?

- Refers to an organization's shared values, assumptions, and beliefs specific to workplace safety or, more simply, the importance of safety within the organization **relative to other priorities**.
- Arises not because of a set of rules, but because of a **commitment to safety throughout an organization**
- Supports the free exchange of safety information, emphasizes learning and improvement, and assigns greater importance to identifying and solving problems rather than placing blame
- **High importance is assigned to safety all the time**

WHAT IS SAFETY CULTURE?

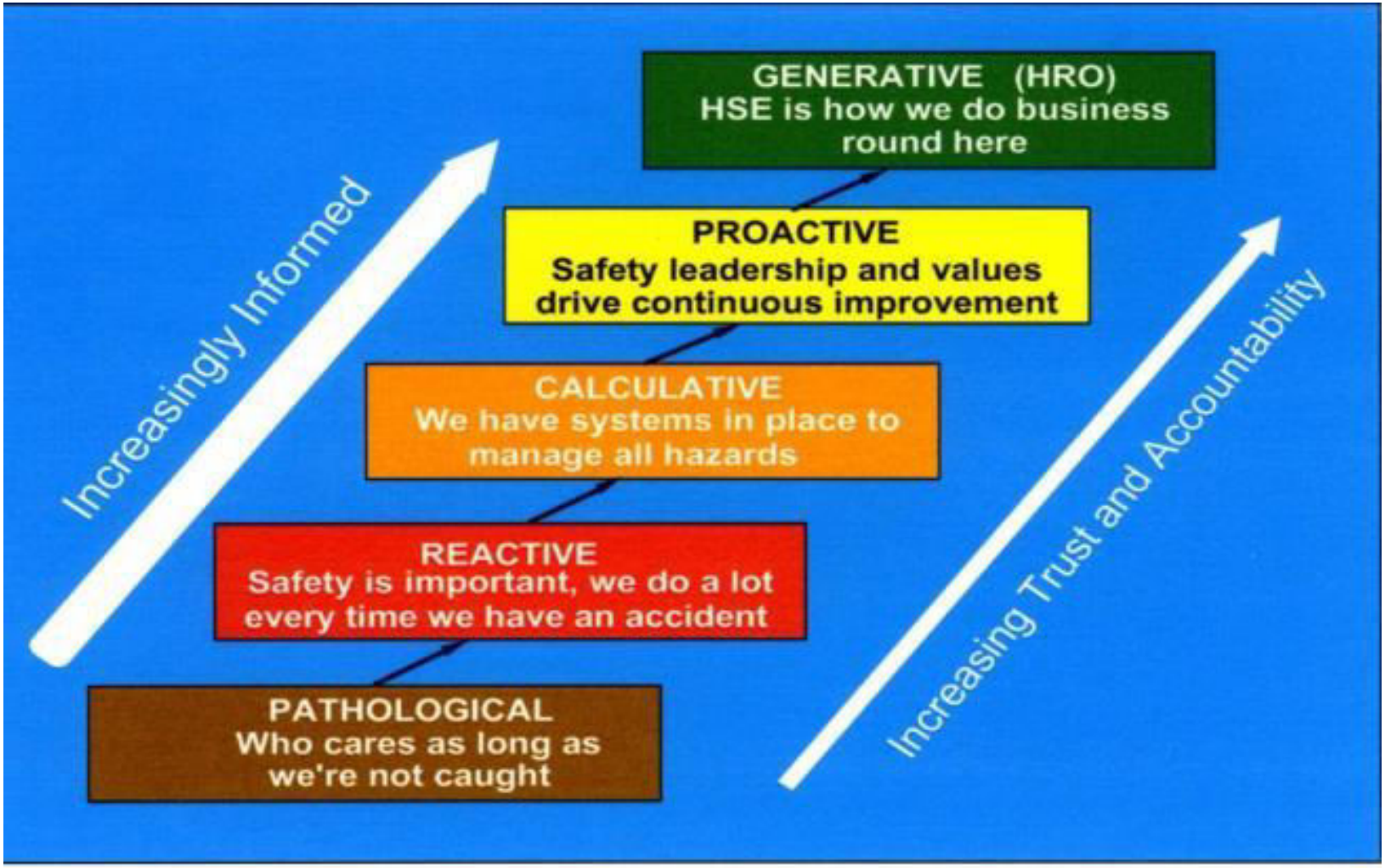
Safety culture refers to an organization's shared values, assumptions, and beliefs specific to workplace safety—or more simply, the relative importance of safety within the organization.

A strong, positive safety culture is not a culture of compliance. A strong safety culture arises not because of a set of rules but because of a constant commitment to safety throughout an organization. A positive safety culture supports the free exchange of safety information and assigns greater importance to solving problems than to placing blame. High importance is assigned to safety at all times, not just when it is convenient or does not threaten personal or institutional productivity goals.

Primary Data-Gathering

- **Committee Knowledge & Experience**
  - An unprecedented and unique group of experts
    - University academic leadership and safety and health administrators, highly distinguished chemistry faculty members, and experts in the field of safety culture and human–systems integration
- **Committee Meeting Information Gathering**
  - May, 2013 at the National Academies; approximately 30 participants
  - June, 2013 in Berkeley, CA; approximately 30 participants
    - Included a site-visit to UC Berkeley Laboratories
  - August, 2013 in Boston, MA; approximately 35 participants
  - ➢ During open sessions committee heard from a wide range of stakeholders
- **Community input through study website**
- **Literature on safety culture in other industries**
  - Developing benchmarks from specific examples
- **Additional data-gathering (highlighted works)**
  - *Creating Safety Cultures in Academic Institutions* (ACS, 2012)
  - *Prudent Practices in the Laboratory* (NRC, 2011)
  - *Texas Tech University Laboratory Explosion: Case Study*

Culture Topology – Focused on Safety



Hudson, 2007; Parker et al., 2006

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Findings, Conclusions, and Recommendations

FOCUS ON CHEMICAL RESEARCH IN FOUR CORE CATEGORIES

- **A) Institution-Wide Dynamics and Resources**
  - A strong, positive safety culture is a core element in the responsible conduct of research.
- **B) Research Group Dynamics**
  - The deeply rooted hierarchy and highly competitive nature of academic research can inhibit the advancement of a strong, positive safety culture.
- **C) Data, Hazard Identification, and Analysis**
  - Leading indicators from hazard analysis, risk mitigation, and best practices are not being widely used in laboratory safety planning.
- **D) Training and Learning**
  - Laboratory safety training is highly variable across institutions, departments, and research groups.

A) Institution-Wide Dynamics and Resources

FINDINGS AND CONCLUSIONS

- [F1] Safety is emerging as a priority and a core value of many academic institutions and of individual laboratories. **A strong, positive safety culture is more beneficial than a compliance-only culture.**
- [F2] A strong, positive safety culture is a core element in the **responsible conduct of research**.
- [C1] If laboratory safety is an unquestioned core value and operational priority for the institution, then **safety will never be traded for research productivity**.
- [F3] The **availability and commitment** of university resources to laboratory safety varies across institutions.
- [F4] Universities often do not provide **sufficient incentives** to promote a strong, positive safety culture. In some cases, they may create barriers or disincentives.
- [C2] University policies and resource allocations have a **strong impact** on a department's ability and willingness to provide for a strong, positive safety culture. If an institution or individual laboratory wants to develop and sustain a safe and successful research program, then it needs to consider the resources it has available for safety and explore research options and requirements accordingly.

A) Institution-Wide Dynamics and Resources

RECOMMENDATIONS

- **Recommendation 1:** The president and other institutional leaders must demonstrate that safety is a **core value** of the institution and show an ongoing commitment to it.
- **Recommendation 2:** The provost or chief academic officer, in collaboration with faculty governance, should incorporate fostering a strong, positive safety culture as an element in the **criteria for promotion, tenure, and salary decisions for faculty.**
- **Recommendation 3:** All institutions face the challenge of limited resources. Within this constraint, institutional head(s) of research and department chairs should consider the **resources they have available for safety** when designing programs, and identify types of **research that can be done safely** with available and projected resources/infrastructure.
- **Recommendation 4:** University presidents and chancellors should **establish policy and deploy resources** to maximize a strong, positive safety culture. Each institution should have a comprehensive **risk management plan** for laboratory safety that addresses prevention, mitigation, and emergency response. Leaders should develop risk management plans with input from faculty, students, environmental health and safety staff, and administrative stakeholders and ensure that other university leaders, including provosts, vice presidents for research, deans, administrative officers, and department chairs, do so as well.

B) Research Group Dynamics

FINDINGS

- [F6] There is **variability across academia** with regard to the involvement of researchers at all levels in establishing and sustaining a strong, positive laboratory safety culture.
- [F7] The **deeply rooted hierarchy and highly competitive nature** of academic research can inhibit the advancement of a strong, positive safety culture.
- [F8] Students and postdocs are **dependent on the principal investigator** for their professional advancement. The power differential in this relationship may affect group members' willingness to raise safety concerns.
- [F9] Most researchers in academia are still in the **early phases of their professional development**. As such, they may not have the requisite knowledge and skills to recognize and understand the risks associated with their work.
- [F10] Research is regularly performed independently (including during off-hours and alone) and may be carried out with **limited or no oversight or feedback**.

B) Research Group Dynamics

CONCLUSIONS

- [C3] Contribution and engagement by both principal investigators and by researchers through an **open and ongoing dialogue** are critical to creating a strong, positive safety culture. Safety culture is more likely to be sustained when safety issues are **discussed broadly and frequently** as an integral part of the research training and development process.
- [C4] There are several key attributes related to research group dynamics that contribute to the advancement of the laboratory safety culture. A strong, positive safety culture:
  - includes **open communication** about safety as a key element that is sought out, valued, and acted upon;
  - values **learning and continuous improvement** with respect to safety;
  - includes **regular safety communication**, such as "safety moments" in academic research events (e.g., seminars, group meetings, doctoral defenses, and teaching);
  - **empowers student and research trainees** to have a "voice" and maintain an environment that encourages raising safety concerns freely without fear of repercussions.
- [C5] A research group with a strong, positive safety culture **engages with environmental health and safety personnel collaboratively**.

B) Research Group Dynamics

RECOMMENDATIONS

- **Recommendation 5:** Department chairs and principal investigators should make greater use of **teams, groups, and other engagement strategies** and institutional support organizations (e.g., environmental health and safety, facilities), to establish and promote a strong, positive, safety culture.

- **Recommendation 6:** Department chairs should provide a mechanism for creating a **robust safety collaboration** between researchers, principal investigators, and environmental health and safety personnel.

C) Data, Hazard Identification and Analysis

FINDINGS AND CONCLUSIONS

- [F11] **Leading indicators** from hazard analysis, risk mitigation, and best practices are not being widely used in laboratory safety planning. Often these data are **not being collected** for academic and non-industrial laboratories.
- [F12] **Incident and near-miss data** are important sources of information for driving improved safety performance and for monitoring progress. Such key data are often **repressed or distorted** when there is a punitive approach in response to incidents.
- [C6] **Information is a key** input to establishing and promoting a strong, positive safety culture. Incident and near-miss reports are important learning tools for laboratory safety, but presently are not effectively reported, compiled, analyzed, and disseminated within the research community. To ensure that useful data are available, a change in reporting and the availability and sharing of information is necessary.
- [F14] **Hazard analysis is not routinely incorporated into experimental designs**, procedures, and records in academia.
- [C7] Routine hazard analysis is a **critical component** in research planning and execution. It represents an element of a strong, positive safety culture. **Comprehensive hazard analysis** and use of engineering controls are especially important for experiments that are new to the individual and/or are being scaled-up.

C) Data, Hazard Identification and Analysis

RECOMMENDATIONS

- **Recommendation 7:** Organizations should incorporate **non-punitive incident and near-miss reporting** as part of their safety cultures. The American Chemical Society, Association of American Universities, Association of Public and Land-grant Universities, and American Council on Education should work together to establish and maintain an anonymous reporting system, building on industry efforts, for centralizing the collection of information about and lessons learned from incidents and near misses in academic laboratories, and **linking these data to the scientific literature**. Department chairs and university leadership should incorporate the use of this system into their safety planning. Principal investigators should **require** their students to utilize this system.
- **Recommendation 8:** The researcher and principal investigator should **incorporate hazard analysis into laboratory notebooks** prior to experiments, integrate hazard analysis into the research process, and ensure that it is specific to the laboratory and research topic area.

D) Training and Learning

FINDINGS AND CONCLUSIONS

- [F15] Laboratory safety training is **highly variable** across institutions, departments, and research groups.
- [C8] A **high-quality** training program is an important element of a strong, positive safety culture.
- [F16] There is a **lack of comprehensive, early, and individual-laboratory-centric training** and education for researchers, principal investigators, and in some cases, environmental health and safety staff. Many researchers arrive at a new institution or in a new laboratory without proper training or appreciation for appropriate safe laboratory practice.
- [C9] Classroom and online training is **necessary but not sufficient** to ensure knowledge, skills, qualifications, and abilities to perform safely in a laboratory environment and to establish a strong, positive safety culture.

D) Training and Learning

RECOMMENDATIONS

- **Recommendation 9**: Department leaders and principal investigators, in partnership with environmental health and safety personnel, should develop and implement actions and activities to complement **initial, ongoing, and periodic refresher training.** This training should ensure understanding and the ability to execute proper protective measures to mitigate potential hazards and associated risks.

Recommendations Recap

WHAT CAN YOU DO?

1. Institution leaders must **actively demonstrate** that safety is a core value.
2. Leaders should **include fostering a positive safety culture** in criteria for faculty promotion, tenure, and salary decisions.
3. Leaders should **consider what research can be done safely,** given resources available.
4. Institutions should **have comprehensive risk-management plans** for lab safety.
5. Department chairs and principal investigators (PIs) should **use engagement strategies and institutional support** to promote a strong safety culture.
6. Department chairs should **promote robust safety collaborations** among PIs, researchers, and safety professionals.
7. ACS and other organizations should **establish and maintain** an incident and near-miss reporting system.
8. Researchers should **incorporate hazard analysis** into lab notebooks and research processes.
9. Department chairs and PIs should **develop lab-centric activities** to complement other safety training.

Paraphrasing of recommendations used from Chemical and Engineering News (**2014**), *92*, 7.

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In Summary, a Strong Safety Culture will:

- ensure that all researchers that set foot in an academic laboratory, from inexperienced students to senior principal investigators, understand that a research environment requires special precautions;
- ensure that researchers are aware of the hazards posed by the materials with which they and other labs are working;
- guarantees that researchers are prepared to take rapid and appropriate measures to protect themselves and co-workers, particularly in the case of unexpected events;
- place the highest priority on best practices and encourage researchers to raise concerns about potential safety problems;
- exhibit the following characteristics:

  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) promotion and communication of safety and last, but not least,
  7) provide institutional support for funding safety

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http://dels.nas.edu/safescience

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