

Assessment of NIST's Material Measurement Laboratory, Physical Measurement Laboratory, and Center for Neutron Research

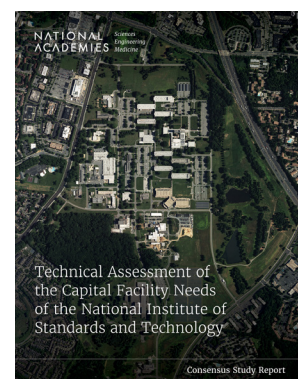
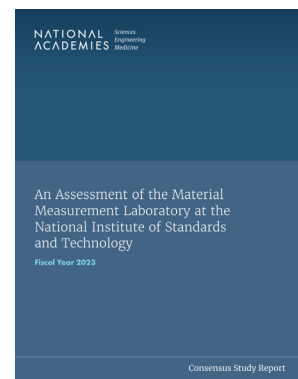
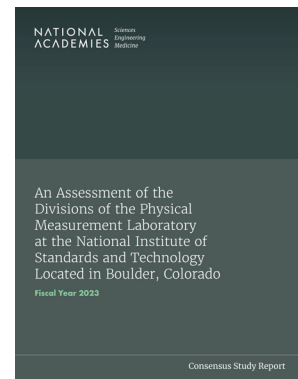
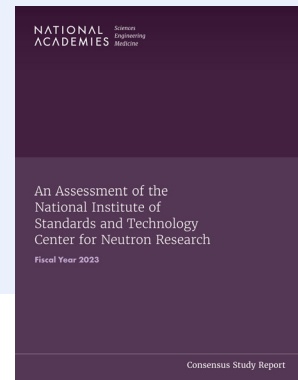
The National Institute of Standards and Technology (NIST) plays a critical role in supporting U.S. innovation, industrial competitiveness, and public health—from ensuring the safe production of pharmaceuticals to setting critical standards for financial transactions. However, while NIST laboratories perform world-class research and NIST staff are among the best in their fields, they face considerable challenges due to deteriorating facilities and difficulty retaining technical expertise. **Without sufficient budget and resources to address these challenges, NIST's ability to perform essential research and take on new missions will be significantly hindered.**

The National Academies of Sciences, Engineering, and Medicine have published multiple reports assessing the quality of NIST's technical work¹ and evaluating whether the available scientific expertise, facilities, and resources are sufficient to achieve NIST objectives. Three recent reports evaluating [NIST's Material Measurement Laboratory \(MML\)](#), [Physical Measurement Laboratory \(PML\)](#), and [Center for Neutron Research \(NCNR\)](#) highlight several common issues of concern, including the need for extensive facilities improvements, improved human resources efforts, and better laboratory safety protocols.

NIST'S FACILITIES ARE AGING AND THREATENING NIST'S MISSION

NIST is tasked with fulfilling important missions essential for the nation's security and economic competitiveness. This mission is at risk due to severe funding deficits for facility maintenance and modernization over a span of decades. Many NIST laboratories, including MML and PML, are not able to consistently support sensitive equipment and groundbreaking research because facility deficiencies are causing equipment damage, interrupting experiments, and making it harder to maintain the precise

¹ There are currently six major NIST laboratories: Center for Neutron Research, Communications Technology Laboratory, Engineering Laboratory, Information Technology Laboratory, Material Measurement Laboratory, and Physical Measurement Laboratory.



environmental conditions needed for modern metrology. It must be noted that NIST staff have developed workarounds and continue to produce impressive and field-leading results from degraded and degrading facilities. They will not be able to do this for much longer, and such workarounds often introduce inefficiencies.

Past and ongoing facility issues at NIST include:

- The PML laboratories in Boulder, Colorado, experience frequent site-wide power interruptions that can ruin sensitive experiments, prompting staff to deploy complicated workarounds to protect their research. PML's poor water quality has also caused corrosion in the pipes, contaminated the water supply for sensitive experiments, and contributed to a pipe break that flooded a laboratory, destroyed expensive equipment, and caused a year-long setback.
- The MML laboratories in Boulder and in Gaithersburg, Maryland, are negatively affected by poor temperature and humidity control in addition to inadequate air flow in their laboratories, which are not compatible with state-of-the-art measurements and instrumentation. Aging infrastructure also led to serious flooding of MML research laboratories in Gaithersburg in 2022, resulting in a loss of millions of dollars of equipment and time.

A 2023 National Academies' report on [NIST's overall capital facility needs found that NIST needs an additional \\$420 million to \\$550 million per year in funding over at least 12 years to address its infrastructure needs.](#)

This includes funding to upgrade and build new modern laboratories, as well as funding for safety, maintenance, and major repairs to bring existing facilities back to acceptable condition and address the more than \$800 million backlog in deferred maintenance.

Individual NIST laboratories have only a limited ability to address larger-scale facilities inadequacies. The MML and PML reports recommend that those laboratories work with NIST's Office of Facilities and Property Management (OFPM)—which has developed a coordinated recovery

plan to begin tackling NIST's widespread facilities issues—to identify and prioritize needed improvements.

NCNR is a user facility that supports the work of thousands of researchers across the nation. While NCNR does not have the same level of facility maintenance issues as MML or PML, many of NCNR's key instruments are aging and are no longer state of the art. The NCNR report recommends that, in addition to the planned reactor replacement, NCNR will need to replace or upgrade the current instrument suite to meet the future needs of the U.S. hard condensed matter research community. NCNR has created a working group geared toward maintaining the operations of the current aging reactor until a replacement can be installed.

ATTRACTING AND RETAINING WORLD-CLASS TECHNICAL EXPERTISE

Ongoing facilities issues are impacting NIST's ability to attract the next generation of world-class researchers, which is critical for NIST to be able to achieve its mission. Researchers report that they have had to repeat or delay experiments due to utility failures. Postdoctoral researchers have ended their postdocs without having been able to collect the data they needed to publish their work. NIST is already at a great disadvantage in the compensation that it can offer staff compared to what industry can offer. To make matters worse, potential hires are less likely to choose to work at NIST when other academic institutions, companies, and countries can offer modern facilities that enable field-leading work.

The NIST hiring process also needs substantial improvement in order to support its skilled workforce. **To bring in and cultivate the best technical experts, NIST needs an excellent human resources department to handle hiring new talent, as well as robust mentorship and career development programs for early-career researchers.** NIST is often tasked with supporting new congressionally directed initiatives, and the hiring needs for these programs can disrupt ongoing, long-term staffing efforts. There is also a need to plan for knowledge transfer so that critical skills are not lost when experienced researchers retire.

At NCNR, there is concern that there will not be adequate staffing to support normal operations when they resume, which could slow work. Many instrument scientists and technical staff left after an unplanned shutdown began in early 2021, from which NCNR is now recovering. NCNR has made progress toward addressing staffing concerns by training a fifth shift of reactor operators to enable 24/7 operations.

IMPROVING LABORATORY SAFETY

NIST's ongoing infrastructure issues also represent safety issues. Floods can lead to sparks that create fires, and inadequate exhaust can lead to contaminated laboratory air that impacts experimental results and affects the health of research staff. In addition, the onus of working with aging infrastructure and equipment can have an impact on overall staff attitudes toward safety. Laboratory safety requires every individual to take responsibility for not only maintaining but also improving the safety of their environment and the environments of those around them.

While initial steps have been taken to improve safety at MML, PML, and NCNR, improvements are still needed to adequately ensure the safety of staff and visitors. In order to implement best practices, NIST laboratories should consider engaging with experienced industrial partners for advice on improving their laboratory safety protocols. **Laboratory safety inspections and standards at MML and PML should be reevaluated with the goal of bringing safety across the divisions to a level that is comparable with major industrial companies.**

The 2021 reactor incident at NCNR, which resulted in a 2-year shutdown, led the NCNR director to prioritize creation of an improved safety culture at NCNR, with new rules and protocols to be implemented for both staff and visiting researchers. The assessment report commended this.

RECENT NATIONAL ACADEMIES' CONSENSUS STUDY REPORTS WITH A FOCUS ON THE NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (NIST)

- [An Assessment of the National Institute of Standards and Technology Center for Neutron Research: Fiscal Year 2023 \(2024\)](#)
- [An Assessment of the Divisions of the Physical Measurement Laboratory at the National Institute of Standards and Technology Located in Boulder, Colorado: Fiscal Year 2023 \(2024\)](#)
- [An Assessment of the Material Measurement Laboratory at the National Institute of Standards and Technology: Fiscal Year 2023 \(2023\)](#)
- [Technical Assessment of the Capital Facility Needs of the National Institute of Standards and Technology \(2023\)](#)

ONGOING LABORATORY ASSESSMENTS FOR NIST

- [Assessment of the National Institute of Standards and Technology \(NIST\) Information Technology Laboratory \(ITL\)](#)
- [Assessment of the National Institute of Standards and Technology \(NIST\) Engineering Laboratory \(EL\)](#)

FOR MORE INFORMATION

This Consensus Study Report Highlights was prepared by the Laboratory Assessments Board (LAB). LAB brings together top experts from across the country to conduct independent assessments for federal laboratories. These forward-looking assessments evaluate current research and development (R&D) efforts, identify opportunities and challenges, and provide actionable roadmaps to help sponsoring organizations achieve their R&D goals.

For more information, please contact Katie Bratlie at kbratlie@nas.edu. Learn more about the work of LAB, for both the National Institute of Standards and Technology and other federal laboratories, at nationalacademies.org/lab.

These studies were sponsored by the National Institute of Standards and Technology. Any opinions, findings, conclusions, or recommendations expressed in these publications do not necessarily reflect the views of any organization or agency that provided support for the project.

These Consensus Study Reports are available from the National Academies Press | (800) 624-6242 | <http://www.nap.edu> | <http://www.nationalacademies.org>

Division on Engineering and Physical Sciences

**NATIONAL
ACADEMIES** Sciences
Engineering
Medicine

The National Academies provide independent, trustworthy advice that advances solutions to society's most complex challenges.

www.nationalacademies.org