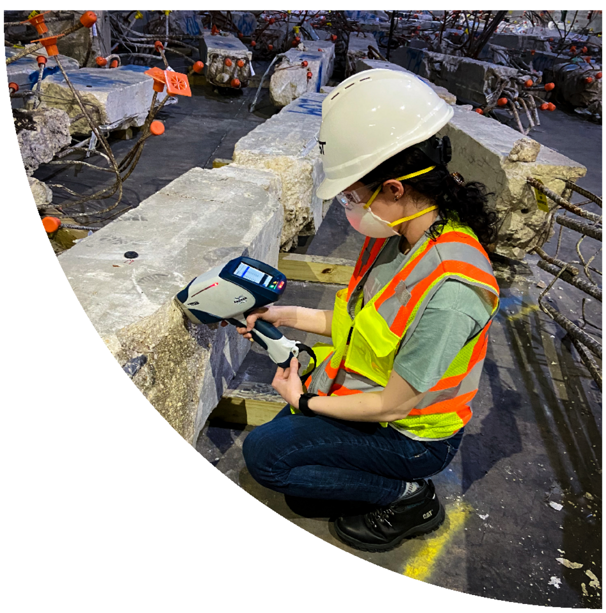
NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY
U.S. DEPARTMENT OF COMMERCE

NIST Safety Commission Report

AUGUST 2023



Disclaimer

The opinions, findings, and recommendations in this report reflect the views of the NIST Safety Commission, an advisory body established in accordance with the Federal Advisory Committee Act, 5 U.S.C. § 1001 et seq. Commission members serve in their personal capacities. The views expressed in this report do not necessarily represent the views of the National Institute of Standards and Technology, the United States Department of Commerce, or the organizations that employ the Commission members.

Contents

List of Acronyms

ACOEM	American College of Occupational and Environmental Medicine
ADFO	Alternate Designated Federal Officer
ADMR	Associate Director for Management Resources
ANS	American Nuclear Society
ANSI	American National Standards Institute
ASSP	American Society of Safety Professionals
CAFDIS	Concerted Action in the Fight Against Doping in Sport
CASPER	Coalition for Anabolic Steroid Precursor and Ephedra Regulation
CF	Causal Factor
CSO	Chief Safety Officer
CSP	Certified Safety Professional
DART	Days Away, Restricted, or Transferred
DFO	Designated Federal Officer
DOE	U.S. Department of Energy
EH&S	Environmental, Health and Safety
EL	Engineering Laboratory
ERM	Enterprise Risk Management
FACA	Federal Advisory Committee Act
FACOEM	Fellow, American College of Occupational and Environmental Medicine
GSHED	Gaithersburg Safety, Health and Environment Division
HR	Hazard Review and Approval System
IRIS	Incident Reporting and Investigation System
ISO	International Organization for Standardization
IT	Information Technology
KSAs	Knowledge, Skills, and Abilities
LTIFR	Lost Time Incident Frequency Rate
MOP	Management Observation Process
NCNR	NIST Center for Neutron Research
NFRL	National Fire Research Laboratory
NHTSA	National Highway Traffic Safety Administration
NIOSH	National Institute for Occupational Safety and Health
NIST	National Institute of Standards and Technology
NRC	U.S. Nuclear Regulatory Commission
NSC	National Safety Council
NTIS	National Technical Information Service
NTSB	National Transportation Safety Board
OEM	Occupational and Environmental Medicine
OGE	U.S. Office of Government Ethics
OMB	Office of Management and Budget
OSHA	Occupational Safety and Health Administration
OSHE	Office of Safety, Health, and Environment
OU	Organizational Unit
PPE	Personal Protective Equipment
R&D	Research and Development
RC	Root Cause
RGE	Regular Government Employee
RHI	Relative Hazard Index
SGE	Special Government Employee
SME	Subject Matter Expert
SMS	Safety Management System
STEM	Science, Technology, Engineering, and Math
TRIR	Total Recordable Incident Rate
U.S.C.	United States Code
UC	University of California
UCLA	University of California, Los Angeles
VA	U.S. Department of Veterans Affairs
WIP	Workplace Inspection Program

Executive Summary

The National Institute of Standards and Technology (NIST) Safety Commission was created in response to two serious incidents at NIST laboratories. On February 3–4, 2021, at the NIST Center for Neutron Research,[1] an unplanned shutdown was followed by an aborted confinement re-entry. On September 26, 2022, at the National Fire Research Laboratory,[2] a suspended portion of an elevated concrete structure undergoing demolition collapsed, resulting in the death of an engineering technician. In December 2022, Dr. Laurie Locascio, NIST Director, established the Commission to examine all aspects of safety and make recommendations as to how NIST can substantively improve research safety.

A NIST SAFETY COMMISSION MEETING ON THE GAITHERSBURG, MARYLAND, CAMPUS

Safety Culture

The Commission found that NIST has not established an organizational culture that values safety (i.e., a "safety culture") at a level commensurate with the quality of its research. NIST does not prioritize safety sufficiently, whether in messaging, planning, training, or day-to-day operations.

Regarding the latter, NIST leaders make small decisions every day, including decisions between competing priorities (e.g., safety vs. productivity), and these decisions create an overall perception among the employees about safety's relative importance. In interviews with Commission members, NIST employees indicated that safety does not take precedence. For example, interviewees stated that they often felt pressure, when conducting hazard reviews, to derive a relative hazard index (RHI) score of no greater than 2, as a higher score would entail additional work and require additional approvals.

The outcomes of this weak safety culture are highlighted in the results of a safety culture survey, which the National Safety Council administered in Fiscal Year 2023. NIST scored under the 60th percentile in several categories, indicating significant room for improvement on multiple dimensions. Overall, proactive creation and observation of rigorous procedures to provide the best possible safety practices are often sidestepped in favor of mere compliance with the regulatory minimum, and sometimes even that minimum is not attained. The opinion of all of the staff from the NIST Office of Safety, Health, and Environment (OSHE) who were interviewed was that the safety culture at NIST was poor. Many expressed extreme frustration and indicated that they were considering looking for positions elsewhere.

Similarly, interviewees notified the Commission about the poor state of NIST buildings, services, and utilities. Chronic underfunding of the NIST facilities and maintenance budget has created unsafe work conditions and further fueled the impression among researchers that safety is not a priority, as they often feel compelled to undertake unauthorized workarounds to enable their work to be completed. In addition, facility and infrastructure deficiencies increase risk directly (e.g., through physical workplace hazards) and indirectly (through adoption of unauthorized workarounds).

Safety Management System and Enterprise Risk Management

The infrastructure issues are partly the result of an inadequate safety management system (SMS), specifically the lack of a systems- and risk-based enterprise risk management (ERM) program. The NIST ERM program is passive, with no directive to perform

1 NIST, "NIST Center for Neutron Research," April 7, 2020 (updated February 10, 2023), https://www.nist.gov/ncnr.

2 NIST, "National Fire Research Laboratory," n.d., https://www.nist.gov/el/fire-research-division-73300/national-fire-research-laboratory-73306.

proactive risk assessments and with narrow evaluations of risk; minimal attention is paid to employee safety. Absence of a sound and comprehensive ERM program deprived NIST of a holistic framework to identify and prepare for organizational safety risks, with appropriate mitigation plans in place. Leadership did not have information that enabled prudent, well-informed decision-making to address both safety and infrastructure needs more effectively.

The NIST SMS has other significant issues. A well-functioning SMS organization gathers information from a variety of sources, both passively (through reported data) and actively, systematically, and proactively (through observations and audits). The SMS then analyzes the information to produce solid recommendations and actions that advise top management in the discharge of their duties. These elements are evaluated in a continuous feedback cycle so as to achieve an acceptable level of residual risk, as defined by NIST. At this time, the NIST SMS structure possesses no such comprehensive feedback loop or functional quality assurance system and is incomplete.

In the current NIST organizational structure, the steward of the SMS is OSHE, run by the Chief Safety Officer (CSO). However, OSHE has little impact on NIST decision-making, diminishing the safety perspective. For example, the Office currently has no direct authority to lead hazard reviews and thus has limited "stop work" authority. This shortcoming is due, in part, to the Office's limited interaction with, and thus ability to advise, the NIST Director—which, in turn, signals that safety does not need to be considered at the top level (undermining development of a positive safety culture). To enhance safety's role and help signal its prioritization, OSHE must be given real authority and should report directly to the NIST Director (see figure below). In addition, the CSO should be a permanent voting member of the ERM Council.

Another factor contributing to NIST SMS deficiency is their inaccurate use of, and therefore unjustified confidence in, their hazard risk assessment process. The risk matrix used in this process has the dimension of "likelihood of occurrence" but does not specify a time period within this dimension. As risk is a probabilistic term, this lack of a time or frequency metric makes a standardized determination of risk impossible, and the resulting inconsistency obfuscates communication about and assessment of risk, and derivation of RHI.

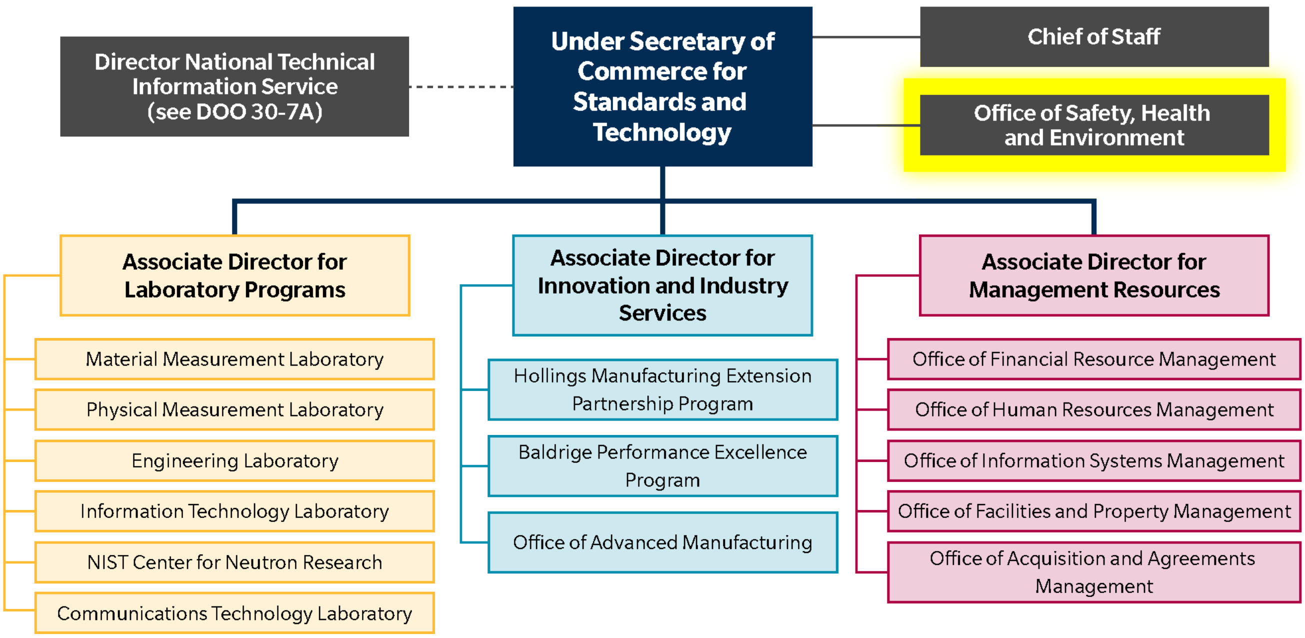


FIGURE ES-1. SUGGESTED NIST ORGANIZATIONAL CHART. *graphic credit: NIST 2020.*

The SMS is also subject to challenges due to underlying information technology systems that are difficult to use and not integrated, either with each other or with other important safety-related databases (such as the chemical inventory).

Furthermore, an effective SMS requires a comprehensive audit or quality assurance mechanism to provide accurate information on whether corrective actions are successfully implemented and effective. NIST demonstrates a longstanding absence of comprehensive feedback loops that are needed to build and assess all aspects of safety programs, providing timely insight to all levels of the organization. There was a plan to begin full audits in 2024, but these audits were to be the last step in setting up the SMS. This strategy is far from ideal and, in addition, represents a failure of NIST to implement strong recommendations to do so made by the Blue Ribbon Commission review in 2010; the safety audit and assessment process should be ongoing, coupled with new safety policies, procedures, and programs to ensure their efficacy.

Finally, the follow-up to safety incidents, once they have taken place, is flawed. Of greatest concern is investigation and determination of causality, as NIST personnel usually do not demonstrate an understanding of what constitutes a root cause and how that differs from a proximate cause. Without that distinction, NIST staff do not achieve a full understanding of circumstances and contributing factors, and so solutions do not address the underlying problems. Corrective actions that address root causes and their contributing factors are stronger and have been shown to result in a greater likelihood of preventing future incidents and harm than corrective actions based solely on proximate causes.

Conclusions

NIST's approach to safety is incomplete and superficial. Numerous aspects of the SMS are fragmented, inoperative, or missing; effective use of safety professionals is limited; and leadership has not prioritized safety as a valued component of quality research. The status quo creates and reinforces a reactive, backward-looking, compliance-type approach that is antithetical to the development and maintenance of a healthy safety culture.

NIST has been on a safety improvement journey for some time, dating back to the Blue Ribbon Commission reports in 2008 and 2010, in addition to issues identified in more recent safety culture surveys. This journey should have resulted in better outcomes than it has to date, indicating that NIST must commit significant effort and resources in order for this Commission's work and recommendations to take hold.

The Commission has identified 17 recommendations (listed below) to address these concerns; the full report provides details on the Commission's findings. If NIST implements concrete and decisive action plans based on these findings and recommendations, the organization will be on the path to becoming a more effective research and development organization, with a robust SMS and a strong commitment to safety. If concrete actions are not taken, meaningful improvements are unlikely.

Summary of Recommendations of the NIST Safety Commission

Organization and Leadership

1 **RECOMMENDATION:** Revise the reporting structure such that the Office of Safety, Health, and Environment (OSHE) and all related environmental, health and safety (EH&S) functions report directly to the NIST Director. Further, the Chief Safety Officer (CSO) should be a voting member of the Enterprise Risk Management (ERM) Council. Moreover, the NIST Director should make any other organizational changes needed to ensure the success of these specific recommendations.

Safety Management Systems and Safety Processes

2 **RECOMMENDATION:** Establish and implement a safety audit system into the Safety Management System (SMS) that proactively identifies hazards and their associated risks, provides quality-assurance-based feedback on performance of corrective actions and activities, and is compatible and consistent with the intention of a high-quality SMS as exemplified by the standards set by ISO 45001 or ANSI Z10.

3 **RECOMMENDATION:** Improve the Hazard Review and Approval System (HR) and Relative Hazard Index (RHI) process, to include quantifiable likelihood definitions based on specified timeframes, validation/verification of user proficiency, and requirements for a reviewing role by OSHE.

4 **RECOMMENDATION:** Develop more relevant safety training and more effective methods of delivery, addressing specific safety concerns of researchers and staff that are generated to provide targeted and actionable information.

5 **RECOMMENDATION:** Revise the Workplace Inspection Program such that inspection teams include both subject matter experts and OSHE staff, inspection teams have authority to mandate changes, inspections look beyond compliance issues to work practices and research hazards, and inspection findings are corrected and verified in a timely manner.

6 **RECOMMENDATION:** Improve the Incident Reporting and Investigation Program to enable effective incident reporting functionality, usage, prioritization, response, and communication. Improve the Incident Reporting and Investigation Program to enable effective incident investigations with regard to explicit risk-based prioritization of what is investigated, who leads the investigation, and how incidents are investigated; identification of true root causes (not just identification of superficial proximate causes); formulation of recommendations and actions that clearly address root causes (not just proximate causes); identification of contributing factors to mitigate risks; timeliness of investigations; and follow-through on completion and effectiveness of recommended corrective actions.

7 **RECOMMENDATION:** Conduct a comprehensive review and audit of all safety-related information technology (IT) systems, and based upon that review, make the necessary changes/fixes to ensure seamless integration and interoperability of safety information across all safety system IT tools. In addition, establish an advisory panel of safety stakeholders to periodically review effectiveness of these systems, and empower the panel to make recommendations for continual improvement.

Safety Culture

8 **RECOMMENDATION:** Improve the ERM program, and its current standard of processes and practices, to better address critical research safety matters. For example, enterprise-wide audits/scans of safety issues should be conducted; and the process of adding items to the Risk Inventory, which informs strategic decisions by NIST leadership, should be more timely and efficient.

9 **RECOMMENDATION:** Make appropriate administrative, policy, and organizational changes to establish and promote an enterprise-wide sense of responsibility and ownership for safety, by 1) increasing the role of OSHE in Organizational Unit (OU) safety operations, 2) holding all employees accountable for their safety roles, awareness, and performance, and 3) eliminating differences between federal employees and associates regarding their safety roles and responsibilities.

10 **RECOMMENDATION:** Take visible and proactive measures to inculcate essential elements of a robust safety culture, with NIST leadership promoting an engaged and informed learning culture involving all NIST personnel.

11 **RECOMMENDATION:** Analyze results from the 2023 National Safety Council's "Safety Culture Survey," along with previous safety culture surveys, to develop a robust safety culture improvement plan.

Facilities and Infrastructure

12 **RECOMMENDATION:** Implement an overall capital investment and infrastructure improvement plan, as many buildings and facilities need significant renovations or replacement to address both research and safety issues. Safety issues alone should justify funding and guide all designs and implementations.

Engagement and Implementation

13 **RECOMMENDATION:** Meet with the NIST Safety Commission approximately 90 days after delivery of the final NIST Safety Commission report to allow discussions ensuring that the plans, actions, and associated schedules for NIST's implementation are consistent with the Commission's intent as set by these recommendations. This timeframe is before the termination of the Commission on November 30, 2023, as set forth by the Charter.

14 **RECOMMENDATION:** NIST should obtain outside advice/expertise/oversight from external experts on its SMS and plans, actions, and associated schedules for implementation, as those are generated in response to the recommendations in the final NIST Safety Commission report.

15 **RECOMMENDATION:** Design and implement changes to the SMS, with a long-term vision to be a world-class model for research safety, in keeping with NIST's role as the world leader in metrics and standards.

Final National Fire Research Laboratory Incident Investigation Report

16 **RECOMMENDATION:** NIST needs to further develop the proximate causes they have already identified and go back into the causal chain to arrive at organizational and systemic-level root causes and contributing factors.

17 **RECOMMENDATION:** Upon reaching the root causes mentioned in Recommendation 16, NIST should derive corrective actions that address those deeper elements of the causal chain, focusing on systemic mitigations for actions taken at the organizational level.

CHAPTER 1

Overview of NIST Safety Commission

The National Institute of Standards and Technology (NIST) Safety Commission was created in response to two serious incidents at NIST laboratories. The first incident took place February 3–4, 2021, at the NIST Center for Neutron Research.[3] An unplanned shutdown was followed by an aborted confinement re-entry. The incident created serious risks and resulted in the shutdown of the beam line, as well as all the research projects that used the neutron beam facility, for more than two years. The second incident took place on September 26, 2022, at the National Fire Research Laboratory.[4] An elevated concrete structure undergoing demolition collapsed, and an engineering technician fell from the structure and died.

Thus, the NIST Safety Commission was formed in late 2022 to examine all aspects of safety and make recommendations as to how NIST can substantively improve research safety. Specifically, the Under Secretary of Commerce and Director of NIST, Dr. Laurie Locascio, established the Commission using authority granted under the Federal Advisory Committee Act. The Safety Commission is directly analogous to the 2008 NIST Blue Ribbon Commission,[5] which was formed in response to a serious plutonium spill incident in a research laboratory.

The NIST Safety Commission consisted of seven appointed members (see Appendix F). The seven members represent a broad spectrum of expertise, with experience in occupational and environmental medicine, occupational safety, patient safety, research safety, accident investigations, industrial and environmental engineering, organizational behavior, and laboratory management. Under the requirements of the Federal Advisory Committee Act rules, Dr. S. Shyam Sunder, NIST Director of the Special Programs Office and Chief Data Officer, served as the Designated Federal Official to assist the Commission in its mission. He supported the Commission in every way, from organizing meetings and visits to gathering documents and answering technical questions.

NIST SAFETY COMMISSION MEETINGS IN JANUARY 2023, GAITHERSBURG CAMPUS

On January 3–4, 2023, the NIST Safety Commission held its first meeting at NIST headquarters in Gaithersburg, Maryland. During the meeting, Dr. Laurie Locascio, the Director of NIST, charged the Commission to:

> *Assess the state of NIST's safety culture and how effectively the existing safety protocols and policies have been implemented across NIST.*

She asked the Commission to evaluate:

- The quality and completeness of NIST safety directives and programs
- The performance of safety protocols and the responses to recent incidents and near-misses
- The impacts of the pandemic and hybrid work environment on safety

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3 NIST, "NIST Center for Neutron Research," April 7, 2020 (updated February 10, 2023), https://www.nist.gov/ncnr.

4 NIST, "National Fire Research Laboratory," n.d., https://www.nist.gov/el/fire-research-division-73300/national-fire-research-laboratory-73306.

5 NIST Office of the Director, "NIST Blue Ribbon Commission on Management and Safety," June 1, 2009 (updated March 20, 2017), https://www.nist.gov/director/nist-blue-ribbon-commission-management-and-safety.

She also asked the Commission to consider:

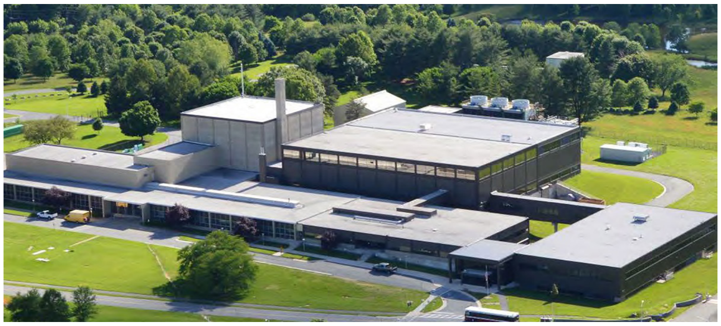
- Perspectives of NIST staff and management
- NIST's responses to significant safety-related incidents and near-misses
- Findings from investigations and reviews of incidents
- Implementation of corrective actions to prevent future incidents and improve safety performance, as well as actions taken to strengthen safety culture at NIST facilities

NIST provided access to a wide scope of information surrounding safety. There were three in-person meetings of the full Commission at NIST sites:

- January 3–4 in Gaithersburg, Maryland
- March 9–10 in Boulder, Colorado
- May 22, 2023, in Gaithersburg, Maryland

NIST NATIONAL FIRE RESEARCH LABORATORY

These meetings included formal presentations and discussions with NIST leadership, as well as discussions with research scientists, staff personnel, and associates. Roundtable forums enabled frank discussions on a range of safety-related topics, including safety protocols, personnel actions, challenges faced by associates, leadership engagement, and funding challenges. Tours of active research laboratories during the site visits enabled observations of work conditions and spontaneous



NIST CENTER FOR NEUTRON RESEARCH

conversations with research staff about safety. In addition, there were several in-person and virtual meetings of Commission subcommittees. Documents provided to the Commission for review included a wide array of presentations, written policies, reports on incidents, safety procedures, committee structures, laboratory inspection reports, and much more. In addition, Commission members received both solicited and unsolicited emails from NIST employees.

Hence, the Commission was able to gain a comprehensive and detailed perspective on the intimate workings of safety systems within NIST research laboratories. Although the work was conducted in a tight timeframe, the Commission is confident of its conclusions. The Commission's opinions, findings, interpretations, recommendations, and overall summary reports on the current conditions at NIST represent the expert opinions of the NIST Safety Commission members. These opinions, in turn, are based on the broad scope of information provided to the Commission, as outlined above. The Commission views the recommendations that are proposed in this report as immediately actionable. NIST can promptly begin the hard work of improving safety in every way for the benefit of NIST employees and the science that they create.

CHAPTER 2

Organization and Leadership for Safety

NIST needs to commit to and prioritize the important role of safety in everything the Institution does. Impactful outcomes in research and development are facilitated when an organization focuses every day on keeping everyone safe. Leaders at all levels need to understand the impacts of their personal actions and the small decisions they make every day, especially decisions between competing priorities. These day-to-day activities leave impressions that accumulate over time, creating an overall perception among the employees of what is valued, expected, rewarded, and supported. If productivity and “getting the work done” are subtly (or not so subtly) prioritized over safety, then a weak safety culture will be the result. Thus, accountability for safety operations needs to be owned, internalized, exhibited, and operationalized by all NIST leaders and employees. This prioritization should be underscored by including safety as a key component of all individual performance assessments, associated merit-based compensation increases, and promotions, for leaders and employees alike.

Clearly, the understanding and responsibility for safety needs to be internalized by every NIST employee. Further, reporting structures must empower the ownership of safety. Because of the natural tension points between safety and productivity, there needs to be an independent Office of Safety, Health, and Environment (OSHE) possessing real authority and reporting directly to the NIST Director (see Figure 3). An independent OSHE department not only provides value through subject matter expertise but also provides a “stop work” authority when necessary to address and remedy unacceptable safety risks. An effective reporting relationship would help to empower the OSHE organization to fully carry out its broad mission.

The understanding and responsibility for safety needs to be internalized by every NIST employee.

Currently, OSHE is placed under the Management Resources directorate. This reporting structure creates several challenges to ensuring an effective safety management system (SMS), strong commitment to safety throughout the organization, and a high-performing organization overall:

- The current structure signals an inadequate prioritization of safety.
- There is no independent reporting structure directly from OSHE to the NIST Director, diminishing OSHE’s ability to inform and advise the NIST Director on safety risks and deficiencies and, thereby, limiting the Director’s ability to act on such critical information.
- OSHE lacks the independence and status needed to adequately influence decisions that impact work occurring throughout the NIST organization.

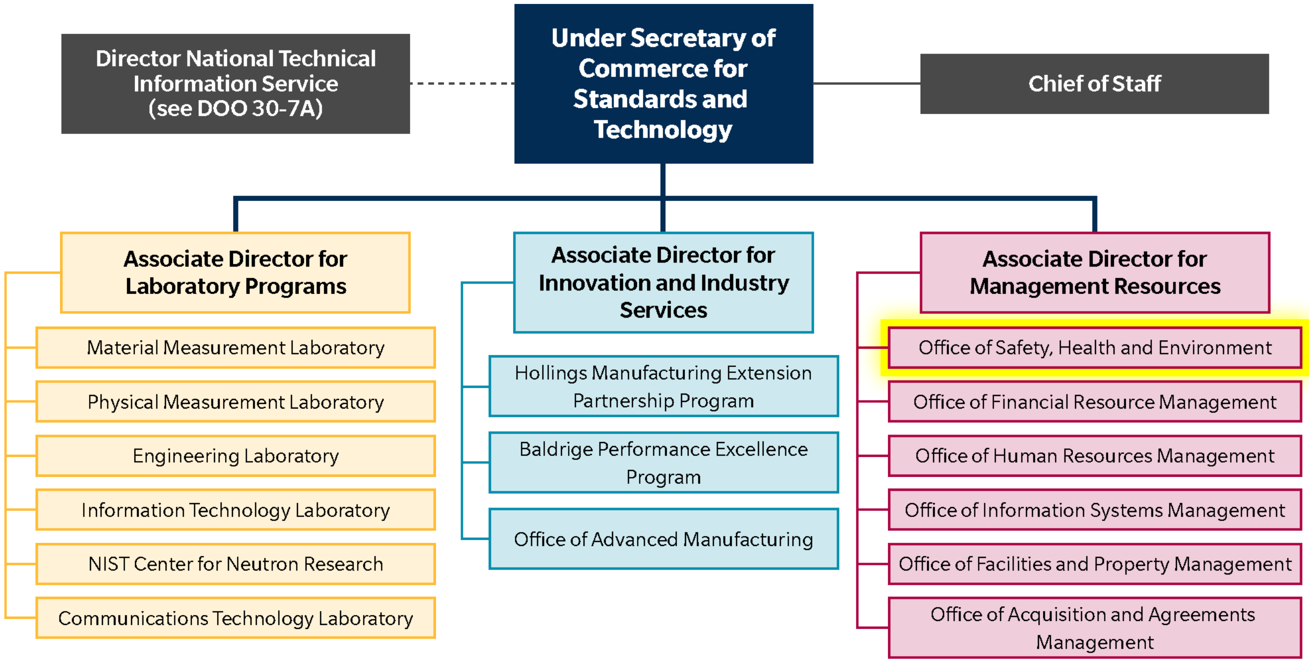


FIGURE 1. CURRENT NIST ORGANIZATIONAL CHART. *graphic credit: NIST 2020.*

Notes

- The NIST Center for Neutron Research is a standalone NIST Organizational Unit (OU).
- The National Fire Research Laboratory is part of the Engineering Laboratory, another standalone OU.
- The Enterprise Risk Management (ERM) Office is part of the Office of Financial Resource Management and reports directly to the NIST Chief Financial Officer, who reports to the Associate Director for Management Resources (ADMR). The ERM Council is chaired by the ADMR, who reports to the NIST Director. Figure 2 depicts these lines of reporting.
- OSHE is led by the Chief Safety Officer (CSO).
- The NIST Director is also the Under Secretary of Commerce for Standards and Technology.
- The National Technical Information Service (NTIS) is not part of NIST. NTIS is a bureau within the U.S. Department of Commerce, similar to NIST. NTIS has its own statutory functions and authorities unrelated to NIST functions and authorities. The NTIS Director has a dotted line reporting relationship to the NIST Director. The NTIS Director also reports to the Secretary of Commerce.

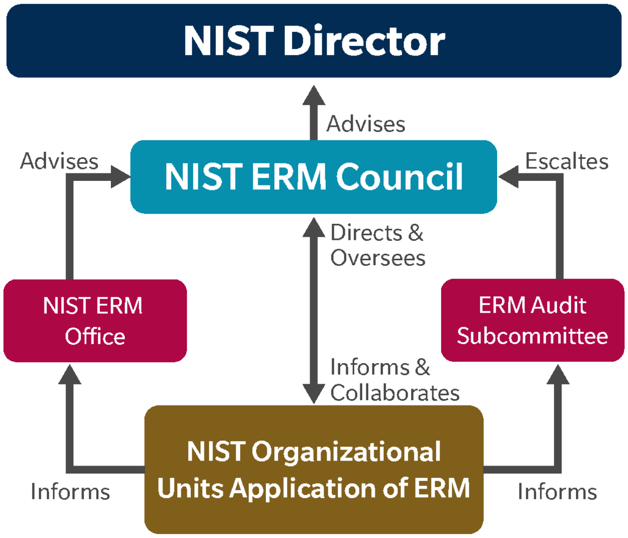


FIGURE 2. REPORTING STRUCTURE OF ERM.
graphic credit: NIST 2022.

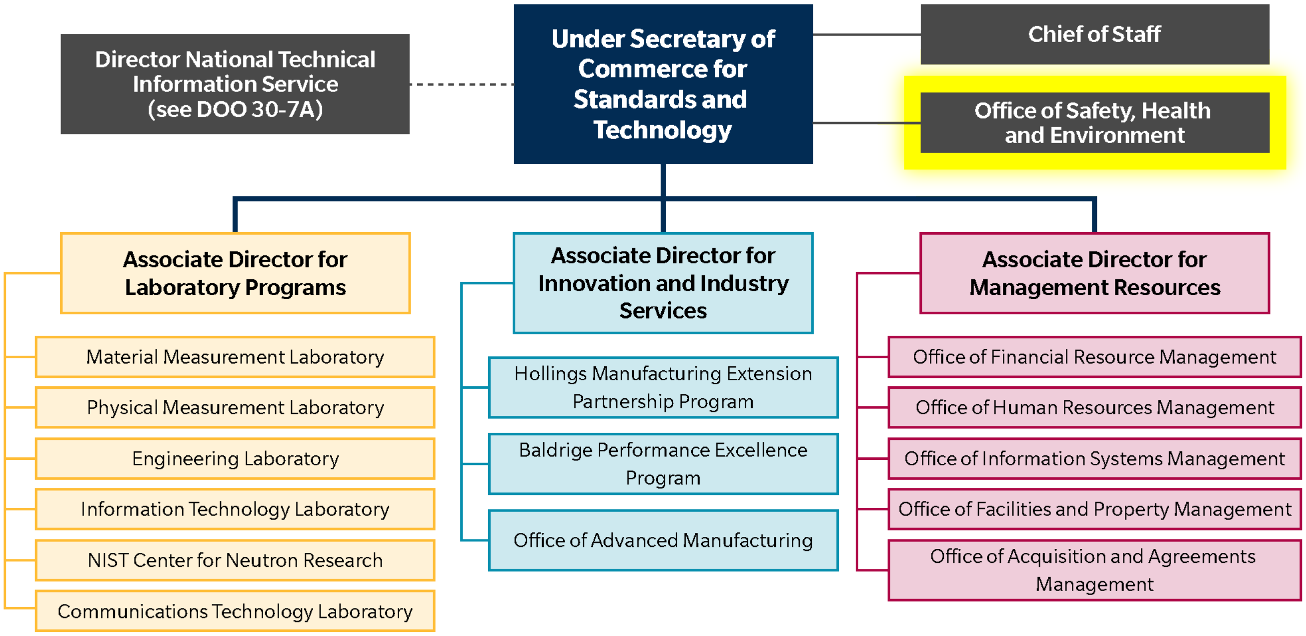


FIGURE 3. SUGGESTED NIST ORGANIZATIONAL CHART. *graphic credit: NIST 2020 (revised).*

A clear understanding and effective implementation of roles, responsibilities, accountabilities, and authorities in safety management must be conducted within the framework of a sound and comprehensive enterprise risk management (ERM) system. An effective ERM must include research hazards as key risks, with appropriate mitigation plans in place, along with an SMS and a safety culture with a focus on and commitment to continuous improvement. In addition, it is vital that the Chief Safety Officer (CSO) be a permanent voting member of the ERM Council to ensure proper focus on safety as an ongoing and significant priority, especially in a complex research and development organization working with high-hazard materials, processes, and equipment. By these criteria, the NIST ERM system is inadequate.

An initial and important step in remedying the deficiencies is to correct this reporting relationship and the dimensions of power—both formal and informal—of the OSHE organization. In addition, clarity must be gained as to who has final decision rights for work authorization, work stoppage, risk assessments, and incident investigations. Line management has a role, and all staff have the responsibility to stop work if unsafe conditions exist. However, these final decision rights should reside within OSHE with a direct line of reporting to the NIST Director, who has the ultimate authority and responsibility to accept residual risks

NIST Enterprise Risk Management Council

MEMBERSHIP

Principals/Voting Members

Chair, Associate Director for Management Resources
Associate Director for Laboratory Programs
Associate Director for Industry and Innovation Services
Chief of Staff, Office of the Director
Chief Financial Officer
Chief Information Officer
Chief Counsel for NIST

Non-Voting Members

U.S. Department of Commerce Liaison
Director, Management and Organization Office
Director, Program Coordination Office
Enterprise Risk Management Officer
Internal Controls Management and Evaluation Office/ Senior Assessment Team Representative
ERM Council Secretary

AGENCY OR OFFICIAL TO WHOM THE COUNCIL REPORTS

The ERM Council reports to the NIST Director to advise on all matters related to ERM at NIST.

after all mitigation efforts. These structural adjustments also ensure that OSHE and the CSO have their necessary and important roles within ERM.

NIST leaders must have deep knowledge of safety systems and essential safety tools and techniques to be able to devise, implement, and lead the safety transformation of OSHE and its relationships to NIST researchers.

Furthermore, if NIST is to make the changes necessary for a highly functioning safety organization, the skillsets for people leading this effort need to be reviewed and supported. Outside consultants may be useful to guide these efforts, but NIST leaders must have the knowledge and demonstrated ability to inspire the trust necessary to change the organization. They must have deep knowledge of safety systems and essential safety tools and techniques to be able to devise, implement, and lead the safety transformation of OSHE and its relationships to NIST researchers. The leaders driving this change should be able to formulate, implement, and communicate the essential transformation in safety execution at NIST. Leaders should also possess the demonstrated ability to re-envision the current SMS from the ground up. Huge strides can be made in less than two years; there are examples of organizations larger than NIST that have done so.

In addition, an effective risk and safety management process requires the onsite presence of an occupational and environmental medicine (OEM) physician and subject matter expert (SME) who holds authority to ensure safety in meeting OEM program requirements with access to a medical team of competent and qualified licensed medical professionals in a physician-led team-based model. Further, this OEM physician can be integrated to contribute to and advise on risk assessments and other SMS programs. There is a notable absence of OEM capability in many aspects of NIST operations. Currently, the Gaithersburg NIST campus has a Health Unit serviced by an outside provider working under contract. The lack of a dedicated employee and possible reluctance to bring in someone paid by contract hour limits OEM effectiveness. There are several potential opportunities for improvement:

NIST GAITHERSBURG CAMPUS

NIST BOULDER CAMPUS

- Review the current contract(s) to ensure that NIST is receiving all necessary medical support for all aspects necessary for NIST SMS and medical programs. Consider a dedicated in-house NIST physician to lead a physician-led team-based care model to meet mission needs.
- Hire a qualified OEM physician/SME with knowledge in areas of OEM, SMS, and regulatory agency standards (OSHA, NIOSH, CDC, NRC, other) to improve and expand OEM program capabilities and serve as the physician leader to OEM ancillary medical personnel in a physician-led team-based care model.
- Work with both the Gaithersburg and Boulder Campus Department of Commerce agencies to ensure OEM programs meet mission requirements.

- Establish a process to include the qualified OEM physician in the NIST Hazard Review process, SOP generation, and site visits with workers to meet OSHE program needs where and when appropriate.
- Establish a working group to assess the feasibility of improving overall worker wellness through regular physical examinations, hazard reviews, and new medical requirements for regulated activities.
- Publicize all OEM and health and wellness services offered by NIST.
- Plan to ensure adequate Health Unit staff based on the increased demand generated by these OEM program enhancements.

Finally, as with every institution across the nation, the COVID-19 pandemic had myriad impacts on NIST. At this time, ongoing health and operational challenges presented by COVID infections are not thought to be relevant to the foundational safety vulnerabilities this Commission identified. However, the pandemic created legacies and societal changes that are relevant to NIST as it addresses safety in the near term.

First, there is a conflict between onsite and remote work. While administrative staff may be able to do their work remotely, experimentalists need to be on site—and they need the assistance, experience, and knowledge of their research colleagues. Therefore, NIST leadership needs to evaluate those situations and develop optimal approaches to the balance of onsite and remote work to ensure mission success and safe and secure operations.

Second, with what has become known as the "Great Retirement," NIST has seen a great number of retirements. Those retirements created knowledge gaps in many different areas, including safety management. These retirements exposed systems-level vulnerabilities in which personal/individual knowledge was not formally standardized and documented and therefore disappeared. Thus, NIST leadership needs to evaluate this situation (possibly with the assistance of the ERM Council), consider whether there are areas where high-risk vulnerabilities could exist as a result of loss of personnel, and develop mitigation plans to address any issues.

1 **RECOMMENDATION:** Revise the reporting structure such that the Office of Safety, Health, and Environment (OSHE) and all related environmental, health and safety (EH&S) functions report directly to the NIST Director. Further, the Chief Safety Officer (CSO) should be a voting member of the Enterprise Risk Management (ERM) Council. Moreover, the NIST Director should make any other organizational changes needed to ensure the success of these specific recommendations.

1a. FINDING: Placement of OSHE under the Management Resources directorate does not adequately prioritize research safety or inform the NIST Director of safety risks.

1b. FINDING: It is not clear that NIST leadership has demanded the highest level of professional and technical expertise from all personnel involved in safety.

1c. FINDING: Research safety is not adequately considered or prioritized in the ERM Risk Inventory by the ERM Council, despite significant risks to human life or institutional mission, as demonstrated by known incidents involving injuries, physical damages, and a fatality.

1d. FINDING: The occupational and environmental medicine (OEM) physician and medical team of competent and qualified/licensed professionals are underutilized or missing resources in the risk management process, discounting their value as an existing quality assurance asset. The current placement of the OEM physician neither adequately prioritizes occupational health and safety within NIST nor informs the NIST Director of operational program status or employee health and safety concerns.

1e. FINDING: While issues resulting from the COVID pandemic presented NIST with additional safety challenges, they are not thought to be material to the foundational safety vulnerabilities this Commission identified and described in detail below, along with many documented in the 2008 and 2010 Blue Ribbon Commission reports.

1f. FINDING: In the fifteen years since the first NIST Blue Ribbon Commission on Management and Safety report and the many changes to safety management systems since, NIST leadership has not required the person leading OSHE to have i) a thorough knowledge of safety systems, ii) demonstrated ability to successfully run a large safety organization, and iii) ability to lead the creation and implementation of new SMS components needed at NIST.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CHAPTER 3

NIST Safety Management System

Introduction

A safety management system (SMS) is an organizational construct, based on clearly communicated foundational goals, that informs top management of risks to safety so that they can make well-informed decisions as to what risks should be mitigated or accepted. Ensuring delivery of reliable and timely information requires an explicit systems-based process that proactively identifies hazards and their associated risks, together with options to prevent or mitigate these risks. In addition, the system must monitor the results of decisions that have been made and the organization's ever-changing operational environment. To be successful, these activities require a robust feedback loop that continually operates to inform the organization at all levels, enabling a culture based on learning to prevent problems before they occur. Components of a well-functioning SMS include key elements such as:

- Policy, Structure, and Procedures
    - ¤ The framework upon which the SMS is based
- Risk Management System
    - Risk Assessment
        - ¤ Defined by transparent and widely communicated explicit risk prioritization criteria, which are based on the actual and potential severity of outcomes and the likelihood (probability) of occurrence over defined periods of time
        - ¤ Considers not only events that have already occurred but also close calls of events or situations that could lead to undesired events and outcomes
    - Hazard Identification
    - Investigations
        - ¤ Determination of causality that probes sufficiently to uncover the root causes and contributing factors that are responsible for hazards and risks
        - ¤ Recommendations for corrective actions
    - Risk Mitigation
    - Risk Acceptance
- Quality Assurance
    - ¤ Essential component of the feedback loop

A well-functioning SMS gathers information from a variety of sources, both passively (e.g., through reported data) and actively, systematically, and proactively (e.g., through observations and audits). The SMS then analyzes the information to produce solid recommendations and actions that advise top management in the discharge of their duties. The SMS evaluates these sources of information in a continuous feedback cycle so as to achieve an acceptable level of residual risk, as defined by NIST, in a manner that is clearly, consistently, and transparently communicated by leadership at all levels, explaining the implications for the safety of the personnel and public that is consistent with the achievement of organizational goals and mission. At this time, no such SMS exists in practice that is linked with action at NIST.

NIST has invested significant effort into developing and implementing the components of an SMS. Much of that effort has occurred since the NIST Blue Ribbon Commission reports of 2008[6] and 2010.[7] Figure 4 shows key safety-related events at NIST, including the 2008 and 2010 Blue Ribbon Commissions, which were established to look at NIST's management structure and management systems as they relate to safety policies, procedures, and practices. At this time, however, the overall SMS structure is not complete, as will be discussed in the following sections. It must

6 Final Report of the NIST Blue Ribbon Commission on Management and Safety, November 2008, https://www.nist.gov/system/files/documents/2017/05/09/final1108.pdf.

7 Final Report of the NIST Blue Ribbon Commission on Management and Safety II, November 2010, https://www.nist.gov/system/files/documents/2017/05/09/BRCIIFinalNov12.pdf.

be noted that this deficiency represents a significant enterprise risk to NIST, not only to the safety and wellbeing of its workforce, but to the facilities themselves and to the reputation of the research organization. This deficiency became clearly evident in the early stages of the Commission's work, leading to the issuance of the interim set of recommendations and findings.[8]

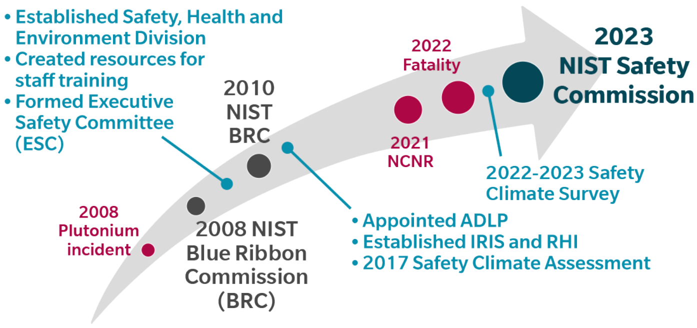

FIGURE 4. TIMELINE OF KEY SAFETY EVENTS.
graphic credit: NIST 2023.

Policies, Structure, and Procedures

In the current NIST organizational structure, OSHE, run by the Chief Safety Officer (CSO), is the steward of the SMS. OSHE reports to the Associate Director for Management Resources (ADMR) rather than having direct and unfiltered communication with the NIST Director. The associated policies related to safety are implemented such that the CSO and OSHE are primarily in an advisory capacity, with no direct authority to compel any actions related to safety, health, or environment at the Operating Unit (OU) level other than stop work authority. OSHE formulates and communicates the policies that designate when, how, and by what entity hazard reviews are performed, but it is the OUs that are the entities that ultimately decide what they will do and how they do it. This vulnerability, caused by OSHE's lack of active involvement in combination with an absence of a well-functioning line of communication to top leadership regarding hazards and risk, was also noted in the report of the Fatality Accident Investigation.

8 NIST Safety Commission, "Recommendations and Findings of the NIST Safety Commission," April 7, 2023, https://www.nist.gov/system/files/documents/2023/04/13/NIST%20Safety%20Commission_Interim%20Final%20Report_Findings%20and%20Recommendations_040723.pdf.

OSHE has no direct authority to direct or approve OU hazard reviews. The CSO informed the Commission that the OUs may invite OSHE to participate in hazard reviews, but OSHE is not required to participate. Of approximately 3,000 Hazard Reviews in the Material Measurement Laboratory Hazard Review database records, the Alternate OSHE Hazard Review Program Manager estimated that 35% had a cursory review by OSHE and 20% had a detailed review (site visit, etc.).

Similarly, the OUs are responsible for the policies that govern when and how investigations of incidents take place, along with the determination of causation, corrective actions, and follow-up. Again, with some exceptions (e.g., the radiation safety officer and environmental program manager), OSHE is only an invited participant, with no authority over the resulting products, determination of cause, or recommendations of the investigation. In addition, OSHE does not actively audit, observe, solicit, or investigate close call and precursor events so as to prevent or mitigate the occurrence of safety events on an explicit systematic basis or have a formal plan to do so.

OSHE's position in the NIST organization and its role as practiced have generally consisted of passive observation, inconsistent involvement even when "invited," largely passive collection of administrative data, and simple compliance audits of static physical hazards such as electrical, chemical, and tripping hazards. OSHE has had very little proactive involvement in observation and assessment of work and processes as actually practiced. In fact, OSHE safety staff stated during interviews that they have been denied access to labs that they wanted to enter to assess for safety-related purposes.

The routine and deliberate absence of proactive observation of activities and procedures as actually practiced, in favor of compliance, provides an incomplete and potentially misleading picture as to the actual status of safety and risk. This may also contribute to a hierarchical inconsistent perception of safety culture, as indicated by safety culture surveys in 2017 and 2023. A specific example from the 2017 survey was that 89% of supervisors responded that job hazard assessments were completed before new hazardous work activities began, whereas only 57% of nonsupervisory skilled trade staff stated this to be true. This striking difference in the reported execution of proactive hazard assessments that inform appropriate risk-related actions is consistent with what was identified by investigations of past adverse events such as the NIST Boulder plutonium incident in 2008, the fuel rod incident in 2021 that was reminiscent of two similar prior incidents that involved partially latched fuel elements, and the death in September of 2022.

This incomplete and superficial approach to safety that concentrates on and limits itself to addressing proximate causes, rather than root causes and contributing factors, is not systems-based and creates and reinforces a reactive, and backward-looking, compliance-type approach. NIST's approach does not actively audit, observe, solicit, and investigate close-call and precursor events so as to prevent or mitigate the occurrence of safety events and is antithetical to the development and maintenance of a healthy safety culture.

Further, NIST policies have historically promoted a siloed approach to safety wherein OUs can have different and independent approaches. This organizational weakness contributed directly to and was subsequently identified as a factor in the recent fatality where the OUs were each responsible for independently performing and implementing hazard assessments and actions; collecting reports; and prioritizing further action, investigation, and follow-up as to implementation of corrective action plans. Neither OSHE nor the Enterprise Risk Management (ERM) system provided any proactive quality assurance, audit, or oversight related to these activities. This absence of an organizational structure—one that provides a direct link from OSHE to top leadership, with the responsibility to the NIST Director for policy creation and oversight of and responsibility for direct oversight of all OU and other NIST activities that impact safety and health—is a significant vulnerability in the current management of NIST's safety environment.

Weaknesses of NIST policies and procedures extend to occupational and environmental medicine (OEM) activities, which have been cited by the Occupational Safety and Health Administration (OSHA) for deficiencies, including fall protection, not specifying a respiratory program manager, and the conduct of an OSHA compliant silica exposure prevention and monitoring program.

These weaknesses highlight the need for NIST to focus on evaluating and identifying hazardous positions requiring medical surveillance and complying with associated OSHA and other applicable medical surveillance requirements. OSHE has not utilized the expertise that could be made available from OEM resources to conduct proactive fitness-for-duty evaluations for all employees as part of a comprehensive hazard assessment and injury prevention program, which would provide an increased opportunity to enhance worker safety and welfare.

There are also concerning restrictions in the current contract with the outside vendor for the Gaithersburg facility. A 2022 amendment states: "Contractor shall not provide any safety or health related policy recommendations to NIST senior management without written approval from GSHED [Gaithersburg Safety, Health and Environment Division] Division Chief."[9] Such restrictions may inhibit clear and timely communication and transparency to inform upper management of hazards and risks that are present. Also, the limited medical information available to OSHE leadership calls into question their ability to make well-informed decisions regarding technical medical issues and could possibly lead to medical and regulatory problems.

An example of limited medical knowledge available to OSHE leadership potentially having a negative impact on decision-making involved the recent fatality incident investigation. The medical data included in the NIST Incident Investigation Report appear not to have been sufficiently investigated as to possible contributions to the occurrence of the event and the fatal outcome. (See Appendix E – Quality and Thoroughness of the Incident Investigation.) This lack of thoroughness regarding the medically related components of the investigation may have resulted from a deficiency in the investigation team; specifically, there was no participation of a qualified physician or other medically trained personnel familiar with, possessing experience in, and qualified to investigate events of this nature.

9 Amendment of Solicitation/Modification of Contract 1333ND19PNB150076P22016, effective date February 28, 2022, page 7.

		POTENTIAL SEVERITY OF THE CONSEQUENCES OF A HAZARDOUS EVENT OR EXPOSURE TO A HAZARD			
		CATASTROPHIC Death or permanent disability system or facility loss lasting environmental or public-health impact	**SEVERE** Serious injury; temporary disability subsystem loss or significant facility/ property damage temporary environmental or public-health impact	**MODERATE** Medical treatment beyond first aid; lost-work-day(s) more than slight facility/ property damage external reporting requirements; more than routine clean-up	**MINOR** First-aid only negligible or slight facility/property damage no external reporting requirements; routine clean-up
LIKELIHOOD OF OCCURRENCE	**FREQUENT** Likely to occur repeatedly	CRITICAL RHI=4	CRITICAL RHI=4	SERIOUS RHI=3	MEDIUM RHI=2
	PROBABLE Likely to occur multiple but infrequent times	CRITICAL RHI=4	CRITICAL RHI=4	SERIOUS RHI=3	MEDIUM RHI=2
	OCCASIONAL Likely to occur at some time	CRITICAL RHI=4	SERIOUS RHI=3	MEDIUM RHI=2	LOW RHI=1
	REMOTE Possible, but not likely to occur	SERIOUS RHI=3	MEDIUM RHI=2	MEDIUM RHI=2	LOW RHI=1
	IMPROBABLE Very unlikely; can reasonably assume it will not occur	MEDIUM RHI=2	LOW RHI=1	LOW RHI=1	MINIMAL RHI-0

FIGURE 5. RISK ASSESSMENT MATRIX. *graphic credit: NIST 2020.*

(From: NIST S 7101.20 Appendix C. Risk-Assessment Matrix. *This matrix is used to determine the risk level, or Relative Hazard Index (RHI), for a given hazard.)*[10]

Risk Management System: Hazard Identification, Risk Assessment, Risk Mitigation, and Risk Acceptance

The Commission interviewed OU management and technical staff regarding the performance of hazard assessments and reviews that are required by NIST. The discussions revealed a general understanding and agreement that there is value in performing hazard assessments.

Many individuals in the OUs felt that OSHE's participation was valuable, stating that they wished OSHE staff were present more often and that OSHE's participation were required. Interviewees also stated that, when conducting hazard reviews, they often felt pressure not to arrive at a relative hazard index (RHI) score greater than 2 because of the additional work that would result from such a score. Some staff reported that they had been pressured by management to downgrade an RHI score. In fact, the recent NIST report regarding the September 2022 fatality, titled "Investigation of the Fatality at the National Fire Research Laboratory," included emails in which the Safety Professional indicated that the demolition activity that ultimately resulted in the fatality should be classified as an RHI 3, but it was ultimately classified as an RHI 2 by management.

One contributing factor to this debate is the tool that is used for determining risk. The Risk Assessment Matrix appearing in NIST S 7101.20,[11] Appendix C, that NIST employs (Figure 5) uses the dimensions of Severity of Occurrence and Likelihood of Occurrence, which is a commonly accepted technique to determine the metric for risk. However, the definition of likelihood employed by

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10 NIST, "Work and Worker Authorization Based on Hazard Reviews ('Hazard Review')," NIST S 7101.20, approval date December 23, 2020, https://www.nist.gov/system/files/documents/2023/08/07/NIST%20S%207101-20_Work%20and%20Worker%20Authorization%20Based%20on%20Hazard%20Reviews_12172020.pdf.

11 NIST S 7101.20, https://www.nist.gov/system/files/documents/2023/08/07/NIST%20S%207101-20_Work%20and%20Worker%20Authorization%20Based%20on%20Hazard%20Reviews_12172020.pdf.

NIST does not include specific time periods. None of the policy documents that OSHE shared with the Commission use actual time references in determining likelihood, nor did OSHE staff refer to such explicit time-based definitions in our discussions. Furthermore, ERM has not identified this flawed approach as an overarching organizational safety vulnerability at the NIST enterprise level.

This is problematic since risk is a probabilistic term; if the likelihood has no time period specified, it makes the determination of risk in a reliable standardized manner impossible. This, in turn, creates a situation which makes clear communication virtually unachievable. Additionally, it makes it virtually impossible to support a well-informed decision-making process, because the various parties involved in the organization are not using the same frame of reference for their discussions when attempting to formulate a cogent assessment of risk from an enterprise perspective. As a result of this lack of a time metric in the NIST likelihood definition, decisions regarding prioritization, corrective actions, evaluation of success, or acceptance of residual risk may be—or at least be perceived as—arbitrary and unduly subject to personal opinion and not reproducible.

This weakness in the definition of likelihood is curious because other source documents do specify time periods. For example, the NIST ERM Reference Card defines three time periods: near (impact felt within 1 year), mid (impact felt within 1–2 years), and far (impact felt in 3 years or beyond); these clarifications make the likelihood definitions usable (although cumbersome).

3 **RECOMMENDATION:** Improve the Hazard Review and Approval System (HR) and Relative Hazard Index (RHI) process, to include quantifiable likelihood definitions based on specified timeframes, validation/verification of user proficiency, and requirements for a reviewing role by OSHE.

- **3a. FINDING:** The HR is a capable tool for hazard identification but requires improvements for quality hazard management.
- **3b. FINDING:** RHI assessments are somewhat arbitrary, contributing to a false sense of safety risk acceptance.
- **3c. FINDING:** The current risk matrix used by NIST is deficient and lacks defined time references to determine likelihood.
- **3d. FINDING:** ANSI Z10 is being incorrectly interpreted and used as a risk assessment aid.
- **3e. FINDING:** The emergency response plans that are part of the hazard review package in the HR are not well understood or practiced and thus not consistently/reliably actionable by staff.

NIST has reporting mechanisms that do not fully realize their safety potential. For example, an important component of a well-functioning SMS is a system for hazard reporting and incident reporting (including close calls) that encourages and allows direct submission from any individual, regardless of the person's employment relationship to NIST. However, NIST has an explicit policy prohibiting any and all individuals (e.g., associates) from submitting incident reports directly. This restriction is an impediment to clear communication of safety concerns and is antithetical to the development of a well-functioning safety culture that engages all personnel.

A further problem is that these systems are not integrated with each other, nor are they integrated with other important safety-related databases (e.g., the chemical inventory and safety training system). Both researchers and staff at NIST commented on the safety IT systems' weaknesses, including an inability to function in a coordinated manner. The Commission, therefore, recommends undertaking a significant overhaul of the safety IT system. Specifically, NIST should define the information needed to support SMS operations and improve the ability to efficiently and effectively support safety activities—not only for management (e.g., OSHE) but for all NIST personnel, regardless of position in the hierarchy.

7 **RECOMMENDATION:** Conduct a comprehensive review and audit of all safety-related information technology (IT) systems, and based upon that review, make the necessary changes/fixes to ensure seamless integration and interoperability of safety information across all safety system IT tools. In addition, establish an advisory panel of safety stakeholders to periodically review effectiveness of these systems, and empower the panel to make recommendations for continual improvement.

7a. FINDING: NIST created a number of IT safety systems, but they do not work together or share common data.

7b. FINDING: Explicit usability testing was not employed for the tools, such as IRIS [Incident Reporting and Investigation System], and this resulted in less-than-desired use, efficiency, and benefit from their employment.

Hazard identification and risk assessments should occur in all three phases of research activities: set-up, experiments, and tear-down. Currently, NIST's Workplace Inspection Program (WIP) does not apply to the set-up and tear-down phases. NIST has confined its current WIP efforts primarily to static physical conditions (e.g., hazard signage, chemical storage, labeling, waste containers, and certification of fume hoods and safety showers) and the presence of personal protective equipment (PPE) as appropriate for the space. This restricted scope of activity creates a situation in which safety vulnerabilities remain unidentified by OSHE and unmitigated, as evidenced in the recent Fatality Incident Investigation. Just as chemical waste at the end of an experiment is clearly identified as a hazardous material, all types of research projects need to have a cradle-to-grave mindset when it comes to identifying hazards and assessing risks. As a result of these significant deficiencies in the WIP, the Commission made the following interim recommendation.

5 **RECOMMENDATION:** Revise the Workplace Inspection Program such that inspection teams include both subject matter experts and OSHE staff, inspection teams have authority to mandate changes, inspections look beyond compliance issues to work practices and research hazards, and inspection findings are corrected and verified in a timely manner.

5a. FINDING: Laboratory inspections do not always include OSHE staff and are sometimes led by people lacking sufficient expertise or who were not unbiased, for example, a person inspecting a laboratory under their authority.

5b. FINDING: The laboratory inspection checklist was detailed with appropriate topic areas to be examined; however, it focused on compliance rather than on actual work practices or research hazards and risks specific to that laboratory.

5c. FINDING: Inspection findings are not prioritized consistently for correction, many corrections have no timeframe mandated for completion, and are not verified by safety staff to have been completed or to have been effective in achieving their goals to mitigate identified vulnerabilities and eliminate or control risk at an acceptable level.

5d. FINDING: OSHE staff reported that, while they are periodically invited by Organizational Units (OUs) to visit certain specific research spaces, their requests to access research spaces were sometimes denied.

Investigations, Determination of Causality, and Recommendations for Corrective Actions

Decisions on whether an investigation is indicated or in determining which events should receive higher priority are hampered by the absence of a Risk Matrix approach. This lack of clear criteria (including time-based risk assessment), in combination with the siloed approach where individual OUs make their own determination of priorities, hampers systemic learning and utilization of resources to address hazards in an effective and efficient manner to support safety on a NIST-wide basis. Lack of a well-reasoned standardized approach to investigations then deprives leadership of consistent and actionable risk-based assessments upon which to base decisions.

Another vulnerability when performing incident investigations is due to the fact that OSHE staff, and NIST personnel more broadly, do not use or demonstrate an understanding of what constitutes a root cause and how that differs from a proximate cause. The recurring treatment of proximate causes as "root causes" prevented a deeper understanding of circumstances, contributing to undesired outcomes as identified in the Fatality Report. For example, the facts that the "two man" requirement wasn't adhered to and that the underlying facts and resultant decisions not to increase the RHI, as recommended by the safety representative in the Fatality Report, were not mentioned as potential contributing factors led to missing the root causes of incomplete and flawed management oversight. This is important because corrective actions that address the root causes and contributing factors are stronger and have been shown to result in a greater likelihood of preventing future incidents and harm than corrective actions based solely on proximate causes. Similarly, other NIST investigations that OSHE provided for the Commission to review consistently identified proximate causes as "root causes." Deeper analyses would have led to an understanding of the root causes and contributing factors in the incidents. After in-depth discussions with Commission members, OSHE personnel acknowledged that the causal statements in the internally performed investigations were really only proximate causes. This same weakness and lack of thoroughness to follow the causal chain was demonstrated throughout the Fatality Investigation.

The failure of NIST personnel to perform thorough investigations that identify root causes is not a newly identified problem. For example, the [report](https://www.nist.gov/system/files/documents/2022/08/02/T.%20Mason%20Report%20on%20NCNR_2022.pdf) [12] to NIST by Dr. Thomas Mason, the Director of Los Alamos National Laboratory, who was one of the external, independent subject matter experts retained by NIST to provide their individual assessments of the unplanned shutdown of the NIST Reactor, resulted in several findings, including the following:

> *The failure to properly resolve the root causes of those prior events, leading to the Feb. 3 2021 incident, indicates deeper problems with nuclear safety culture at NCNR that are acknowledged by the management team.*
>
> *In the minds of some staff there seems to be some conflation of lack of action on industrial safety issues with lack of action to address reactor operations staffing shortfalls – both being taken as examples of lack of management commitment to safety.*

All of these comments identify concerning safety issues for which OSHE, the CSO, and the ERM organization have both responsibility and oversight.

Corrective actions that address root causes and contributing factors are stronger and have been shown to result in a greater likelihood of preventing future incidents and harm than corrective actions based solely on proximate causes.

Since the incident causes identified in past NIST investigations were only proximate causes, the resultant recommended actions were then typically superficial. The recommendations tended to direct staff members only to comply with policies and regulations without touching on the underlying causes as to why the policies and regulations were not followed. Another concerning issue was that the investigations were often not timely and implementation of corrective actions was often many months or more than a year later. This lack of thoroughness, effectiveness, and timeliness, as exemplified in numerous investigations shared with the Commission, represents a lack of prioritization of safety-related activities and oversight by both NIST management and ERM, which then undermines the development of a strong safety culture.

Based on interviews with OSHE leadership, staff, and reviews of incident reports (including a review of the fatal accident report detailed in Appendix E), it has become clear to the Commission that OSHE, and NIST more broadly, does not possess the knowledge or the capacity to perform root cause analyses that go beyond the identification of proximate causes. The ability to determine root causes and to formulate corrective actions that are based on root causes is

12 NIST NCNR Reactor Incident Review, prepared for NIST by Thomas Mason of Los Alamos National Laboratory, February 14, 2022, https://www.nist.gov/system/files/documents/2022/08/02/T.%20Mason%20Report%20on%20NCNR_2022.pdf.

fundamental to achieving a proactive, robust, and effective safety management process. The correction of this shortcoming may not be achieved without outside unbiased perspectives. Thus, there is a need to secure the services of personnel with demonstrated knowledge and expertise in safety investigations that reliably identify root cases and associated systems-based corrective actions. This immediate need is consistent with Recommendation 14. Of even greater importance, the person leading OSHE must have a thorough knowledge of safety systems and have demonstrated ability to successfully run a large safety organization, as well as implement one where one did not previously exist.

6 **RECOMMENDATION:** Improve the Incident Reporting and Investigation Program to enable effective incident reporting functionality, usage, prioritization, response, and communication. Improve the Incident Reporting and Investigation Program to enable effective incident investigations with regard to explicit risk-based prioritization of what is investigated, who leads the investigation, and how incidents are investigated; identification of true root causes (not just identification of superficial proximate causes); formulation of recommendations and actions that clearly address root causes (not just proximate causes); identification of contributing factors to mitigate risks; timeliness of investigations; and follow-through on completion and effectiveness of recommended corrective actions.

- **6a. FINDING:** A significant number of researchers interviewed did not know how to submit Incident Reporting and Investigation System (IRIS) reports, were not authorized to submit IRIS reports, found the reporting system too cumbersome, were not encouraged to report close calls, and did not know how reports were utilized in improving their work environment.
- **6b. FINDING:** Placing responsibility and authority for initiating investigations, determining actions, and following up on actions at each OU level creates an actual or perceived conflict of interest, limits generalized learning, and may result in unrecognized and increased organizational risk.
- **6c. FINDING:** The tools for determining hazard-induced risk use definitions of likelihood that have no specified period of time over which the likelihood is defined. This leads to inconsistent prioritization and inefficient allocation of resources and detracts from the establishment and maintenance of a robust and sustainable culture of safety.
- **6d. FINDING:** The investigation process is not sufficiently standardized, and the metrics for quality and success of the investigations are not adequate; for example, root causes may not be correctly identified.
- **6e. FINDING:** Investigation reports performed by OUs or OSHE seldom properly identified and determined contributing factors and root causes.
- **6f. FINDING:** Investigations and their subsequent actions are not accomplished in a timely manner.
- **6g. FINDING:** No systematic method exists to audit what is accomplished or to provide independent quality assurance for the investigation process or the success of interventions.
- **6h. FINDING:** Incident reporting information is being emailed to employees without categorization or prioritization as to individual relevance, resulting in staff stating they view it as spam and, thus, in a detrimental impact on safety.

14 **RECOMMENDATION:** NIST should obtain outside advice/expertise/oversight from external experts on its SMS and plans, actions, and associated schedules for implementation, as those are generated in response to the recommendations in the final NIST Safety Commission report.

- **14a. FINDING:** Missing actions addressing recommendations from previous NIST-created commissions and surveys and technical errors in the current NIST SMS suggest that NIST could benefit from continuing outside advice and expertise.

Quality Assurance – An Essential Component of an Effective Feedback Loop

The Commission was briefed on several occasions that there is no comprehensive audit or quality assurance mechanism in place to provide accurate information on whether corrective actions are successfully implemented or, even more importantly, whether they have their desired salutary effect on safety. Instead, OSHE is forced to rely on what the OUs report has been completed and does not confirm that the information provided is valid. OUs have been allowed to perform their own self-assessments and report their results to OSHE. This vulnerability was described as a longstanding concern, and OSHE's plan is to begin comprehensive audits in 2024. The Commission was informed that a detailed and thorough audit program was intentionally planned to be the last step in setting up the SMS because OSHE wanted to finish issuing safety requirements that were essential to hazard mitigation, such as fall protection and crane safety, and to complete all of the other elements of the SMS prior to beginning a formal audit program.

The Commission was perplexed and alarmed by OSHE's decision to deliberately delay having actual information from audits to inform NIST of current safety conditions and the success of the SMS. This was all the more concerning in view of the fact that, subsequent to the plutonium mishap in 2008, the NIST Blue Ribbon Commission on Management and Safety II stated in their Final Report of November 2010:[13]

> *Audit is an important part of a safety assurance program. Self-assessment is not an audit; rather, it is an important part of an audit. Because the Department of Commerce has no such function, another source will be needed…we recommend the following actions:… 3. Establish an Audit mechanism.*

Almost 13 years later, NIST still has not implemented this recommendation and has not planned to adopt this important tool to inform a healthy SMS until 2024.

NIST demonstrates a longstanding absence of effective and comprehensive feedback loops assessing all aspects of the safety programs that provide timely insight to all levels of the organization, especially top leadership. This deficiency impedes the organization's ability to proactively identify hazards and mitigate risks, as well as to understand how well various activities, policies, and procedures are enabling the achievement of organizational goals. Instead, OSHE has focused on workplace inspections that emphasize compliance with static physical/environmental standards, but has not routinely and actively participated or consistently engaged in proactive observation of work as it was actually accomplished to identify ongoing real-world hazards and risks. Consequently, OSHE and management are somewhat blind to actual and consistent hazards and risks. This vulnerability existed in spite of concrete recommendations in the past regarding the importance of instituting effective audit activities. As a result, a situation exists at NIST that some have described as "work as imagined as opposed to work as performed."

The Commission's review has determined that the lack of a robust and integrated audit program in NIST's SMS is a common contributing factor to many of NIST's recent safety incidents and to poor interoperability of the various components of the SMS. Further, the lack of a quality assurance feedback loop that provides all levels of the organization with actionable and timely information cripples a potential systems-based proactive approach to safety. Based on these findings, the Commission issued the following recommendation.

13 Final Report of the NIST Blue Ribbon Commission on Management and Safety II, November 2010, https://www.nist.gov/system/files/documents/2017/05/09/BRCIIFinalNov12.pdf.

2 RECOMMENDATION: Establish and implement a safety audit system into the Safety Management System (SMS) that proactively identifies hazards and their associated risks, provides quality-assurance-based feedback on performance of corrective actions and activities, and is compatible and consistent with the intention of a high-quality SMS as exemplified by the standards set by ISO 45001 or ANSI Z10.

2a. FINDING: The lack of an audit process in NIST's SMS has not been appropriately prioritized, causing a material weakness and elevated risk to the organization's safety posture.

2b. FINDING: This recommendation was also made by the 2008 NIST Blue Ribbon Commission: "Currently NIST has no independent, systematic, and comprehensive internal audit procedures to ensure compliance with safety standards and regulations."

2c. FINDING: This recommendation was also made by the 2010 NIST Blue Ribbon Commission: "NIST's safety program will indicate metrics that would be appropriate to monitor safety requirements that are applicable throughout NIST. Once these requirements have been established, safety performance will be monitored, measured, assessed, and audited."

COMPARISON OF ANSI Z10 AND ISO 45001

OCCUPATIONAL HEALTH AND SAFETY MANAGEMENT SYSTEM STANDARDS

ANSI Z10	OR	ISO 45001
▪ Comprehensive, systems-based standard.	**PRIMARY FOCUS**	▪ A global standard for OSH management systems.
▪ Designed to align with ISO 45001 for organizations desiring conformance with both standards. ▪ Considered the gold standard of OHSMS in the United States.	**UNIQUE CHARACTERISTICS**	▪ Can help create a global foundation of worker safety standards and inspections that can be used by all global supply chains covering contractors and subcontractors in every country that supply products into these supply chains.
▪ Not being currently used by certification bodies	**CERTIFICATION**	▪ Developed with the goal of certification along the lines of other management systems standards such as ISO 9001 and ISO 14001. ▪ Organizations certified to OHSAS 18001 must migrate to ISO 45001 by September 2021 to maintain their certification.
▪ Easier to understand and implement, based on United States business practices, legal system, and union/management relations.	**EASE OF USE**	▪ With 64 countries involved, consideration was given to a wide array of cultures, business practices and legal systems.
▪ Only available in English.	**LANGUAGE**	▪ Written in International English. Language compromises were necessary to accommodate translation and practices in countries around the world. This standard is available in many languages.
▪ Provides flexibility in tailoring its requirements to an organization's safety and health risks.	**FLEXIBILITY AND SCALABILITY**	▪ Does have some flexibility but is more specific in some sections.
▪ Includes an occupational health section with a strong emphasis on health.	**OCCUPATIONAL HEALTH**	▪ Not as focused on occupational health as the Z10 Standard.
▪ Much greater emphasis on worker participation than ISO 45001.	**WORKER PARTICIPATION**	▪ Very extensive but more specific on worker participation than ANSI Z10 due to certification requirements.
▪ A Guidance and Implementation Manual is available. ▪ ASSP offers a guidance document for smaller organizations at no cost.	**IMPLEMENTATION AND SUPPORT**	▪ A Guidance and Implementation Manual is currently in development. ▪ ASSP sells the US adoption of the standard and it costs much less than the International version.

Learn more at
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AMERICAN SOCIETY OF SAFETY PROFESSIONALS STANDARDS

FIGURE 6. KEY HEALTH AND SAFETY STANDARDS.
American Society of Safety Professionals, n.d., www.assp.org/docs/default-source/standards-documents/std_comparisonchart_z10vsiso45001.pdf?sfvrsn=f7148a47_4. Reprinted with permission.

Enterprise Risk Management

Enterprise Risk Management (ERM) is another component of the overall NIST SMS program. The broad conceptual goal of how ERM is to be carried out is described in OMB Circular A-123[14] and is depicted in Figure 7.

As noted in OMB Circular A-123, an effective and thorough ERM program is critical to the success of an SMS. The Commission was provided somewhat limited information on the NIST ERM program (superficial summaries of the ERM Council meetings, broad working documents, and a meeting with the director of the ERM Program), but was able to formulate opinions on actions that could be improved to better serve the ERM program's intended mission. The following are limitations identified in the current processes:

- ERM is not set up to be predictive.
- The ERM Office receives inputs and forwards them to the ERM Council, which considers those inputs for incorporation into the tracked risk items. However,

14 Shaun Donovan, Director, "OMB Circular No. A-123, Management's Responsibility for Enterprise Risk Management and Internal Control" (official memorandum, Washington, DC: Office of Management and Budget, July 15, 2016), https://www.osec.doc.gov/opog/privacy/Memorandums/OMB_Circular_A-123.pdf.

the Office does not proactively directly gather source information or independently perform risk assessments and has no plans to do so in the future.

- The ERM Director has not been present in briefings of the NIST Director.
- Employee safety had not historically been included in ERM documentation, but one safety measure is up for consideration for incorporation in 2023.
- Risks are not evaluated broadly. While legacy radioactive materials have been identified as problematic, other residuals from experiments—such as biological, chemical, and structural (basis of the fatality)—are not considered.

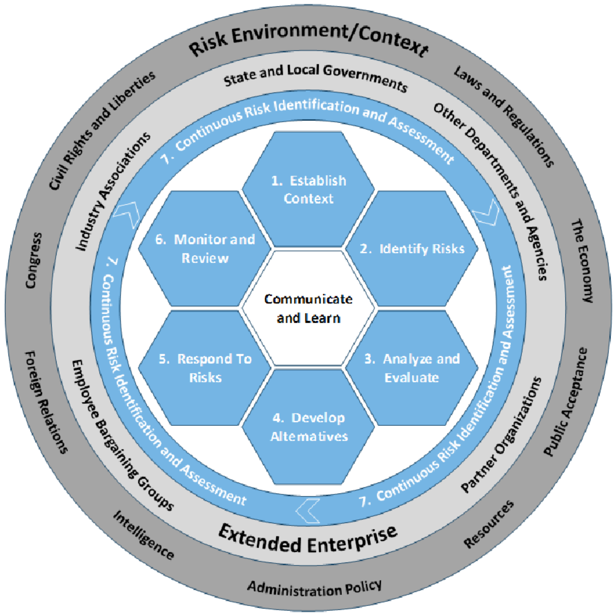
The ERM program's passive role is in direct conflict with the responsibilities described by the ERM Director in NIST ERM training videos and is also not consistent with the description and intent of ERM, as described in OMB Circular A-123.

The independent subject matter expert assessment report to NIST by Dr. Thomas Mason on the 2021 NIST NCNR Reactor Incident[15] stated:

> *It was surprising to learn the NCNR had only been added to the NIST Risk Matrix shortly before the incident and only then in the context of an ageing reactor that might not meet beam delivery needs of the scientific community. The fact it represents the highest hazard operation across all of NIST seems not to have been formally recognized. While the NRC [U.S. Nuclear Regulatory Commission] license and NCNR design are predicated on the absence of a possibility of offsite impact, the potential adverse consequence of a serious accident in terms of NIST reputation and risk to staff should elevate the visibility and management attention.*

It appears that ERM is not being used in a manner that informs and enables NIST management to be appropriately equipped to make well-informed risk-based decisions, especially with respect to the safety of personnel. This vulnerability is long-standing.

15 NIST NCNR Reactor Incident Review, prepared for NIST by Thomas Mason of Los Alamos National Laboratory, February 14, 2022, https://www.nist.gov/system/files/documents/2022/08/02/T.%20Mason%20Report%20on%20NCNR_2022.pdf.



1. ***Establish the Context-*** understanding and articulating the internal and external environments of the organization.
2. ***Initial Risk Identification-*** using a structured and systematic approach to recognizing where the potential for undesired outcomes or opportunities can arise.
3. ***Analyze and Evaluate Risks-*** considering the causes, sources, probability of the risk occurring, the potential positive or negative outcomes, and then prioritizing the results of the analysis.
4. ***Develop Alternatives-*** systematically identifying and assessing a range of risk response options guided by risk appetite.
5. ***Respond to Risks-*** making decisions about the best option(s) among a number of alternatives, and then preparing and executing the selected response strategy.
6. ***Monitor and Review-*** evaluating and monitoring performance to determine whether the implemented risk management options achieved the stated goals and objectives.
7. ***Continuous Risk Identification-*** must be an iterative process, occurring throughout the year to include surveillance off leading indicators of future risk from internal and external environments.

FIGURE 7. ILLUSTRATIVE EXAMPLE OF AN ERM MODEL.
Office of Management and Budget Circular A-123: Management's Responsibility for Enterprise Risk Management and Internal Control, July 15, 2016, https://www.whitehouse.gov/wp-content/uploads/legacy_drupal_files/omb/memoranda/2016/m-16-17.pdf.

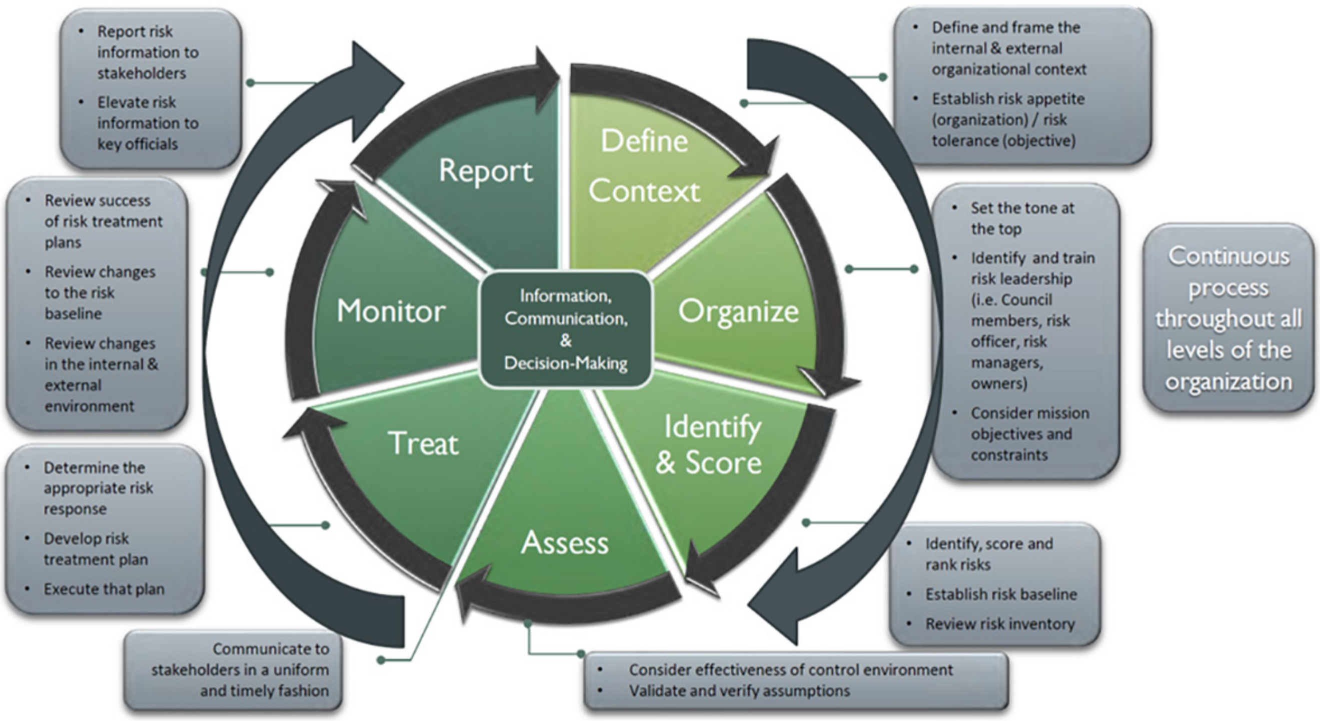


FIGURE 8. INSIDE THE NIST ENTERPRISE RISK MANAGEMENT PROCESS. *graphic credit: NIST, Enterprise Risk Management (ERM) at NIST," presentation (unpublished), 2022.*

An effective ERM model includes a step to monitor and review actions (see Figure 8, Step 6), as described in the NIST ERM training module. This action is not accomplished with respect to safety-related issues. As a result, the ERM program does not have a functioning improvement cycle or insight into the status or efficacy of safety activities.

The risk resulting from this omission is exemplified by the failure to institute an audit system as part of a safety assurance program, as recommended 13 years ago by the NIST Blue Ribbon Commission on Management and Safety II in their 2010 final report.[16] This failure was also a material contributor to the recent fatality, as described in the recent Fatality Incident Investigation.

In another example, the Risk Matrix being used by NIST for job or activity hazard reviews does not contain a time-related metric and is not consistent with the NIST ERM training module, which does include three time periods (near, mid, and far) in the risk matrix illustrated on the ERM Risk Reference Card (Slide 28). In addition, a time domain analysis was not used in the Fatal Accident Investigation. These inconsistencies have never been addressed or identified as requiring correction by the ERM Office, even after being specifically pointed out by the Safety Commission in its Interim Report to NIST top management in early March 2023 as well as during meetings in early February 2023 with the CSO and OSHE staff. Furthermore, ERM training materials clearly state that risk assessment is a continuous process, but the ERM Director informed the Commission that the ERM group members simply accept what is reported to them, rather than doing independent assessments.

These failures to perform the basic requirements of an ERM program create a disjointed mechanism that allows and perpetuates a siloed approach that inhibits organizational learning and the development of a robust safety culture and creates a situation conducive to the occurrence of adverse events. These concerns led the Commission to issue the following recommendation.

16 Final Report of the NIST Blue Ribbon Commission on Management and Safety II, November 2010, https://www.nist.gov/system/files/documents/2017/05/09/BRCIIFinalNov12.pdf.

8 **RECOMMENDATION:** Improve the ERM program, and its current standard of processes and practices, to better address critical research safety matters. For example, enterprise-wide audits/scans of safety issues should be conducted; and the process of adding items to the Risk Inventory, which informs strategic decisions by NIST leadership, should be more timely and efficient.

- **8a. FINDING:** The ERM system is being used as a general business tool, and safety risks to personnel are not adequately considered.
- **8b. FINDING:** The ERM process and ERM Council do not adequately address and manage risks, thus appearing ineffective, addressing only high-level safety risks. The ERM Council is failing to inform executive leadership's safety awareness for timely risk-setting deliberations and prioritizations.
- **8c. FINDING:** The ERM process has technical shortcomings, for example, the likelihood criteria of the Risk Scoring Matrix, objective uses of Risk Appetite and Risk Tolerance, and reporting of Risk Treatment Plans and their status as required by OMB Circular A-123 V.B. The Matrix does not employ likelihood definitions that have a grounding in an actual time reference, without which reliable determination of risk is virtually impossible.
- **8d. FINDING:** While ERM personnel do personally brief the ERM Council, they are not present when the NIST Director is briefed. This increases the likelihood that senior managers are deprived of an accurate picture of the systems-level implications of the hazards and risks that exist.
- **8e. FINDING:** ERM personnel do not proactively explore or identify organization risks that have enterprise implications. ERM personnel reported that they take input only from NIST organizational elements and do not systematically verify the veracity of the reports.
- **8f. FINDING:** Deficiencies in safety issues even being considered by the ERM Council were also noted by Thomas Mason (Director, Los Alamos National Laboratory) in his 2022 NIST Center for Neutron Research (NCNR) Reactor Incident Review: "...the NCNR had only been added to the NIST Risk Matrix shortly before the incident and only then in the context of an ageing reactor that might not meet beam delivery needs of the scientific community. The fact it represents the highest hazard operation across all of NIST seems not to have been formally recognized."[17]

Other examples of ERM and OSHE not actively addressing safety were revealed during site visits the Safety Commission conducted. During tours in March 2023 of some the labs at the Boulder facility that used lasers, the Commission observed that the safety precautions taken in different labs in the same building were vastly different in their approaches to safety. Specific examples included their thoroughness, robustness of safety design, and use of robust engineering controls versus relying on far weaker administrative controls. When Commission members asked senior lab managers what they would do in the event of a laser-induced injury, not one manager could describe a standard approach or had a ready answer as to what they would do, who they would call for assistance, or where they could get immediate attention for an injured employee.

One senior manager said he had just had such an event occur in the recent past, and he ended up driving the employee to a local urgent care center, and he said that, if it happened again, "I guess I would do that." This situation has been in existence for many years and has not been identified, addressed, or rectified by OSHE/ERM/NIST.

- **3e. FINDING:** The emergency response plans that are part of the hazard review package in the HR are not well understood or practiced and thus not consistently/reliably actionable by staff.

17 NIST NCNR Reactor Incident Review, prepared for NIST by Thomas Mason of Los Alamos National Laboratory, February 14, 2022, https://www.nist.gov/system/files/documents/2022/08/02/T.%20Mason%20Report%20on%20NCNR_2022.pdf.

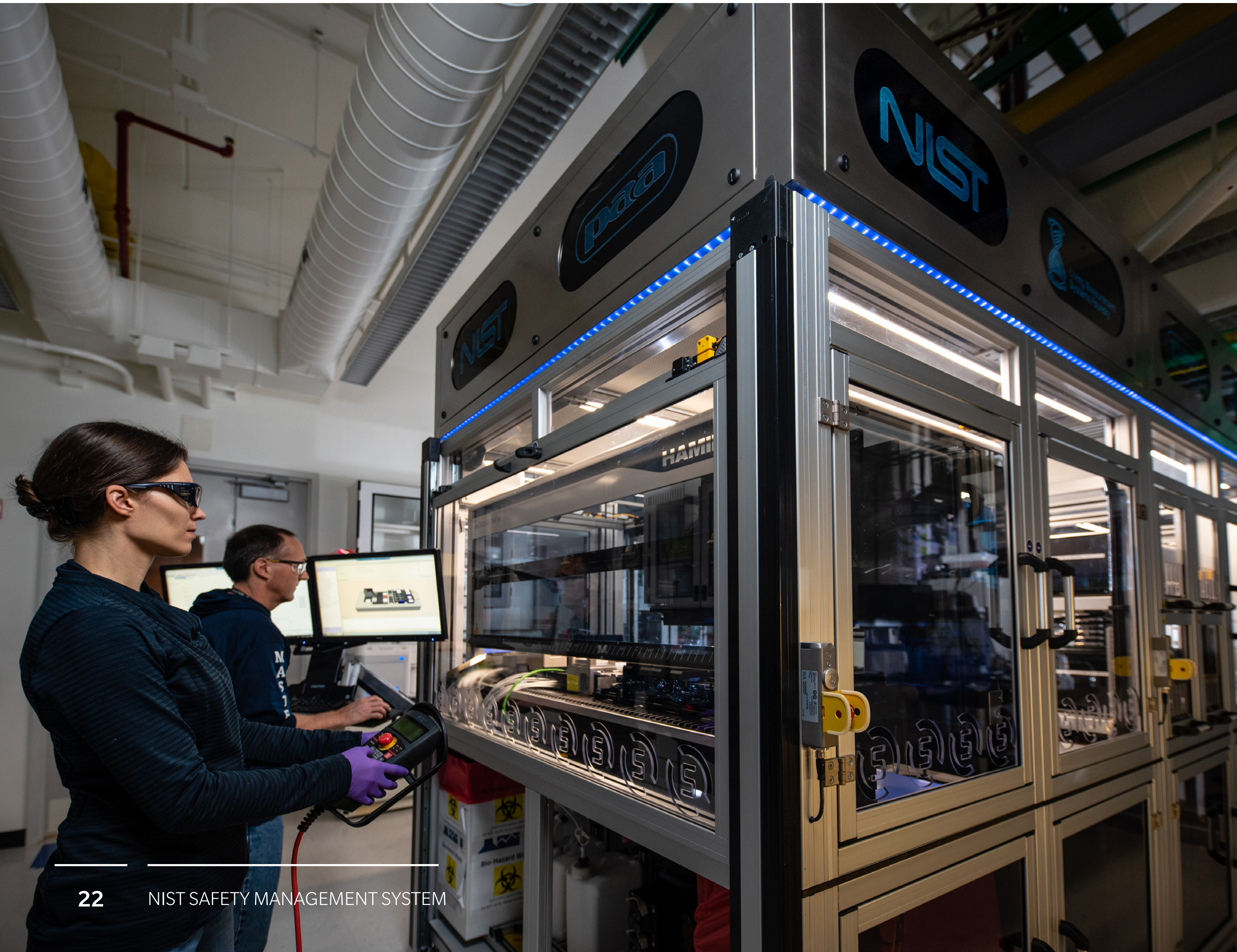
Summary of the NIST Safety Management System

The current SMS at NIST, while well-intended, has many opportunities for improvement before it will be able to function as an effective SMS.

The current NIST Director has taken the first courageous and important step toward this goal by establishing this Commission, which was tasked with examining the entire NIST enterprise with regard to safety. The hard part lies ahead when NIST will have to establish an effective SMS and address the following vulnerabilities:

- A flawed risk assessment tool
- Investigations that are not thorough and do not identify the foundational root causes and contributing factors
- Lack of timely investigations and resulting actions
- Recommended actions that are superficial and ineffective
- Safety IT tools that fail to communicate with each other
- An ERM system that does not fully comply with either OMB guidance or NIST's own ERM policies
- Absence of a robust quality assurance and audit system
- Lack of deep systems-based safety knowledge and demonstrated competency and proficiency

Only when these have been addressed can NIST have a true SMS that proactively promotes the health and safety of the workforce and community.



CHAPTER 4

Safety Culture

Organizational Culture

Organizational culture is the shared values and beliefs that drive behavior in an organization. Although the concept of organizational culture is widely understood, the relationship between organizational culture and safety culture, along with their impact on safety performance, is not. Organizational culture and the associated norms, beliefs, and values that shape behavior within the organization establish the foundation for safety culture. For example, it is difficult to have a strong safety culture within a broader organizational cultural context that does not create a strong sense of psychological safety, justice, and fairness. Relatedly, strengthening an organization's safety culture often requires strengthening the broader organizational culture.

Safety culture, specifically, can be considered both a top-down and bottom-up phenomenon; policies, practices, and procedures create an overall environment in which bottom-up tension points are resolved, with safety being a priority.[18] These policies, practices, and procedures must be married with strong leadership at all levels, creating and reinforcing an environment wherein safety is prioritized. A strong safety culture is one in which proactive actions (e.g., job methods, processes, procedures, and risk assessments) are taken to continuously improve all aspects of safety.[19] While safety knowledge and training can positively influence compliance with accepted safety standards, a proactive safety culture requires a broader work environment that signals to employees that it is psychologically safe to speak up and that leadership actively seeks input, listens to this input, and responds constructively.

18 D. Zohar and D. A. Hofmann, "Organizational climate and culture," *The Oxford Handbook of Industrial and Organizational Psychology*, ed. S.W.J. Kozlowski (Oxford University Press, D.A., 2012), 643–666).

19 M. A. Griffin and A. Neal, "Perceptions of safety at work: A framework for linking safety climate to safety performance, knowledge, and motivation," *Journal of Occupational Health Psychology* 5 (2000): 347–358.

A strong safety program and culture not only results in compliance with accepted safety standards; it also creates a proactive orientation of ongoing safety improvement, shared at all levels of the organization, and a coherence in all elements of the organization reinforcing safety as a core value.

A strong safety culture also requires a positive, reinforcing cycle of proactive identification of existing safety issues, action by leadership to address these issues, and communication of actions taken. This full cycle of learning and ongoing improvement builds a strong safety culture in which voicing safety issues is rewarded and reinforced by closed-loop communication on actions taken. Beyond this learning cycle, other core components of a strong safety culture include leadership accountability, rewards and recognition, employee involvement, safety reporting to executive leadership, robust SMSs, and safety performance and measurement that focuses on leading indicators. All of these components need to be strongly aligned to reinforce safety as a core value, thereby forming a strong safety culture.

Beyond Compliance

A strong safety culture requires much more than compliance. Thus, compliance with safety requirements should not be the end goal of a safety program, but rather the natural outcome of a working environment with strong safety systems and a mindset that prioritizes safety.

NIST staff, however, demonstrate a "compliance mindset" in which safety compliance is considered the ultimate goal. Furthermore, the Commission found through interviews, document reviews, analysis of the fatality investigation, and reviews of other incidents that NIST has not even achieved consistent compliance with accepted safety standards.

Stated clearly, a strong safety program and culture not only results in compliance with accepted safety standards; it also creates a proactive orientation of ongoing safety improvement, shared at all levels of the organization, and a coherence in all elements of the organization reinforcing safety as a core value. This is what NIST needs to achieve.

Top-Down and Bottom-Up Approaches

Building a strong safety culture requires every person in the organization to emphasize, through their words and actions, that safety—both personal and operational—is a core operating principle.

From a strategic perspective, safety culture needs to be planned and fostered by senior leadership. Without senior leadership buy-in, no safety culture change process will be successful. Senior leadership needs to create a supportive culture (as described above) and establish safety as a foundational component of the organization's operations (structures, procedures, polices). Below is a list of senior leaders' responsibilities. While certainly not exhaustive, this list constitutes the top-down part of building a strong safety culture.

- Model a safety-first approach in both words and actions, considering both the intended and untended consequences of leaders' words (or lack of words) and actions (or lack of actions)
- Ensure safety performance can occur by securing and allocating resources to:
  - Provide appropriate equipment, in good working order, where it is easily accessible
  - Invest in the physical work environment so that it supports safe work and does not create incentives, intended or not, that promote workarounds
- Create a detailed organizational structure that involves safety professionals in all strategic decisions, thereby ensuring safety considerations are front and center in decision-making
- Align other supporting processes, such as the risk assessment processes, safety reviews, and learning systems
- Establish a strong system for continuous improvement

The bottom-up aspect of safety culture moves the focus from organizational and safety culture to the roles of individuals. Staff are confronted every day with a multitude of signals suggesting what is prioritized in their particular work environments. The indicators include:

- How their jobs are designed
- Whether they have adequate tools and resources
- How the physical facilities are maintained—and what their upkeep (or lack of upkeep) signals about the value of the worker and the work
- What senior leadership's implicit and explicit goals are
- What goals and objectives are emphasized by influential peers and immediate supervisors
- How tension points between safety and cost/productivity are resolved day in and day out
- How middle and senior managers allocate resources—and how those decisions signal what is truly important and valued
- How much status and power the OHSE organization has

A strong safety culture is created when these signals consistently, explicitly, and transparently emphasize that safe performance is valued, expected, rewarded, and supported, thus creating a coherence within the culture. In contrast, a weaker safety culture occurs when messaging is inconsistent or, worse, consistently prioritizes other things (cost, schedule, productivity) above safety. Clearly, some of the signals noted above are under senior leadership's control, but others reside with middle and front-line leaders—and with every employee. Building a strong safety culture requires every person in the organization to emphasize, through their words and actions, that safety—both personal and operational—is a core operating principle. In this sense, safety culture is "enacted" every day, in every part of the organization, by the collective words and actions of the individuals carrying out the work. These words and actions must align with the core value of safety, as well as the policies, practices, and procedures helping to guide this work.

Improving safety culture, therefore, requires consideration of the broader organizational culture to ensure the foundational elements are present. Different aspects of the safety infrastructure must be shifted to align these signals for every employee within the organization. Improving SMSs, safety training, and other programmatic elements (as outlined in this final report) will have positive impacts on the safety culture, as these changes will start to align and create a more coherent signal to employees that safety is a core value. Safety culture is the result of the collective actions taken by everyone at NIST—but it begins with clear rationales and definitive actions taken by NIST leadership.

Cultural Inconsistency at NIST

Employee Categorization

With respect to organizational structures and how they signal the priority of safety (and the safety culture that results from those signals), the Commission observed a significant distinction between federal employees and associates, especially as pertains to the degree to which they can participate in, influence, access, and carry out certain safety-related activities.

As one salient example, associates do not have a consistent policy for personal protective equipment (PPE) reimbursement; federal employees do. Technically, while NIST may provide all generic PPE required for associates (including, e.g., safety glasses, gloves, lab coats, face masks, N95 masks, OSHA toes), NIST is not allowed to reimburse associates for user-specific custom PPE such as prescription safety glasses and custom work shoes, although in some instances this did happen. As a result, some associates either had to purchase their own user-specific PPE or chose to go without. This choice signals a "lesser than" employment category and does not provide the appropriate resources to do the job safely—a core component of a strong safety culture. In another example, associates did not have access to, or the authority to engage with, safety systems such as the Incident Reporting and Investigation System (IRIS).

Institutions with strong safety cultures engage every person in safety processes and safety improvement. Having inconsistent safety policies and procedures increases the personal risks to associates and creates a status distinction between two employee groups, which hinders the development of a strong collaborative organizational culture and a strong safety culture.

9 **RECOMMENDATION:** Make appropriate administrative, policy, and organizational changes to establish and promote an enterprise-wide sense of responsibility and ownership for safety, by 1) increasing the role of OSHE in Organizational Unit (OU) safety operations, 2) holding all employees accountable for their safety roles, awareness, and performance, and 3) eliminating differences between federal employees and associates regarding their safety roles and responsibilities.

9a. FINDING: NIST's philosophy of OU ownership of safety has the (unintended) consequence of relegating OSHE to an advisory role with little to no authority and lessened safety impact. This siloed approach results in a failure to take advantage of learning from one OU and sharing across the NIST enterprise to proactively mitigate risks.

9b. FINDING: Federal employees and associates perform many similar research activities and thus have similar exposures to risks and propensity for being involved in safety incidents yet have distinctly different safety authority. This inequity results in exposure to unmitigated safety risks.

9c. FINDING: There is a lack of consistent understanding of safety principles at the most fundamental level throughout the organization, which adversely affects a positive safety culture.

9d. FINDING: NIST's approach to safety is primarily reactive and compliance-based, compared to a preferred proactive and sustained approach. The compliance approach results in a safety culture that is fragmented and inconsistent and in which the value that the organization places on safety is merely cosmetic.

In Commission interviews, significant themes emerged about breakdowns in the positive, ongoing, continuous improvement learning cycle. Participants noted ongoing safety issues, some of which had existed for years; examples include poor lighting, electrical wiring issues, flooding, and non-operable safety showers. There also appears to be a breakdown in communication as to whether and when issues are resolved. In short, the process to raise safety issues is portrayed as either unclear or burdensome; and in terms of outcomes, the response to raised issues is untimely, the issue is treated as not time-urgent, and/or no action is taken.

New safety policies, procedures, and programs at NIST must be coupled with an active audit system to verify their efficacy, or inform the need for changes, in helping drive improvements in NIST's safety culture.

When issues are reported, yet seemingly no action is taken, the result can be a "learned helplessness" or "why bother" attitude among employees. In other words, individuals can eventually conclude that the organization does not really care about or value safety and that pointing out issues is fruitless. Individuals, particularly safety professionals, perceive a lack of control over their environment. This perceived lack of control is a contributing factor to work burnout and psychological exhaustion. Over time, the lack of timely resolution of these types of issues signals that safety is not a priority and communicates a lack of concern for worker well-being. Furthermore, the non-responses lead to the adoption of workarounds that increase the risk of harm and injury—and indeed, the Commission found that workarounds were commonly accepted when core issues were not properly resolved.

Focus group sessions with the Commission and reviews of prior reports, such as the 2022 assessment report on the NIST NCNR Reactor Incident by Thomas Mason (Director, Los Alamos National Laboratory), highlighted the ongoing failure of NIST leadership to prioritize safety aspects or to address safety issues effectively and in a timely and sustained manner.[20] As noted in the NIST NCNR report, "...the inadvertent message sent to staff that impacts the nuclear safety culture is that safety is not as important as the marquee scientific investments that do attract funding." This finding is consistent with discussions about how the decisions, actions, and statements by leaders throughout NIST signal what is truly valued, expected, rewarded, and supported within the NIST organization. Currently, there are far too many signals suggesting that other issues take priority over safety.

In addition to ensuring that raised safety concerns are treated with appropriate urgency, NIST leadership can engage staff and promote the importance of safety through direct contact and visits to research spaces. This is known colloquially as "management by walking around." An effective approach involves management visiting sites while work is being conducted, without advance notice, and the visiting leaders should be engaged in learning about and providing advice—not only on scientific results and technical challenges but also on hazards and risks.

NIST has a formal program titled Management Observation Process (MOP), created to institutionalize this strategy.[21] Unfortunately, MOP is failing to achieve its goals and may actually be worsening the safety culture. The Commission spoke with leaders who had never participated and with staff who had never seen their supervisors conduct such visits, thus reinforcing the message that safety is not important. Visits that did occur did not necessarily take place when work was being conducted such that safety issues could be observed. Instead, the MOP visits were more of a tour of the work environment, with significant advance notice.

20 NIST NCNR Reactor Incident Review, prepared for NIST by Thomas Mason of Los Alamos National Laboratory, February 14, 2022, https://www.nist.gov/system/files/documents/2022/08/02/T.%20Mason%20Report%20on%20NCNR_2022.pdf.

21 NIST, "Management Observation Process," NIST S 7101.05, issue date August 8, 2019, https://www.nist.gov/system/files/documents/2023/08/07/NIST%207101-05_Management%20Observation%20Process_080819.pdf.

Safety Assessments

Finally, part of the learning cycle (described in the introduction to this section) should be an ongoing safety audit and assessment process. An organization with a strong safety culture eagerly and proactively seeks out information on safety performance, identifying gaps in order to close them. Thus, new safety policies, procedures, and programs at NIST must be coupled with an active audit system to verify their efficacy, or inform the need for changes, in helping drive improvements in NIST's safety culture.

Unfortunately, as discussed in Section 3 (Safety Management Systems), NIST will not have full implementation of rigorous safety audits and assessments until 2024, despite numerous changes to safety procedures and programs that have been implemented over more than ten years (since the 2008 NIST Blue Ribbon Commission).

10 **RECOMMENDATION:** Take visible and proactive measures to inculcate essential elements of a robust safety culture, with NIST leadership promoting an engaged and informed learning culture involving all NIST personnel.

10a. **FINDING:** Instantiations of a compliance mindset instead of a proactive safety attitude, particularly in training, field inspection, and policy, have been observed and reported, which promotes minimal safety for standard procedures and increases safety risk in unique, complex, or non-standard/non-routine procedures.

10b. **FINDING:** Transparency, awareness, and follow-up of safety-related activities and actions are lacking, leading to mistrust and pessimism of some staff toward management's and leadership's safety commitment. Further, an absence of explicit risk-based prioritization and acceptance of residual risks in the determination of what safety actions are taken erode staff confidence in the value of safety.

10c. **FINDING:** The management observation process is not having its intended effect of visibility, engagement, and effectiveness promoting safety, because of inconsistent participation by leadership and deficiencies in execution (e.g., the process is not conducted during active laboratory operations and is focused on compliance issues rather than hazards and risks).

10d. **FINDING:** NIST staff spoke of a lack of safety prioritization by NIST leadership. This finding was also reported by Thomas Mason (Director, Los Alamos National Laboratory) in his 2022 NIST NCNR Reactor Incident Review: "… staff observation of the difficulty in resolving long standing safety concerns of a non-nuclear nature (examples cited include ladders and stairwells). This reflects a NIST challenge of deferred maintenance and insufficient funding to address infrastructure deficiencies that is not limited to NCNR, however the inadvertent message sent to staff that impacts the nuclear safety culture is that safety is not as important as the marquee scientific investments that do attract funding."[22]

22 NIST NCNR Reactor Incident Review, prepared for NIST by Thomas Mason of Los Alamos National Laboratory, February 14, 2022, https://www.nist.gov/system/files/documents/2022/08/02/T.%20Mason%20Report%20on%20NCNR_2022.pdf.

Safety Culture Survey

In Fiscal Year 2023, NIST took the positive step of having the National Safety Council (NSC) administer a Safety Barometer survey.[23] Although the results suggest some positive indicators (e.g., a Supervisor Engagement percentile score of 86.8), more of the results are concerning. For example, the Management Commitment, Employee Involvement, Safety Support Activities, and Safety Support Climate dimensions all scored under the 60th percentile, indicating significant room for improvement on multiple dimensions. Overall, NIST scored in the 70th percentile relative to their peer group assigned by the NSC based on the North American Industry Classification System categories, and in the 64th percentile compared with the entire NSC database of 1,530 organizations, thus indicating significant concerns across the board with respect to safety culture.

Further, the NSC-assigned peer group does not provide a useful juxtaposition. Rather than compare itself to a broad group of institutions, NIST should be comparing its safety culture to other national institutes and laboratories that conduct research with hazardous materials, processes, and equipment (e.g., NASA, the National Institutes of Health, the National Renewable Energy Laboratory, the U.S. Department of Defense, and the U.S. Department of Energy). Even among this group of peers, NIST should aim to be a leader, not merely average, in safety culture.

The NSC survey report also noted a number of "focus areas," or areas requiring further efforts. These represent the lowest-performing questions on the survey and are areas of concern to the Commission, as some are key drivers of safety culture. The ten questions highlighted as focus areas are:

- Employees using basic precautions for hazardous materials
- Management setting annual safety goals
- Effectiveness of safety committee (e.g., Executive Safety Committee, Safety Advisory Committee, and OU) in improving safety conditions
- Quality of preventative maintenance systems operation
- Perception that good environmental conditions are kept
- Management providing adequate safety staff
- Management publishing a policy on the value of employee safety
- Safety standards relative to production/work output standards
- Perception that medical resources are sufficient
- Employees following procedures to isolate hazardous energy sources

These focus areas align with problematic findings identified from staff interviews and document reviews conducted by the Commission. One notable example is that, during the interviews, OSHE members unanimously described the safety culture as poor while exhibiting significant emotional distress over the work environment at NIST, while NIST leadership had a significantly more positive view of the safety culture.

Therefore, NIST should take significant, quick, and decisive actions that will improve the organizational and safety culture of the institution. As part of those actions, NIST needs to dive more deeply into these NSC survey results and, combined with the Commission's recommendations, develop a plan of action, with tasks to be executed over the next three, six, nine, and twelve months.

One important consideration is that the NSC Safety Culture Survey results may indicate that some staff and leaders within the organization do not fully understand what a progressive safety culture entails. Thus, having key leaders and employees engage in a benchmarking exercise with other federal institutions known for having a strong safety culture (see the list of peers above) might be a very instructive first step. Additionally, consultation with experts should be considered as a mechanism for ensuring an ongoing critical review of safety improvement activities.

23 NIST, "2022–2023 NSC Safety Barometer Results," December 2022 – February 2023, https://www.nist.gov/system/files/documents/2023/08/07/NIST%20Full%20Report%202022_2023%20NSC%20Survey%20Results%20Report_041823.pdf.

The NSC safety perception survey should be considered a baseline measurement, and NIST should conduct additional surveys periodically to help determine clear conclusions and outcomes from actions taken. Assuming NIST takes quick action on many of the recommendations contained within this report, it might be useful to repeat the survey in a more frequent cadence over the next few years (e.g., annually instead of biannually).

Finally, it is important to remember that safety culture surveys are the start of a conversation, not the end. In other words, these surveys do not provide answers, nor do they enable any firm conclusions. Rather, they spotlight areas where conversations should start and with what priorities. Results should precipitate further investigation—through focus groups and other ways to engage employees—of what lies behind the numbers.

Other Indicators

While safety culture surveys are an integral component of measuring safety improvement, there are other safety measurement indicators to evaluate. There are usually three categories of leading indicators: operations-based, systems-based, and behavior-based. There has been a shift in industry toward looking at leading indicators, largely owing to the increased understanding that organizational and human factors (as opposed to purely physical or technical failures) are primary causes of safety incidents. Given the range of activities occurring within NIST, we recommend senior leadership work with external consultants who can help formulate both organization-wide and sub-unit-level leading indicators. Although forward-looking leading indicators are very important to examine, lagging indicators should also be analyzed. These include items such as LTIFR (lost time incident frequency rate), TRIR (total recordable incident rate), and DART (days away, restricted, or transferred) rate.

Remote Work

The above discussion clearly explains and highlights the major role that NIST leadership contributes to organizational culture and safety culture. The importance of this role should be considered in light of the impacts of the COVID-19 pandemic (as noted in Section 2). NIST leaders could possibly do the majority of their work remotely, yet experimentalists need to be onsite to conduct much of their research. Those experimentalists could benefit from the direct person-to-person assistance, experience, and knowledge of their senior colleagues in evaluating hazards, observing experiments in progress, and setting safety expectations so critical for establishing a strong safety culture.

11 **RECOMMENDATION:** Analyze results from the 2023 National Safety Council's "Safety Culture Survey," along with previous safety culture surveys, to develop a robust safety culture improvement plan.

11a. FINDING: Key actions identified from the 2017 safety culture survey do not include metrics to demonstrate implementation or sustained organizational and safety culture improvement. Both leading and lagging indicators should be considered to measure safety improvement.

11b. FINDING: The safety culture perception is inconsistent throughout NIST. A positive view of the current safety culture is possibly overrated by upper management and indicates an undesirable hierarchical difference in perception as to the confidence of staff. This is particularly concerning with respect to some staff views of upper management's attitude and support of safety.

CHAPTER 5

Facilities and Infrastructure

The NIST Safety Commission was not directly charged with reviewing the conditions of NIST facilities and physical infrastructure. However, the Commission received information, from senior leadership briefings and through interviews with bench researchers and administrative staff, on the poor state of NIST buildings, services, and utilities. Many of these comments were further substantiated by document reviews and visits performed by the Commission.

In 2023, the National Academies of Sciences, Engineering, and Medicine issued a report focused on NIST facilities titled Technical Assessment of the Capital Facility Needs of the National Institute of Standards and Technology.[24] The goal of this effort was to review and make recommendations on NIST facility and utility infrastructure in greatest need of recapitalization or repair, as well as issues with the greatest impacts on implementing the research mission. The report concluded:

> *NIST facilities are not world class and are therefore a growing impediment against attracting and retaining staff in a highly competitive STEM environment. Moreover, the longstanding facilities problems have created a culture of workarounds by scientific staff that distracts from R&D efforts.*

Practically speaking, these facility and infrastructure deficiencies increase risk directly (e.g., through physical workplace hazards), indirectly (through unauthorized workarounds being adopted as standard practice), and symbolically. It is this third dimension—the symbolic value of facility and infrastructure investment (or the lack thereof)—that is often overlooked. Similar to the broken learning cycle discussed in Section 4, insufficient ongoing investment in facilities and infrastructure communicates to employees minimal concern for their safety, limited investment in their work more broadly, and a lack of respect for the highly trained and professional employees they are. During interviews, Commission members observed that the perpetual underfunding of NIST facilities had a negative impact on participant attitudes and commitment to the organization. These facility and infrastructure deficiencies increase both the need for workarounds and the job demands of the physical environment; in other words, the physical environment and resulting workarounds make doing the work more difficult. These increased job demands can become a low-grade stressor that eventually starts to erode motivation and work engagement.

The work ethos and safety culture are negatively affected by the broken and failing facilities and the disheartening effects of continuing deferral of needed improvements.

Overall, substandard, broken, and failing facilities and infrastructure create numerous challenges for NIST personnel:

- The timely progress of NIST science is impeded by the substandard facilities needed to support advancement.
- The work ethos and safety culture are negatively affected by the broken and failing facilities and the disheartening effects of continuing deferral of needed improvements.
- NIST personnel are directly endangered by failing and failed structures and the patchwork of workarounds created in place of true fixes and upgrades.

24 The full report is available here: https://nap.nationalacademies.org/catalog/26684/technical-assessment-of-the-capital-facility-needs-of-the-national-institute-of-standards-and-technology.

The current condition of infrastructure is additional evidence of a long-standing missed opportunity to identify and prioritize needs: the ERM Council and NIST top leadership should employ a systems-based and risk-informed management process, which is the hallmark of a healthy and well-functioning SMS. Such a system would be used to employ existing resources and, as needed, obtain additional resources to achieve both research and safety objectives.

While infrastructure issues are a contributing factor to safety vulnerabilities, the Commission does not believe that the infrastructure issues are the root cause of NIST's safety problems. The infrastructure issues merely add to the safety issues; the underlying problems go much deeper. The infrastructure issues are impacted by an inadequate systems- and risk-based ERM program, which could provide leadership with integrated systems- and risk-based information to enable prudent, well-informed decision-making. In fact, an argument could be made that a systems-based, risk-informed decision-making process would have reconciled the infrastructure needs more effectively to date.

12 **RECOMMENDATION:** Implement an overall capital investment and infrastructure improvement plan, as many buildings and facilities need significant renovations or replacement to address both research and safety issues. Safety issues alone should justify funding and guide all designs and implementations.

12a. FINDING: The 2023 National Academies of Sciences, Engineering, and Medicine report "Technical Assessment of the Capital Facility Needs of the National Institute of Standards and Technology" highlights the significant infrastructure deficiencies at NIST by stating, "Most of the older laboratories that have not been renovated fail to provide the functionality needed by world-class scientists on vital assignments of national consequence."

12b. FINDING: While mentioning safety in context—"A substantial number of facilities, in particular the general purpose laboratories, have functional deficiencies in meeting their environmental requirements for temperature and humidity, and of electrical systems for stability, interruptability, and for life safety"—the report fails to cite significant actual injuries, property damages, and close calls that resulted from substandard infrastructure.

12c. FINDING: There are many instances in decades-old facilities in which safety considerations were not incorporated in the design process (e.g., Prevention through Design), making issues difficult to address in later stages of development and operation.[25]

12d. FINDING: Aging infrastructure, deferred maintenance, deferred repairs, and numerous workarounds have negative impacts on staff morale. The low staff morale in several areas contributes to a less favorable view of safety culture. The poor infrastructure and required workarounds *symbolically* convey a diminished concern by management about employee safety and well-being.

12e. FINDING: These facility issues have not been systematically addressed with respect to their safety context for prioritization by NIST management, thus inhibiting a robust organizational safety culture.

25 The National Institute for Occupational Safety and Health (NIOSH) website explains Prevention through Design: https://www.cdc.gov/niosh/topics/ptd/default.html.

CHAPTER 6

Engagement and Implementation

From many one-on-one discussions between the Commission and NIST personnel, it is clear that people care deeply about the institution, its ongoing science, and the safety of its personnel. However, numerous and substantial impediments are hindering achievement of a robust safety culture. High among those impediments are insufficient prioritization of safety by both leadership and staff, inadequate SMSs, and inconsistent safety competencies. Those and many specific issues were previously identified in the 2008[26] and 2010[27] Blue Ribbon Commission reports, which were created in response to the 2008 plutonium spill incident. It is clear to the Commission that NIST worked to change numerous aspects of its SMS after that incident, but despite substantial initial progress, some components were never completed, some were not continuously improved, and others were never addressed.

Again NIST is challenged—by not one but two major incidents that have highlighted, in dramatic fashion, the organization's ongoing safety challenges. First, an unplanned shutdown and an aborted confinement re-entry on February 3–4, 2021, at the NCNR resulted in termination of more than two years of active research projects using the nation's premier neutron beam facility. Second, failures of safety protocols in the NFRL resulted in the death of an engineering technician on September 26, 2022. These events, along with other not-insignificant incidents in recent years, have led to this NIST Safety Commission and a commitment from the Director of NIST, Dr. Laurie Locascio, to meaningful and lasting change. Her charge to the Commission was to clearly identify the state of safety at NIST and issues that require correction. Subsequently, her mandate to NIST after receiving the Commission's report will be to create, improve, and live by safety systems that will make NIST not merely compliant with safety requirements but a model for research safety.

Indeed, at the May meeting of the Commission, Dr. Locascio outlined numerous actions she initiated to implement the Commission's recommendations. She has established an Executive Safety Leadership Team, allocated resources to address safety needs, changed the authorities and role of the CSO, set expectations and accountabilities for leadership, and made a commitment as the NIST Director to prioritize safety going forward. For these actions to result in real change that will truly benefit NIST, these initial steps must be followed through with concrete action plans, timetables for implementation, mandated commitment to safety by all NIST personnel, complete overhaul of SMSs, and an overall goal for NIST to become a model for safety. OSHE will play an outsized role in this transformation, so the dialogue that was started between NIST leadership and the NIST safety community must be continued and expanded.

Like Director Locascio, the Commission wants to see fundamental change at NIST. Thus, as a result of these perspectives, the Commission has two recommendations beyond those focused on safety leadership, SMSs, and safety culture.

First, Commission members offer their time and commitment to assist NIST in implementing the journey to a more effective SMS, building personnel's trust, and ingraining organization-wide perspectives essential to a strong safety culture. Hence, the Commission can meet with NIST after delivery of this report to provide advice, guidance, and interpretations on the numerous safety improvements recommended through this report.

26 *Final Report of the NIST Blue Ribbon Commission on Management and Safety*, November 2008, https://www.nist.gov/system/files/documents/2017/05/09/final1108.pdf.

27 *Final Report of the NIST Blue Ribbon Commission on Management and Safety II*, November 2010, https://www.nist.gov/system/files/documents/2017/05/09/BRCIIFinalNov12.pdf.

Second, beyond the Commissioners, there are safety professionals in the nation who could provide outstanding coaching, expertise, guidance, and insight as NIST reworks its safety programs. Bringing in outside critical eyes can help to spot vulnerabilities, identify improvements, and introduce new ideas and methods that will greatly aid NIST in its quest to improve safety. These outside critical eyes could also assist with increasing safety competencies across the organization and developing safety-conscious leaders, from senior leadership to first-line supervisors and all levels in between.

Indeed, NIST need not reinvent the wheel of safety. There are well-known examples of organizations completely changing their approaches to safety and deriving tremendous rewards as a result. (Consider the classic case of Paul O'Neill's tenure as Chief Executive Officer of Alcoa, starting in 1987.) In addition, numerous tools and programs are available to guide SMSs. For example, OSHA provides guidance on many aspects of SMSs and safety structures emphasizing management leadership, worker participation, robust hazard identification and control, and training. In fact, OSHA contributed to consensus standards that have been published at both the national (ANSI Z10-2019) and international levels (ISO 45001-2018).

NIST will reap enormous benefits, both along the way and when it elevates safety to a new level.

Ideas without plans, goals, timelines, and accountabilities remain just that—ideas. Thus, the Commission recommends NIST develop and execute a clear plan of actions designed to improve all of the components of safety across the institution. Key parts of this plan should be clear expectations, rationales, timelines, roles, responsibilities, accountabilities, and authorities to guide and measure improvements. There are no simple quick fixes that will result in a positive safety culture, so a multipronged and sustained approach is necessary; but NIST will reap enormous benefits, both along the way and when it elevates safety to a new level. NIST is in a unique position as a creator of national and international standards to improve its own outcomes and potentially grow into a national model of SMS practices across federal agencies.

13 **RECOMMENDATION:** Meet with the NIST Safety Commission approximately 90 days after delivery of the final NIST Safety Commission report to allow discussions ensuring that the plans, actions, and associated schedules for NIST's implementation are consistent with the Commission's intent as set by these recommendations. This timeframe is before the termination of the Commission on November 30, 2023, as set forth by the Charter.

13a. FINDING: There has been a consistent pattern of incomplete responses and mixed success of corrective actions in relation to recommendations of NIST-created commissions and surveys, such as the 2008 and 2010 NIST Blue Ribbon Commissions and the 2017 Employee Engagement Survey.

14 **RECOMMENDATION:** NIST should obtain outside advice/expertise/oversight from external experts on its SMS and plans, actions, and associated schedules for implementation, as those are generated in response to the recommendations in the final NIST Safety Commission report.

14a. FINDING: Missing actions addressing recommendations from previous NIST-created commissions and surveys and technical errors in the current NIST SMS suggest that NIST could benefit from continuing outside advice and expertise.

CHAPTER 7

Conclusions and Outlook

The Commission identified numerous areas where NIST can improve safety across the institution from top to bottom. The root causes of NIST's safety deficiencies are embodied in the findings and recommendations of the Commission. Those specific root causes include:

- Safety not treated as a priority for mission success at all levels of the organization and, in particular, by senior leadership
- Inadequate treatment of safety as an enterprise risk
- Lack of a rigorous quality assurance program
- Unclear and inconsistent roles, responsibilities, accountabilities, and authorities for implementing safety
- Incomplete, inefficient, and inconsistent SMSs and processes
- Safety competencies not established as a priority in mission and mission support organizations

If NIST implements concrete and decisive action plans based on the Commission's findings and recommendations, the organization will be on the path to becoming a more effective research and development organization with a robust SMS and strong commitment to safety. All personnel at NIST will feel valued and safe, and continuous improvement and learning will be a part of everyday activities. NIST could then become a safety leader among research and development organizations and federal agencies that conduct research. Achieving this vision will require sustained commitment and lasting change, where all personnel at NIST are part of a questioning, learning, and safe workplace that produces high-impact science and technology for the nation. It will be well worth the effort.

> ***This will require sustained commitment and lasting change, where all personnel at NIST are part of a questioning, learning, and safe workplace that produces high-impact science and technology for the nation.***

NIST is a premier scientific institution conducting cutting-edge science projects to advance the nation's industrial competitiveness by advancing measurement science, standards, and technology to benefit our economic security. The Commission recommends a guiding principle to achieve that mission: Science done well is science done safely.

> ***Science done well is science done safely.***

15 **RECOMMENDATION:** Design and implement changes to the SMS, with a long-term vision to be a world-class model for research safety, in keeping with NIST's role as the world leader in metrics and standards.

15a. FINDING: NIST has not incorporated a robust audit system into its SMS to provide metrics on safety program efficacy.

15b. FINDING: NIST has not effectively partnered with other federal agencies that use similar hazardous equipment, materials, and processes to establish and share successful practices for safe research.

15c. FINDING: NIST has not effectively partnered with other federal agencies that have expertise in worker protection (such as the Occupational Safety and Health Administration Voluntary Protection Program) to proactively design, implement, study, and analyze safety systems designed to prevent fatalities, injuries, and illnesses.

15d. FINDING: NIST has not utilized resources available from, or even considered becoming, one of the NIOSH Centers of Excellence for *Total Worker Health*.[28] These Centers build the scientific evidence to develop innovative solutions to complex problems in keeping employees safe and productive.

15e. FINDING: NIST has not benchmarked its SMS or safety leadership actions to other federal agencies working with high hazards, such as NASA or the U.S. Department of Energy.

28 Information about the NIOSH Centers is available here: https://www.cdc.gov/niosh/twh/centers.html.

APPENDIX A

NIST Safety Commission Charter

U.S. DEPARTMENT OF COMMERCE
NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY
NIST SAFETY COMMISSION

CHARTER

1. **Committee's Official Designation (Title).** NIST Safety Commission (Commission).

2. **Authority.** The Commission is being established under agency authority pursuant to 15 U.S.C. § 1512 and in accordance with the Federal Advisory Committee Act, as amended (FACA), 5 U.S.C. App.

3. **Objectives and Scope of Activities.** The Commission shall provide advice to the Director of the National Institute of Standards and Technology (NIST) on matters relating to (a) safety policies, (b) safety management system, practices, and performance, and (c) safety culture.

4. **Description of Duties.** The Commission will function solely as an advisory body, in accordance with the provisions of the FACA. The Commission shall assess the state of NIST's safety culture and how effectively the existing safety protocols and policies have been implemented across NIST. The NIST Director may charge the Commission with specific areas of focus.

   The Commission shall submit one or more oral and written reports to the NIST Director on its findings. The Commission shall provide an oral briefing of its preliminary findings to the NIST Director within 75 days of beginning its activities, and written findings within 150 days of beginning its activities.

5. **Agency or Official to Whom the Committee Reports.** The Commission shall report to the Director of NIST.

6. **Support.** NIST, through the Director's Office, shall provide support for the Commission and shall ensure compliance with the requirements of the FACA, governing federal statutes and regulations, and established Department of Commerce policies and procedures.

7. **Estimated Annual Operating Costs and Staff Years.** The estimated annual operating cost to NIST, to include travel, meetings, and contract support, is approximately $500,000. The estimated annual personnel cost to NIST is 1.5 full-time equivalents.

8. **Designated Federal Officer.** The Director of NIST will appoint a Designated Federal Officer (DFO) and Alternate Designated Federal Officer (ADFO) from among the employees of NIST. The DFO will: approve or call all Commission meetings and subcommittee meetings; prepare and approve all meeting agendas; attend all Commission meetings and subcommittee meetings; adjourn any meeting when the DFO determines adjournment to be in the public interest; and chair meetings when directed to do so by the Director of NIST. The ADFO will serve as DFO when the DFO is not available.

9. **Estimated Number and Frequency of Meetings.** It is estimated that the Commission will convene approximately three times over a 150-day period.

10. **Duration.** It is anticipated that the Commission will carry out its activities over the period of one year. While it is anticipated that the activities of the Commission will be largely completed over a period of 150 days, additional time will be required to allow for follow-on requirements from NIST.

11. **Termination.** This Commission will terminate one (1) year from the date of filing its charter with the standing committees of the U.S. Senate and House of Representatives having legislative jurisdiction of the agency unless earlier terminated or renewed by proper authority.

12. **Membership and Designation.** Members of the Commission shall be appointed by the Director of NIST. The Commission shall be composed of not more than seven members who are qualified to provide advice to the NIST Director on matters relating to safety policies; safety management system, practices, and performance; and safety culture.

    The membership shall be fairly balanced and drawn from industry, academia, federal laboratories, and other relevant sectors. Membership shall also consider balance among the broad diversity of disciplinary specialties represented in the NIST Laboratories, including the physical sciences; chemical, biological, and materials sciences and engineering; structural engineering and fire research; manufacturing and mechanical engineering; and information and communication technologies.

    Each member will be a qualified expert with public or private sector experience in one or more of the following areas: (a) management and organizational structure; (b) laboratory management and safety; (c) safety training and operations; (d) hazardous materials safety and security; (e) emergency medical response; or (f) organizational safety culture.

    Each member will serve for the duration of the Commission. Members shall serve in their personal capacities as Special Government Employees (SGEs) as defined in Title 18 of the United States Code, Section 202(a). SGEs are subject to conflict-of-interest laws and regulations, including (but not limited to) the obligation to annually file a New Entrant Confidential Financial Disclosure Report (OGE Form 450) and complete ethics training. Members of the Commission who are full-time or permanent part-time federal officers or employees will be appointed pursuant to 41 C.F.R. § 102.3.130(h) to serve as Regular Government Employee (RGE) members. Members will be individually advised of the capacity in which they will serve through their appointment letters.

    The Director of NIST shall appoint the Commission Chair and a Vice-Chair to serve in the absence of the Chair from among the Commission membership. Both members will serve in those capacities for the duration of the Commission, at the pleasure of the Director.

    Commission members will, upon request, be reimbursed for travel and per diem as it pertains to official business of the Commission in accordance with 5 U.S.C. § 5701 et seq. Commission members will serve without compensation, except that federal government employees who are members of the Commission shall remain covered by their compensation system pursuant to 41 C.F.R. § 102-3.130(h).

    Members shall not reference or otherwise utilize their membership on the Commission in connection with public statements made in their personal capacities without a disclaimer that the views expressed are their own and do not represent the views of the Commission, NIST, the U.S. Department of Commerce, or the U.S. Government.

13. **Subcommittees.** NIST, when necessary and consistent with the Commission's mission and Departmental policies and procedures, may establish subcommittees, drawn in whole or in part from the Commission, pursuant to the provisions of the FACA, the FACA implementing regulations, and applicable Departmental guidance. Subcommittees must report back to the Commission and must not provide advice or work products directly to NIST, and any recommendations based on their work will be deliberated and adopted by the Commission prior to dissemination.

14. **Recordkeeping.** The records of the Commission, formally and informally established subcommittees, or other subgroups of the Commission will be handled in accordance with the General Records Schedule 6.2 or other approved agency records disposition schedule. Subject to the Freedom of Information Act, 5 U.S.C. § 552, records presented to or prepared for or by the Commission are available for public inspection. The DFO will oversee recordkeeping and appropriate filings.

JEREMY PELTER
Digitally signed by
JEREMY PELTER
Date: 2022.12.01 10:10:42 -05'00'

Acting Chief Financial Officer and
Assistant Secretary for Administration

12/01/2022

Filing Date

APPENDIX B

NIST Director's Charge to the NIST Safety Commission

At the first meeting of the NIST Safety Commission on January 4, 2023, in Gaithersburg, Maryland, Dr. Laurie Locascio, the Under Secretary of Commerce for Standards and Technology and the Director of the National Institute of Standards and Technology, charged the Commission to:

Assess the state of NIST's safety culture and how effectively the existing safety protocols and policies have been implemented across NIST.

The Commission will evaluate:

- the quality and completeness of NIST safety directives and programs,
- the performance of safety protocols and the responses to recent incidents and near-misses, and
- the impacts of the pandemic and hybrid work environment on safety.

The Commission should consider:

- perspectives of NIST staff and management,
- NIST's responses to significant safety-related incidents and near-misses,
- findings from investigations and reviews of incidents, and
- implementation of corrective actions to prevent future incidents and improve safety performance, as well as actions taken to strengthen safety culture at NIST facilities.

APPENDIX C

NIST Director's Charge to the NIST Safety Commission Subcommittee to Review NIST's Final National Fire Research Laboratory Incident Investigation Report

At the second full meeting of the NIST Safety Commission on February 9, 2023, in Boulder, Colorado, Dr. Laurie Locascio, the Under Secretary of Commerce for Standards and Technology and the Director of the National Institute of Standards and Technology, charged a subcommittee of the Commission to:

Conduct an independent review of the written final NIST investigation report on the death of an experienced NIST staff member in September 2022, in a fall from an elevated height when part of a research structure collapsed.

The Subcommittee will assess:

- the quality and thoroughness of the incident investigation,
- the quality and thoroughness of the analysis of root causes and causal factors, and
- the applicability and robustness of the planned corrective actions.

The Subcommittee's written report of this independent review—and any recommendations for additional corrective and preventive actions for inclusion in the Commission's final report—will be:

- discussed at the Commission's third public meeting, and
- incorporated as a standalone appendix in the Commission's final report.

The Subcommittees members are:

- Joseph M. Kolly, PhD
- James P. Bagian, MD, PE (ret)
- Darryl C. Hill, PhD, CSP

APPENDIX D

Summary of Findings and Recommendations of the NIST Safety Commission

The following recommendations, based on the indicated findings, represent the opinions of the NIST Safety Commission as derived from presentations and discussions with NIST leadership; review of detailed written information provided by NIST; and frank, live interviews with numerous NIST employees. The key outcomes are summarized below, and the Commission's report places these recommendations and findings in context. The Commission views these recommendations as immediately actionable by NIST as it begins the process of reinventing its safety posture.

Organization and Leadership

1 **RECOMMENDATION:** Revise the reporting structure such that the Office of Safety, Health, and Environment (OSHE) and all related environmental, health and safety (EH&S) functions report directly to the NIST Director. Further, the Chief Safety Officer (CSO) should be a voting member of the Enterprise Risk Management (ERM) Council. Moreover, the NIST Director should make any other organizational changes needed to ensure the success of these specific recommendations.

1a **FINDING:** Placement of OSHE under the Management Resources directorate does not adequately prioritize research safety or inform the NIST Director of safety risks.

1b **FINDING:** It is not clear that NIST leadership has demanded the highest level of professional and technical expertise from all personnel involved in safety.

1c **FINDING:** Research safety is not adequately considered or prioritized in the ERM Risk Inventory by the ERM Council, despite significant risks to human life or institutional mission, as demonstrated by known incidents involving injuries, physical damages, and a fatality.

1d **FINDING:** The occupational and environmental medicine (OEM) physician and medical team of competent and qualified/licensed professionals are underutilized or missing resources in the risk management process, discounting their value as an existing quality assurance asset. The current placement of the OEM physician neither adequately prioritizes occupational health and safety within NIST nor informs the NIST Director of operational program status or employee health and safety concerns.

1e **FINDING:** While issues resulting from the COVID pandemic presented NIST with additional safety challenges, they are not thought to be material to the foundational safety vulnerabilities this Commission identified and described in detail below, along with many documented in the 2008 and 2010 Blue Ribbon Commission reports.

1f **FINDING:** In the fifteen years since the first NIST Blue Ribbon Commission on Management and Safety report and the many changes to safety management systems since, NIST leadership has not required the person leading OSHE to have i) a thorough knowledge of safety systems, ii) demonstrated ability to successfully run a large safety organization, and iii) ability to lead the creation and implementation of new SMS components needed at NIST.

Safety Management Systems and Safety Processes

2 **RECOMMENDATION:** Establish and implement a safety audit system into the Safety Management System (SMS) that proactively identifies hazards and their associated risks, provides quality-assurance-based feedback on performance of corrective actions and activities, and is compatible and consistent with the intention of a high-quality SMS as exemplified by the standards set by ISO 45001 or ANSI Z10.

2a **FINDING:** The lack of an audit process in NIST's SMS has not been appropriately prioritized, causing a material weakness and elevated risk to the organization's safety posture.

2b **FINDING:** This recommendation was also made by the 2008 NIST Blue Ribbon Commission: "Currently NIST has no independent, systematic, and comprehensive internal audit procedures to ensure compliance with safety standards and regulations."

2c **FINDING:** This recommendation was also made by the 2010 NIST Blue Ribbon Commission: "NIST's safety program will indicate metrics that would be appropriate to monitor safety requirements that are applicable throughout NIST. Once these requirements have been established, safety performance will be monitored, measured, assessed, and audited."

3 **RECOMMENDATION:** Improve the Hazard Review and Approval System (HR) and Relative Hazard Index (RHI) process, to include quantifiable likelihood definitions based on specified timeframes, validation/verification of user proficiency, and requirements for a reviewing role by OSHE.

3a **FINDING:** The HR is a capable tool for hazard identification but requires improvements for quality hazard management.

3b **FINDING:** RHI assessments are somewhat arbitrary, contributing to a false sense of safety risk acceptance.

3c **FINDING:** The current risk matrix used by NIST is deficient and lacks defined time references to determine likelihood.

3d **FINDING:** ANSI Z10 is being incorrectly interpreted and used as a risk assessment aid.

3e **FINDING:** The emergency response plans that are part of the hazard review package in the HR are not well understood or practiced and thus not consistently/reliably actionable by staff.

4 **RECOMMENDATION:** Develop more relevant safety training and more effective methods of delivery, addressing specific safety concerns of researchers and staff that are generated to provide targeted and actionable information.

4a **FINDING:** Some safety information is treated as if it were "spam," owing to irrelevance, or is too generic and basic, feeling more like a "check the box" exercise focused on compliance, which results in missed opportunities for safety education and reinforcement.

4b **FINDING:** Many NIST researchers take their safety responsibilities seriously, but all personnel require/desire access to better tools, training, and expertise to fulfill their safety responsibilities.

5 **RECOMMENDATION:** Revise the Workplace Inspection Program such that inspection teams include both subject matter experts and OSHE staff, inspection teams have authority to mandate changes, inspections look beyond compliance issues to work practices and research hazards, and inspection findings are corrected and verified in a timely manner.

5a **FINDING:** Laboratory inspections do not always include OSHE staff and are sometimes led by people lacking sufficient expertise or who were not unbiased, for example, a person inspecting a laboratory under their authority.

5b **FINDING:** The laboratory inspection checklist was detailed with appropriate topic areas to be examined; however, it focused on compliance rather than on actual work practices or research hazards and risks specific to that laboratory.

5c **FINDING:** Inspection findings are not prioritized consistently for correction, many corrections have no timeframe mandated for completion, and are not verified by safety staff to have been completed or to have been effective in achieving their goals to mitigate identified vulnerabilities and eliminate or control risk at an acceptable level.

5d **FINDING:** OSHE staff reported that, while they are periodically invited by Organizational Units (OUs) to visit certain specific research spaces, their requests to access research spaces were sometimes denied.

6 **RECOMMENDATION:** Improve the Incident Reporting and Investigation Program to enable effective incident reporting functionality, usage, prioritization, response, and communication. Improve the Incident Reporting and Investigation Program to enable effective incident investigations with regard to explicit risk-based prioritization of what is investigated, who leads the investigation, and how incidents are investigated; identification of true root causes (not just identification of superficial proximate causes); formulation of recommendations and actions that clearly address root causes (not just proximate causes); identification of contributing factors to mitigate risks; timeliness of investigations; and follow-through on completion and effectiveness of recommended corrective actions.

6a **FINDING:** A significant number of researchers interviewed did not know how to submit Incident Reporting and Investigation System (IRIS) reports, were not authorized to submit IRIS reports, found the reporting system too cumbersome, were not encouraged to report close calls, and did not know how reports were utilized in improving their work environment.

6b **FINDING:** Placing responsibility and authority for initiating investigations, determining actions, and following up on actions at each OU level creates an actual or perceived conflict of interest, limits generalized learning, and may result in unrecognized and increased organizational risk.

6c **FINDING:** The tools for determining hazard-induced risk use definitions of likelihood that have no specified period of time over which the likelihood is defined. This leads to inconsistent prioritization and inefficient allocation of resources and detracts from the establishment and maintenance of a robust and sustainable culture of safety.

6d **FINDING:** The investigation process is not sufficiently standardized, and the metrics for quality and success of the investigations are not adequate; for example, root causes may not be correctly identified.

6e **FINDING:** Investigation reports performed by OUs or OSHE seldom properly identified and determined contributing factors and root causes.

6f **FINDING:** Investigations and their subsequent actions are not accomplished in a timely manner.

6g **FINDING:** No systematic method exists to audit what is accomplished or to provide independent quality assurance for the investigation process or the success of interventions.

6h **FINDING:** Incident reporting information is being emailed to employees without categorization or prioritization as to individual relevance, resulting in staff stating they view it as spam and, thus, in a detrimental impact on safety.

7 **RECOMMENDATION:** Conduct a comprehensive review and audit of all safety-related information technology (IT) systems, and based upon that review, make the necessary changes/fixes to ensure seamless integration and interoperability of safety information across all safety system IT tools. In addition, establish an advisory panel of safety stakeholders to periodically review effectiveness of these systems, and empower the panel to make recommendations for continual improvement.

7a **FINDING:** NIST created a number of IT safety systems, but they do not work together or share common data.

7b **FINDING:** Explicit usability testing was not employed for the tools, such as IRIS, and this resulted in less-than-desired use, efficiency, and benefit from their employment.

8 **RECOMMENDATION:** Improve the ERM program, and its current standard of processes and practices, to better address critical research safety matters. For example, enterprise-wide audits/scans of safety issues should be conducted; and the process of adding items to the Risk Inventory, which informs strategic decisions by NIST leadership, should be more timely and efficient.

8a FINDING: The ERM system is being used as a general business tool, and safety risks to personnel are not adequately considered.

8b FINDING: The ERM process and ERM Council do not adequately address and manage risks, thus appearing ineffective, addressing only high-level safety risks. The ERM Council is failing to inform executive leadership's safety awareness for timely risk-setting deliberations and prioritizations.

8c FINDING: The ERM process has technical shortcomings, for example, the likelihood criteria of the Risk Scoring Matrix, objective uses of Risk Appetite and Risk Tolerance, and reporting of Risk Treatment Plans and their status as required by OMB Circular A-123 V.B. The Matrix does not employ likelihood definitions that have a grounding in an actual time reference, without which reliable determination of risk is virtually impossible.

8d FINDING: While ERM personnel do personally brief the ERM Council, they are not present when the NIST Director is briefed. This increases the likelihood that senior managers are deprived of an accurate picture of the systems-level implications of the hazards and risks that exist.

8e FINDING: ERM personnel do not proactively explore or identify organization risks that have enterprise implications. ERM personnel reported that they take input only from NIST organizational elements and do not systematically verify the veracity of the reports.

8f FINDING: Deficiencies in safety issues even being considered by the ERM Council were also noted by Thomas Mason (Director, Los Alamos National Laboratory) in his 2022 NIST Center for Neutron Research (NCNR) Reactor Incident Review: "…the NCNR had only been added to the NIST Risk Matrix shortly before the incident and only then in the context of an ageing reactor that might not meet beam delivery needs of the scientific community. The fact it represents the highest hazard operation across all of NIST seems not to have been formally recognized."[29]

Safety Culture

9 **RECOMMENDATION:** Make appropriate administrative, policy, and organizational changes to establish and promote an enterprise-wide sense of responsibility and ownership for safety, by 1) increasing the role of OSHE in Organizational Unit (OU) safety operations, 2) holding all employees accountable for their safety roles, awareness, and performance, and 3) eliminating differences between federal employees and associates regarding their safety roles and responsibilities.

9a FINDING: NIST's philosophy of OU ownership of safety has the (unintended) consequence of relegating OSHE to an advisory role with little to no authority and lessened safety impact. This siloed approach results in a failure to take advantage of learning from one OU and sharing across the NIST enterprise to proactively mitigate risks.

9b FINDING: Federal employees and associates perform many similar research activities and thus have similar exposures to risks and propensity for being involved in safety incidents yet have distinctly different safety authority. This inequity results in exposure to unmitigated safety risks.

9c FINDING: There is a lack of consistent understanding of safety principles at the most fundamental level throughout the organization, which adversely affects a positive safety culture.

9d FINDING: NIST's approach to safety is primarily reactive and compliance-based, compared to a preferred proactive and sustained approach. The compliance approach results in a safety culture that is fragmented and inconsistent and in which the value that the organization places on safety is merely cosmetic.

29 The review report is available here: https://www.nist.gov/system/files/documents/2022/08/02/T.%20Mason%20Report%20on%20NCNR_2022.pdf.

10 **RECOMMENDATION:** Take visible and proactive measures to inculcate essential elements of a robust safety culture, with NIST leadership promoting an engaged and informed learning culture involving all NIST personnel.

10a FINDING: Instantiations of a compliance mindset instead of a proactive safety attitude, particularly in training, field inspection, and policy, have been observed and reported, which promotes minimal safety for standard procedures and increases safety risk in unique, complex, or non-standard/non-routine procedures.

10b FINDING: Transparency, awareness, and follow-up of safety-related activities and actions are lacking, leading to mistrust and pessimism of some staff toward management's and leadership's safety commitment. Further, an absence of explicit risk-based prioritization and acceptance of residual risks in the determination of what safety actions are taken erode staff confidence in the value of safety.

10c FINDING: The management observation process is not having its intended effect of visibility, engagement, and effectiveness promoting safety, because of inconsistent participation by leadership and deficiencies in execution (e.g., the process is not conducted during active laboratory operations and is focused on compliance issues rather than hazards and risks).

10d FINDING: NIST staff spoke of a lack of safety prioritization by NIST leadership. This finding was also reported by Thomas Mason (Director, Los Alamos National Laboratory) in his 2022 NIST NCNR Reactor Incident Review: "…staff observation of the difficulty in resolving long standing safety concerns of a non-nuclear nature (examples cited include ladders and stairwells). This reflects a NIST challenge of deferred maintenance and insufficient funding to address infrastructure deficiencies that is not limited to NCNR, however the inadvertent message sent to staff that impacts the nuclear safety culture is that safety is not as important as the marquee scientific investments that do attract funding."[30]

11 **RECOMMENDATION:** Analyze results from the 2023 National Safety Council's "Safety Culture Survey," along with previous safety culture surveys, to develop a robust safety culture improvement plan.

11a FINDING: Key actions identified from the 2017 safety culture survey do not include metrics to demonstrate implementation or sustained organizational and safety culture improvement. Both leading and lagging indicators should be considered to measure safety improvement.

11b FINDING: The safety culture perception is inconsistent throughout NIST. A positive view of the current safety culture is possibly overrated by upper management and indicates an undesirable hierarchical difference in perception as to the confidence of staff. This is particularly concerning with respect to some staff views of upper management's attitude and support of safety.

30 The review report is available here: https://www.nist.gov/system/files/documents/2022/08/02/T.%20Mason%20Report%20on%20NCNR_2022.pdf.

Facilities and Infrastructure

12 **RECOMMENDATION:** Implement an overall capital investment and infrastructure improvement plan, as many buildings and facilities need significant renovations or replacement to address both research and safety issues. Safety issues alone should justify funding and guide all designs and implementations.

12a FINDING: The 2023 National Academies of Sciences, Engineering, and Medicine report "Technical Assessment of the Capital Facility Needs of the National Institute of Standards and Technology" highlights the significant infrastructure deficiencies at NIST by stating, "Most of the older laboratories that have not been renovated fail to provide the functionality needed by world-class scientists on vital assignments of national consequence."

12b FINDING: While mentioning safety in context—"A substantial number of facilities, in particular the general purpose laboratories, have functional deficiencies in meeting their environmental requirements for temperature and humidity, and of electrical systems for stability, interruptability, and for life safety"—the report fails to cite significant actual injuries, property damages, and close calls that resulted from substandard infrastructure.

12c FINDING: There are many instances in decades-old facilities in which safety considerations were not incorporated in the design process (e.g., Prevention through Design), making issues difficult to address in later stages of development and operation.[31]

12d FINDING: Aging infrastructure, deferred maintenance, deferred repairs, and numerous workarounds have negative impacts on staff morale. The low staff morale in several areas contributes to a less favorable view of safety culture. The poor infrastructure and required workarounds symbolically convey a diminished concern by management about employee safety and well-being.

12e FINDING: These facility issues have not been systematically addressed with respect to their safety context for prioritization by NIST management, thus inhibiting a robust organizational safety culture.

Engagement and Implementation

13 **RECOMMENDATION:** Meet with the NIST Safety Commission approximately 90 days after delivery of the final NIST Safety Commission report to allow discussions ensuring that the plans, actions, and associated schedules for NIST's implementation are consistent with the Commission's intent as set by these recommendations. This timeframe is before the termination of the Commission on November 30, 2023, as set forth by the Charter.

13a FINDING: There has been a consistent pattern of incomplete responses and mixed success of corrective actions in relation to recommendations of NIST-created commissions and surveys, such as the 2008 and 2010 NIST Blue Ribbon Commissions and the 2017 Employee Engagement Survey.

14 **RECOMMENDATION:** NIST should obtain outside advice/expertise/oversight from external experts on its SMS and plans, actions, and associated schedules for implementation, as those are generated in response to the recommendations in the final NIST Safety Commission report.

14a FINDING: Missing actions addressing recommendations from previous NIST-created commissions and surveys and technical errors in the current NIST SMS suggest that NIST could benefit from continuing outside advice and expertise.

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31 The National Institute for Occupational Safety and Health (NIOSH) website explains Prevention through Design: https://www.cdc.gov/niosh/topics/ptd/default.html.

15 **RECOMMENDATION:** Design and implement changes to the SMS, with a long-term vision to be a world-class model for research safety, in keeping with NIST's role as the world leader in metrics and standards.

15a **FINDING:** NIST has not incorporated a robust audit system into its SMS to provide metrics on safety program efficacy.

15b **FINDING:** NIST has not effectively partnered with other federal agencies that use similar hazardous equipment, materials, and processes to establish and share successful practices for safe research.

15c **FINDING:** NIST has not effectively partnered with other federal agencies that have expertise in worker protection (such as the Occupational Safety and Health Administration Voluntary Protection Program) to proactively design, implement, study, and analyze safety systems designed to prevent fatalities, injuries, and illnesses.

15d **FINDING:** NIST has not utilized resources available from, or even considered becoming, one of the NIOSH Centers of Excellence for *Total Worker Health*.[32] These Centers build the scientific evidence to develop innovative solutions to complex problems in keeping employees safe and productive.

15e **FINDING:** NIST has not benchmarked its SMS or safety leadership actions to other federal agencies working with high hazards, such as NASA or the U.S. Department of Energy.

Recommendations from NIST Safety Commission Subcommittee Review of NIST's Final National Fire Research Laboratory Incident Investigation Report

16 **RECOMMENDATION:** NIST needs to further develop the proximate causes they have already identified and go back into the causal chain to arrive at organizational and systemic-level root causes and contributing factors.

17 **RECOMMENDATION:** Upon reaching the root causes mentioned in Recommendation 16, NIST should derive corrective actions that address those deeper elements of the causal chain, focusing on systemic mitigations for actions taken at the organizational level.

32 Information about the NIOSH Centers is available here: https://www.cdc.gov/niosh/twh/centers.html.

APPENDIX E

NIST Safety Commission Subcommittee Review of NIST's Final National Fire Research Laboratory Incident Investigation Report

Introduction

At the request of the NIST Director, a Subcommittee of the NIST Safety Commission was established to conduct an independent review of the written final NIST investigation report on the death of an experienced NIST staff member in the National Fire Research Laboratory (NFRL) on September 26, 2022, in a fall from an elevated height when part of a research structure collapsed.[33] The Subcommittee was asked to assess and make recommendations on:

- The quality and thoroughness of the incident investigation
- The quality and thoroughness of the analysis of root causes and causal factors
- The applicability and robustness of the planned corrective actions

The Subcommittee received the final version of the NIST accident investigation report on April 14, 2023. On April 21 and May 5, NIST executive leadership and senior Office of Safety, Health, and Environment (OSHE) staff briefed the Subcommittee on the content of the report.

This Subcommittee assessment is limited, at the direction of the NIST Director, to a review of the report and information obtained from these briefings. No further investigative activities, interviews, site visits, or document reviews were used in this assessment, with one exception: medical professionals of the Commission conducted a limited review of the facts of the resulting accident fatality and cause of death.

The NIST investigation began within the 24 hours following the accident, at the direction of the Chief Safety Officer (CSO). The CSO directed the Deputy CSO to lead the NIST investigation team. The Subcommittee was informed that the CSO and OSHE were treating the investigation as a priority activity. No specific written directives and no specific deadline for completion were issued by the NIST Director. The Federal Occupational Safety and Health Administration (OSHA) conducted a concurrent investigation, though as of the publication of this Subcommittee report, the OSHA report had not yet been issued.[34]

NIST Investigation Team

- Investigation team leader – the Deputy Chief Safety Officer
- The Senior Safety Manager
- An industrial engineer
- An industrial hygienist from the Engineering Laboratory
- A senior supervisor from a different work group within the Engineering Laboratory
- A supervisory engineer

33 NIST, Final Report – Investigation of the Fatality at the National Fire Research Laboratory, April 7, 2023, https://www.nist.gov/system/files/documents/2023/04/13/FINAL%20REPORT--Investigation%20of%20the%20Fatality%20at%20the%20National%20Fire%20Research%20Laboratory_3.pdf.

34 OSHA, Inspection Detail on 1624755.015 – U.S. Department Of Commerce, United States Department of Labor website, accessed August 2023, https://www.osha.gov/ords/imis/establishment.inspection_detail?id=1624755.015.

General Comments

Part A of the NIST accident report, by the NIST investigative team, describes pre-accident conditions and circumstances that are consistent with those observed by the NIST Safety Commission during the course of their broader assessment activities—namely, actions, policies, and organizational functions that are emblematic of a weak safety culture and a weak safety management program. The report describes evidence of a lack of personal responsibility for safety, lack of workplace safety practices, lack of appropriate supervisory safety oversight, and acceptance of improper hazard and risk assessments, all of which resulted in a cavalier (less than thorough or comprehensive) attitude among the Engineering Laboratory (EL) staff toward workplace safety. Additional details are highlighted in the Commission's final report.

Part B of the NIST accident report is the Executive Team Review and NIST-Level Corrective Action Plan. The purpose of this section was explained as the need to consider the incident from a broader systems-level perspective, looking beyond just the causes and corrective actions as they pertained to the NFRL fatality. The Subcommittee agrees, although it is not clear why the investigative team did not address this need for a system-level evaluation. The consensus of the Subcommittee is that the investigative team (in Part A) could have better addressed the subject matter in Part B, thereby avoiding both perception of an incomplete or rushed investigation and, more importantly, potential conflict(s) of interest between an independent investigation team and executive management.

Executive Team to review the NIST Incident

- The Director of the Physical Measurement Laboratory
- The Director of the Office of Facilities and Property Management
- The Director of OSHE

The assessment herein highlights many of the Subcommittee's most significant observations. Neither the NIST Director's charge to the Subcommittee nor the Subcommittee's own determination intended that this assessment be a fully comprehensive analysis of the investigation.

Quality and Thoroughness of the Incident Investigation

The NIST investigation team limited its scope to proximate actions surrounding the event and the functions and responsibilities directly related to the NFRL. The Subcommittee was informed by the NIST Director that she imposed no scheduling pressures to complete the investigation. However, it is the opinion of the Subcommittee that the investigation's overall scope should be broadened for the reasons explained herein.

The NIST investigation team arrived at an accurate and adequate description of the sequence of events leading to and including the accident. Other specific elements of the investigation were sufficiently developed to support inclusion or exclusion of causal factors:

- Engineering analysis of the structural failure
- Investigation of the hazard reviews
- Roles and actions of the work crew and project team
- Explanation of the test program and its planning
- Documentation of wreckage, equipment, and structure

However, several significant issues are either not discussed or not identified as contributing factors to this accident, as discussed below.

- There appears to be a lack of consistency or an overly narrow application in the interpretation, application, and enforcement of standard OSHA and U.S. Department of Homeland Security and Federal Emergency Management Agency requirements and guidelines regarding demolition of building structures. This matter was not developed in the investigation and is likely a critical factor in identifying the appropriateness of the process that led to authorizing the demolition task.
- The report did not discuss in appropriate depth:
    - What the previous work and management practices were (i.e., what usually happened in the past)
    - How those past practices correspond to NIST policies, as well as other external regulations and policies, such as OSHA-related ones (i.e., what should have happened, as defined in policies and regulatory requirements)

- How the past practices and requirements are related to the current fatality accident (i.e., how what should have happened compares with what actually happened in the accident under investigation)

  This investigative avenue would aid in understanding whether the inciting events leading to the mishap were unique or representative of how work is usually performed, as well as whether the administrative controls are sufficiently robust. The inquiry would also reveal something of the historical attitude with respect to safety. This more comprehensive approach, rather than mere identification of proximate causes, would provide a more thorough and in-depth understanding that makes possible the formulation of more useful and effective countermeasures.

- The medical data and analysis in the report, such as the deceased's toxicology results and the physical causes of injuries related to the mechanism of death, appear not to have been sufficiently investigated, nor were they sufficiently documented as to possible contributions either to the event itself or to the fatal outcome. This lack of thoroughness on the medical front may have resulted from the composition of the investigation team, which did not include a qualified physician or other medically trained personnel familiar with, possessing experience in, and qualified to investigate events of this nature.[35]

It is noted, however, that during the review of the medical factors, the Subcommittee found significant shortcomings in the documentation and analysis of the occupational and environmental medicine (OEM) factors leading up to the time of the incident. The Subcommittee found many instances of inadequate OEM practice and expertise, thus compromising their ability to ensure workforce health and safety prior to and at the time of the incident.

These include:

1. Lack of OSHA required components of fall protection and respiratory protection including properly trained spirometry staff to ensure employees were protected from respiratory hazards.
2. Inadequate assessment of environmental factors associated with indoor use of the outdoor-rated, gasoline powered masonry saw.
3. Absence of appropriately qualified OEM expertise in the hazard review process.

As a result of these omissions, the Subcommittee and the NIST investigation team could not thoroughly assess the potential of medically related human factors (qualification, performance, etc.) for their contribution to the causal chain of events.

- The report did not discuss some aspects of site safety management that are very relevant to the circumstances of this accident. These include detailed discussion of concrete saw operations (e.g., hazards assessment, operation protocols, and compliance), as well as management observation processes and their frequency during all phases of the program.
- Work crew actions and the crew's deliberation over the relative hazard index for the demolition task should have been analyzed further to assess their potential impact on causation and corrective actions.

There are other areas of investigation that are not sufficiently discussed and that should be considered for inclusion, mainly to document that these matters were considered and determined to be non-factors:

- Accident timeline: How did work proceed that day (specific times, activities, and actors)? Were there unusual activities or interruptions that distracted the crew from diligence?
- Emergency response: Was the reporting and arrival of the responders timely? What was the nature of the medical assistance and treatment on scene? Did anything contribute to the severity of the outcome? (The Subcommittee was subsequently informed that the emergency response was described in the police report, which was reviewed by the investigation team but not reproduced in the NIST report.)
- Work crew toxicology: Was the crew tested to ensure fitness for duty?
- Work program schedule analysis for each element of the project: Were there schedule pressures that encouraged shortcuts and workarounds?

35 The Subcommittee consulted with Commissioner Dr. Allison L. Jones to review the OEM issues and other medical aspects of the Investigation Report.

Overall, the Subcommittee has concluded that the investigation obtained a comprehensive collection of the relevant factual information necessary as the basis for an investigation report. The report has identified the correct proximate (immediate) cause of the accident, namely improper procedures in the demolition of the test facility floor, leading to its collapse while being occupied by a worker, resulting in his death.

However, the analysis of the factual information to find cause(s), contributing factors, and corrective actions needs further development. Specifically, the report has overlooked and failed to follow up on important factors affecting the ability to identify true root cause(s) of the accident and the associated systems-based corrective actions, as explained below.

Quality and Thoroughness of the Analysis of Root Causes and Causal Factors

Recognizing the accident report's limited scope, the causes and factors identified in the report are correct as developed and written. The Subcommittee observes, however, that the "root causes" as identified in the report are more consistent with proximate causes, as practiced by other investigative methodologies. The report goes on to ultimately identify eleven root causes (RCs) of the accident, associated with two causal factor (CF) categories, as follows.

1. **CF1: Inadequate planning of slab 4 removal**
   a. **RC 1.1:** Initial hazard review package and subsequent versions were inadequately reviewed.
   b. **RC 1.2:** Work was performed outside of the approved scope during demolition of fire-tested floor.
   c. **RC 1.3:** The hazard review package was inadequately re-reviewed and not re-approved.
   d. **RC 1.4:** Work authorization requirements were inconsistently applied when comparing teardown activities to the conduct of the experiment itself.
   e. **RC 1.5:** EL has no mechanism to ensure quality hazard reviews are being developed and approved.
2. **CF2: Accidental loading of slab 4 while it was fully suspended by the rigging**
   a. **RC 2.1:** Standard safe operating procedures were not developed for demolition work of the surrounding floor.
   b. **RC 2.2:** Staff without the appropriate knowledge of workplace hazards were authorized.
   c. **RC 2.3:** Staff continuously performed unsafe acts.
   d. **RC 2.4:** Safety responsibilities were consolidated in a single individual.
   e. **RC 2.5:** Management relied too heavily on experience, perceived or otherwise.
   f. **RC 2.6:** Work operations were not continually monitored or updated for compliance.

It is the opinion of the Subcommittee that the root cause determinations made by NIST should go back further into the causal chain to reach root causes at a more foundational and organizational level. In this way, identification of root causes derived from this accident will more effectively reduce the likelihood of future related scenarios and circumstances, through generalized learning and corrective actions at a systemic level.

Some of the deeper, truer root causes of this accident involve the circumstances (e.g., authorities, policies, and decision-making) that allowed taking on this complicated, high-risk demolition activity without a proper professional experienced crew and without thorough expert engineering and safety planning. The investigation has not followed several of these circumstances back to their organizational and enterprise-level origins—for example, the circumstances that:

- Led to the determination that members of the NIST research team could conduct demolition of a building superstructure.
- Allowed a complete absence of any meaningful assistance or involvement from OSHE to perform independent safety oversight, audits, and quality assurance throughout the planning, execution, and demolition of test programs.

- Allowed incorrect, unvalidated, and unqualified analysis and work outside of areas of expertise to be accepted, relied upon, and used throughout research program execution.

These issues are not specific to the composite floor test program execution. They have origins that predate the program itself and require careful retrospective analysis of decisions made, perhaps, by previous administrations. Issues such as lack of audits and independent quality assurance were cited as weaknesses requiring attention, going back to the Blue Ribbon Commission Report in November of 2010, but solutions have not been implemented; these same issues were likely contributing factors to this accident.

Reaching further back into the causal chain to identify the organizational-level causes will maximize the safety impact of a more systemic set of corrective actions. A specific example is RC 1.2, taken from the NIST report. Walking this further back into the causal chain elucidates organizational causes that can be used to identify corrective actions that have greater propensity to more broadly improve safety. For example, the causal chain responsible for accepting the risk of the demolition task might more appropriately expand upon RC 1.2 to look like this:

RC 1.2: Work was performed outside of the approved scope during demolition of fire-tested floor.

↓

A local decision was made that the technical research team was capable of conducting demolition work on its own.

↓

The decision to conduct this hazardous, non-standard demolition work was not identified as an enterprise risk.

↓

OSHE does not have the organizational authority or an adequate safety management system audit process to ensure enterprise risks are identified and evaluated.

↓

NIST's Enterprise Risk Management (ERM) has an ineffective organizational construct and audit process to ensure enterprise safety risks are brought to executive leadership's attention for risk acceptance and oversight.

This alternate root cause analysis, terminating with the failure of the ERM process, and the penultimate cause citing OSHE shortcomings listed above, can then lead to the development of more systemic corrective actions to address this and other similar enterprise-level safety risks.

For example, in this case, NIST Safety Commission Recommendations 1 and 8 (as identified in the Safety Commission's Final Report) would address these two elements in the causal chain.

1 **RECOMMENDATION:** Revise the reporting structure such that the Office of Safety, Health, and Environment (OSHE) and all related environmental, health and safety (EH&S) functions report directly to the NIST Director. Further, the Chief Safety Officer (CSO) should be a voting member of the Enterprise Risk Management (ERM) Council. Moreover, the NIST Director should make any other organizational changes needed to ensure the success of these specific recommendations.

8 **RECOMMENDATION:** Improve the ERM program, and its current standard of processes and practices, to better address critical research safety matters. For example, enterprise-wide audits/scans of safety issues should be conducted; and the process of adding items to the Risk Inventory, which informs strategic decisions by NIST leadership, should be more timely and efficient.

Therefore, it is recommended that NIST take the time afforded by the Director to delve deeper and go further upstream in the casual chain than the level of proximate causes that are already identified. By doing so, NIST will be able to identify the systemic organizational and enterprise-level causes and formulate more broadly applicable corrective actions that will maximize the safety improvement/impact across the entire NIST enterprise.

Applicability and Robustness of the Planned Corrective Actions

The Subcommittee was informed that the corrective actions in the report are written at three levels of applicability: at the NFRL level, the EL level, and the NIST or enterprise level. The Subcommittee was also informed that these corrective actions were written at a "high level," meaning specifics of timeframes or schedules, responsible agents, publication and communication, and the like were not included at this time. This makes it impossible for the Subcommittee to render more than a tentative opinion as to the corrective actions' applicability and robustness at this time.

In general, the corrective actions in the report address the (proximate) causes identified in the investigation. However, where the corrective actions are superficial, NIST should be careful not to assume these will suffice to mitigate similar problems going forward. For example, consider RC 1.1:

> **RC 1.1:** The initial hazard review package and subsequent versions were inadequately reviewed.
>
> Identified failure: Non-compliance with work authorization procedures composite floor
>
> Project management failed to have the initial and subsequent versions of the Composite Floor System Stabilization and Demolition hazard review package adequately reviewed by a demolition safety subject matter expert. As a result, the following factors were not addressed in the hazard review package:
>
> - Appropriate demolition safety training;
> - Safety requirements for demolition work;
> - Safety best practices for demolition work; and
> - All hazards and associated control measures associated with the demolition work.

And the report develops a corresponding Corrective Action 1:

- The NFRL Group shall evaluate all current activities covered by a hazard review to ensure a subject matter expert with the appropriate safety knowledge, skills, and abilities (KSAs) for the work being performed has sufficiently reviewed the planning of the work and concurred on the identified control measures. Where appropriate, a stop work order shall be issued until the work is completely covered by an approved hazard review.

Recommendations like this are concerning because before this accident occurred, it is likely NIST thought that the hazard review package and the system that allowed Organizational Units to proceed independently were adequate to run NIST operations. Knowing that, it is not clear that these proposed interventions are materially different from past approaches. In this example, the corrective action is little more than telling people to "be careful not to let it happen again."

There are also corrective actions that are not addressed but that should be covered when a more robust analysis of root causes is undertaken. For example, there is no mention of components of OSHA Recommended Practices for Safety and Health Programs for both general industry[36] and the construction industry,[37] which outline that effective safety and health programs incorporate all of the core elements: management leadership, worker participation, hazard identification and assessment, hazard prevention and control, education and training program evaluation and improvement, and communication.

Conclusion

Overall, the Subcommittee concludes that the report has identified the correct proximate (immediate) cause of the accident, namely, improper procedures in the demolition of the test facility floor, leading to its collapse while being occupied by a worker, resulting in his death. However, as detailed above, the report does not take its analysis deep enough into the causal chain of events, resulting in an incomplete investigation.

The Subcommittee opines that the investigation and report can serve as a valuable foundation for the needed additional work. Additional analysis to identify true root causes at the organizational level can build upon the investments already made. It is strongly suggested that the root cause examples cited above serve as a starting point for that work which will then provide the information needed to promote meaningful improvements at NIST. If such work is not performed,

36 The general OSHA Recommended Practices for Safety and Health Programs are available here: https://www.osha.gov/sites/default/files/publications/OSHA3885.pdf.

37 The OSHA Recommended Practices for Safety and Health Programs in Construction are available here: https://www.osha.gov/sites/default/files/OSHA3886.pdf.

this investigation will miss identifying critical safety vulnerabilities and thus reduce the ability to prevent future incidents.

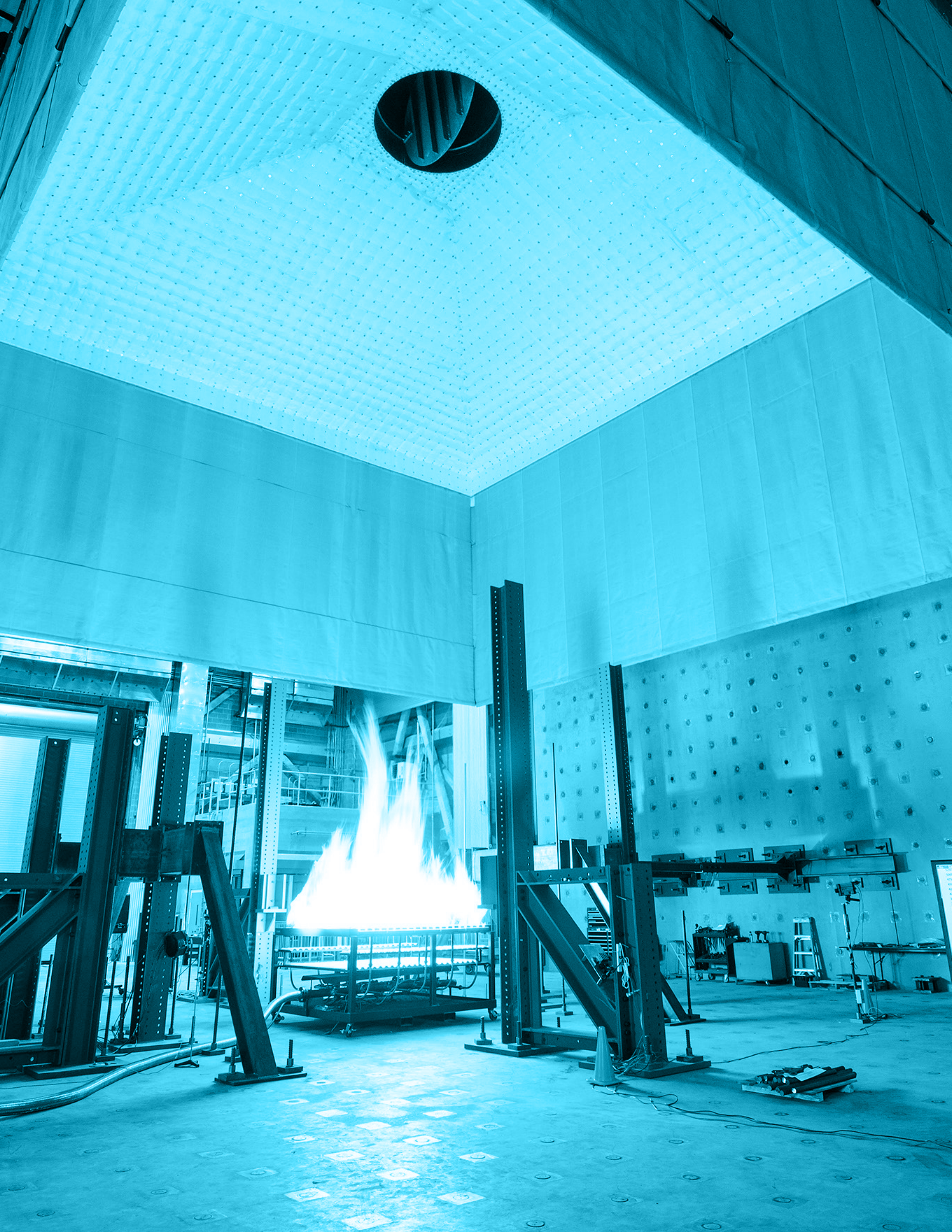
It follows that the majority of the corrective actions in the report are not sufficient in and of themselves. They need to be supplemented or superseded by additional actions at a higher organizational level, addressing true root causes. Without these additional actions, effective and sustainable safety improvements are unlikely. Hence, all corrective actions must have specific details beyond vague terms such as “adequate,” schedules for completion must be established, and metrics must be identified to provide objective evidence of implementation and effectiveness. Furthermore, those actions must also include authorities, identifying which individual has the responsibility and authority to execute the planned actions and which individual is empowered to approve and accept the residual risk after the improvements are implemented.

Recommendations

The NIST accident investigation report should be revised and expanded to more comprehensively address the organizational failures of NIST in the circumstances leading to this fatal accident. In revising the report, the Subcommittee makes the following recommendations:

A. NIST needs to further develop the proximate causes they have already identified and go back into the causal chain to arrive at organizational and systemic-level root causes and contributing factors.

B. Upon reaching the root causes mentioned in Recommendation A, NIST should derive corrective actions that address the deeper elements of the causal chain, focusing on systemic mitigations for actions taken at the organizational level.



APPENDIX F

NIST Safety Commission Biographical Summaries

Mark Peters

PhD, Chair

Executive Vice President
National Laboratory Management and Operations
Battelle Memorial Institute

Mark Peters is the executive vice president for national laboratory management and operations at Battelle Memorial Institute, with responsibilities for governance and oversight of U.S. Department of Energy (DOE) and U.S. Department of Homeland Security national laboratories, for which Battelle has a significant lab management role. Previously, he was the director of Idaho National Laboratory and president of Battelle Energy Alliance, LLC. He was responsible for management and integration of a large, multipurpose laboratory whose mission focuses on nuclear energy, national and homeland security, and energy and environmental science and technology. Prior to joining Battelle, he served as the associate laboratory director for Energy and Global Security at Argonne National Laboratory. Peters serves as a senior adviser on nuclear energy technologies, research and development programs, and nuclear waste policy and has been called upon to provide expert testimony to Congress and to advise in formulation of policies for nuclear fuel cycles, nonproliferation, and nuclear waste disposal.

Peters also served two years as chairman of the National Laboratory Directors' Council, an independent body that coordinates initiatives and advises DOE and other national laboratory stakeholders. In 2021, Peters was elected as a member of the National Academy of Engineering. He was honored as a fellow of the American Nuclear Society (ANS) in 2015. He served on the ANS Public Policy Committee and the executive committee of the ANS Fuel Cycle and Waste Management Division. Peters also serves on several boards and advisory committees, including the Idaho Power Board (2021 to present).

Peters received his doctorate in geophysical sciences from the University of Chicago and a bachelor's degree in geology from Auburn University.

Craig A. Merlic

PhD, Vice Chair

Professor of Chemistry and Biochemistry
Executive Director, UC Center for Laboratory Safety
University of California, Los Angeles

Craig Merlic joined the faculty in the UCLA Department of Chemistry and Biochemistry in 1989, after a National Institutes of Health postdoctoral fellowship at Princeton University. He has created award-winning educational projects for course management and organic spectroscopy, and his teaching in the UCLA Department of Chemistry & Biochemistry was recognized by a Hanson–Dow Award for Excellence in Teaching.

Merlic's research focuses on applications of transition metal organometallic chemistry to organic synthesis and extends from catalysis to synthesis of new chemotherapeutic agents. He has published over 80 papers in peer-reviewed journals and received a National Science Foundation Young Investigator Award, an Alfred P. Sloan Research Fellowship, and a Camille Dreyfus Teacher–Scholar Award. His research has been supported by the National Science Foundation, the National Institutes of Health, and various corporate sponsors.

Merlic has been very active in promoting chemical safety at UCLA, across the University of California system, and at universities nationwide. He serves as chair of the UCLA Chemical and Physical Safety Committee and is a member of the UCLA Safety Oversight Committee. At the University of California system-wide level, he is the Executive Director of the UC Center for Laboratory Safety, which conducts safety projects and promotes safety at all ten UC campuses. The Center also manages the Safety Training Consortium, which provides online safety training for more than 50 universities across the nation.

Merlic obtained his PhD in organic chemistry as a Hertz Foundation Fellow at the University of Wisconsin, Madison, and his BS in chemistry from the University of California, Davis.

James P. Bagian

MD, PE (ret)

Professor of Industrial and Operations Engineering

Co-Director, Center for Risk Analysis Informed Decision Engineering

University of Michigan, Ann Arbor

James P. Bagian, MD, PE (ret) is a professor in the College of Engineering, Department of Anesthesiology, at the University of Michigan. He is the founding director of the Center for Risk Analysis Informed Decision Engineering, as well as the Center for Healthcare Engineering and Patient Safety. He has extensive experience in the fields of human factors, aviation, and patient safety.

Bagian previously served as the first and founding director of the U.S. Department of Veterans Affairs (VA) National Center for Patient Safety and as the VA's first chief patient safety officer. He developed numerous patient safety-related tools and programs that have been adopted nationally and internationally.

A NASA astronaut for over 15 years, Bagian is a veteran of two space shuttle missions, including as the lead mission specialist for the first dedicated Life Sciences Spacelab mission. Following the 1986 Challenger space shuttle explosion, he dove and supervised the capsule's recovery from the ocean floor and was one of the leaders of the development of the space shuttle escape system. He also served as the chief flight surgeon and medical consultant for the Space Shuttle Columbia Accident Investigation Board. He was elected to two terms as the chair of the Joint Commission's Patient Safety Advisory Group and was a board member of the National Patient Safety Foundation, NASA's Aerospace Safety Advisory Panel, the Trauma and Injury Subcommittee of the Department of Defense Health Board, and the National Highway Traffic Safety Administration's oversight Safety Systems Team.

He currently serves on three advisory groups for the National Academies of Sciences, Engineering, and Medicine: the Board on Human–Systems Integration, the Standing Committee on Aerospace Medicine and the Medicine of Extreme Environments, and the Board on Army Research and Development. He is also a member of the Board of Governors of The Doctors Company and the Board of the Accreditation Council for Graduate Medical Education.

Bagian holds a doctorate in medicine from Thomas Jefferson University and a bachelor's in mechanical engineering from Drexel University. He is a fellow of the Aerospace Medical Association and an elected member of the National Academy of Engineering and the National Academy of Medicine.

Darryl C. Hill

PhD, MBA, CSP

Senior Vice President, Safety and Security

FirstGroup America

Darryl C. Hill has 30 years of experience in safety, health, and environmental management. Hill is currently senior vice president of safety and security at FirstGroup America, a transportation services company, and has served in senior environmental, health, and safety roles at ABB, Johnson Controls, and Abbott. Hill is also an adjunct assistant professor at Oakland University, where he has taught undergraduate courses in construction safety, environmental standards, safety training methods, and accident investigation since 1996. He also teaches the capstone graduate course (EHS 6996).

Hill was appointed by the U.S. Secretary of Health and Human Services to serve a three-year term on the National Institute for Occupational Safety and Health (NIOSH) Board of Scientific Counselors. He also served as American Society of Safety Professionals (ASSP) president from 2010 to 2011 and received the highest society honor as a fellow in 2013. He is the editor and a contributing author of ASSP Construction Safety Management & Engineering and a co-editor of ASSP Safety Leadership and Professional Development.

Hill has a PhD in educational leadership (Oakland University), an MS in hazardous waste management (Wayne State University), an MBA (Southern New Hampshire University), and a BS in occupational safety (Iowa State University). He is a Certified Safety Professional (CSP).

David A. Hofmann

PhD

Hugh L. McColl Distinguished Professor of Leadership and Organizational Behavior

Kenan-Flagler Business School

University of North Carolina at Chapel Hill

Dave Hofmann is a professor in the University of North Carolina's Kenan-Flagler Business School. He has also served as associate dean for the full-time MBA program, area chair of organizational behavior, and senior associate dean of academic affairs.

Hofmann's research focuses on organizational climate, leadership, organizational change, organizational design, and decision-making. A specific focus is the impact of leadership and organizational culture on safety and errors in organizations that operate in high-risk environments. He received a Fulbright Senior Scholar Award to study errors and safety issues in organizations at the University of Giessen in Germany, as well as a Robert Wood Johnson Foundation grant to investigate error management and organizational learning on nursing units. In recognition of his work's applied implications, he received the American Psychological Association's Decade of Behavior Research Award in 2006.

Hofmann has served on two safety-related committees for the National Research Council/National Academy of Engineering. One investigated the causes of the BP Deepwater Horizon accident, and the other focused on how to improve safety culture in the offshore industry.

Hofmann earned his PhD in industrial and organizational psychology from The Pennsylvania State University, his master's degree in industrial and organizational psychology from the University of Central Florida, and his bachelor's degree in business administration from Furman University.

Allison L. Jones

MD, MS, FACOEM

Consultant and SME, Occupational and Environmental Medicine

Allison Lynn Jones is a sought-after subject matter expert in preventing and managing occupational and environmental injuries and promoting worker resilience and wellness. Jones has work experience in the hospital occupational and environmental medicine (OEM) industry and in disability management. In addition, she is a certified medical review officer for drug testing programs and has served in both OEM lead physician and medical review officer roles for multiple Fortune 500 companies and government entities.

Jones served as an athlete physician representative on the U.S. Olympic Committee Anti-Doping Task Force and as an observer for the United States in the International Olympic Committee European Union Concerted Action in the Fight Against Doping in Sport (CAFDIS) project. She was instrumental in helping to transition the U.S. Olympic Committee Anti-Doping Task Force to become International Organization for Standardization (ISO) accredited, and she helped transition the organization to the United States Anti-Doping Agency. She also helped lead the American Medical Association's effort to pass policy and create model legislation to assist the Coalition for Anabolic Steroid Precursor and Ephedra Regulation (CASPER).

Jones is active in state and national professional societies, including the American Medical Association. She has lectured on physician wellness and ergonomics to the American College of Surgeons, American Academy of Ophthalmology, and Women in Ophthalmology. Jones is a member of the American Society of Safety Professionals (ASSP), which updates the American National Standards Institute (ANSI) Z10 Occupational Safety and Health Management Standard. A fellow of the American College of Occupational and Environmental Medicine (ACOEM), she helped to review and edit the Back and Hip Chapters for the ACOEM MDGuidelines®.

Jones graduated from the University of Illinois at Chicago, College of Medicine. Also from the University of Illinois, she earned a master's in biology with a neuroscience concentration, a BS in physiology with a neuroscience/biophysics concentration, and a BS in psychology with a neuroscience concentration. She is residency-trained and board-certified in OEM and certified in engineering technology management, with concentrations in strategic technology and business, through the University of Illinois, Urbana-Champaign, Graduate College of Engineering Technology Entrepreneur Center. Jones is a diplomate of the American Board of Preventive Medicine.

Joseph M. Kolly

PhD

Director, Transportation Innovation Center

MITRE Corporation

Joseph Kolly joined MITRE Corporation in 2021 as the director of the Transportation Innovation Center. He oversees the work of MITRE's multimodal transportation research portfolio and the work of several transportation-related departments and laboratories, including MITRE's Integrated Demonstration and Experimentation for Aeronautics (IDEA) laboratory.

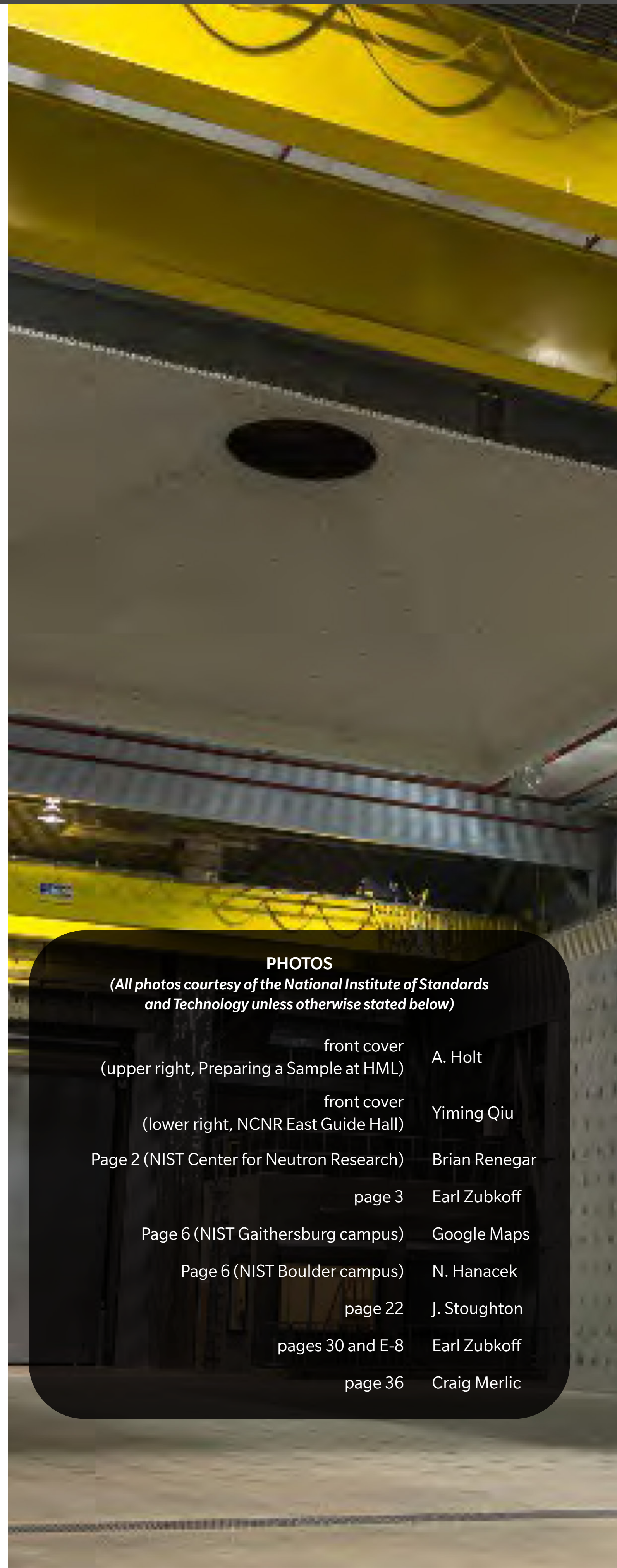
Before joining MITRE, Kolly served as the first chief safety scientist of the National Highway Traffic Safety Administration (NHTSA), where he advised the administrator on technical and safety-related matters across NHTSA's traffic safety portfolio. His primary focus was in the areas of automated vehicles, vehicle safety defects, safety data analysis, risk management, and safety culture.

Previously, Kolly worked at the National Transportation Safety Board (NTSB) for 18 years. He started his NTSB career in 1998 as a mechanical engineer, and he has investigated major incidents across transportation modes. For example, he led applied research and testing programs to investigate the TWA Flight 800 fuel tank explosion. Kolly was later named chief of the Vehicle Performance Division and ultimately became the director of the Office of Research and Engineering. As director, he oversaw the agency's Materials Laboratory, Recorders Laboratory, Vehicle Performance, and Safety Research divisions and was responsible for hundreds of investigations annually.

Before joining the NTSB, Kolly was a senior research scientist at Calspan–University at Buffalo Research Center, where he managed research and testing programs in the fields of hypersonic fluid dynamics, thermodynamics, heat transfer, and optics. He also held the position of operations manager of the Large Energy National Shock Tunnel Facility at the research center.

Kolly has earned numerous awards throughout his career for his exceptional technical and managerial achievements, including the Presidential Rank Award for Meritorious Executive Service. He is also an effective speaker and experienced author in the areas of automated vehicle safety, safety data analysis and management, accident investigation, research methods, laboratory development, and multimodal transportation safety.

Kolly holds a PhD in mechanical engineering from the State University of New York at Buffalo and a BS in mechanical engineering, with high honors, from the State University of New York at Binghamton.



PHOTOS

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