Implementation of Gold Standard Science

> *Gold Standard Science represents a commitment to the highest standards of scientific integrity, defined by nine core tenets: reproducible; transparent; communicative of error and uncertainty; collaborative and interdisciplinary; skeptical of its findings and assumptions; structured for falsifiability of hypotheses; subject to unbiased peer review; accepting of negative results as positive outcomes; and without conflicts of interest.*
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> Adapted from Executive Order 14303 and OSTP Guidance

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The U.S. National Science Foundation (NSF) is an independent federal agency that promotes the progress of science across nearly all fields of science and engineering, including the education and training of the next generation of discoverers, innovators, technicians and entrepreneurs. Over its 75-year history, NSF has endeavored to support the most meritorious ideas with the greatest potential for impact on the nation and its people.

It is only through the continued trust of the public that NSF can support novel and potentially transformative basic and translational research. Maintaining this trust is of utmost importance to all of us at NSF, and that is why Gold Standard Science (GSS) and its nine tenets need to be a basic element of our NSF culture, policies and processes. We also believe NSF needs to foster a culture of self-examination and continuous improvement. It is only through an unwavering commitment to excellence and rigor that NSF and the U.S. science and technology enterprise will remain the best in the world.

Today, NSF is releasing its plan for implementing the president's May 23, 2025, executive order on "Restoring Gold Standard Science" consistent with the guidance provided by the White House Office and Science and Technology Policy on June 23, 2025. The plan includes an overview of how the GSS tenets are reflected in NSF policies and processes related to the evaluation, funding and oversight of the proposals it receives and the awards it makes. Importantly, the plan includes several updated, expanded, and new activities the agency will take over the next year to redouble its commitment to the GSS principles both within NSF and the communities it supports.

NSF will update this plan and progress towards implementation on an annual basis, at a minimum. On behalf of the dedicated staff at NSF, I welcome your feedback on this plan and any other input you have to ensure NSF and the research it supports continue to advance Gold Standard Science for the years ahead.

Brian Stone
NSF Chief of Staff, Performing the Duties of the NSF Director

ABOUT NSF

The U.S. National Science Foundation (NSF) is an independent federal agency that supports science and engineering (S&E) across all fields in all U.S. states and territories. NSF fulfills its mission chiefly by making grants, as well as developing NSF grant-related policies and reports, to support the advancement of science, technology, engineering and mathematics (STEM) research and education. NSF does not perform in-house (i.e., intramural) research other than the statistical research activities in the National Center for Science and Engineering Statistics.

In an average year, NSF funds approximately 11,000 competitive awards and supports 1,900 colleges, universities, small businesses, and other institutions and organizations, and 350,000 researchers, students, teachers and entrepreneurs.[1] NSF plays several important roles within its extramural scientific activities. These include (1) enabling the research community to explore new frontiers of knowledge in areas that have the potential to benefit the United States and its people; (2) structuring and overseeing "merit review" of proposals; (3) making decisions on which proposals to fund; and (4) providing post-award oversight.

GOLD STANDARD SCIENCE AT NSF

To fulfill its mission, NSF focuses on meeting the highest standards of scientific integrity, excellence and rigor — principles that form the bedrock of Gold Standard Science (GSS).

NSF adheres to GSS principles, as appropriate given the breadth of science fields and the diverse research methodologies, in how it selects, funds, and oversees research. NSF's mission leads to research excellence and key advances in scientific knowledge and high societal and economic impact as described below.

Merit Review

NSF receives over 40,000 proposals each year. The agency uses Merit Review in its selection of projects. The following three principles guide its funding decisions as outlined in NSF's Proposal & Award Policies & Procedures Guide (PAPPG):

1. All NSF projects should be of the highest quality and have the potential to advance, if not transform, the frontiers of knowledge.
2. NSF projects should contribute more broadly to achieving societal goals.
3. Meaningful assessment and evaluation of NSF-funded projects should be based on appropriate metrics.

Award Selection, Reporting and Budget Allocation

To promote transparency, NSF publishes detailed information about the projects in its award portfolio. For example:

[1] https://www.nsf.gov/about

- NSF's website contains an award search tool available at nsf.gov, providing access to information about NSF-funded projects. Similar information is also available at www.usaspending.gov.
- NSF publishes the Merit Review Digest, which contains statistical information on proposals awarded and declined for a given period of time.
- NSF by the Numbers facilitates a deep dive into NSF's award portfolio, including NSF-funded institutions, funding rate, proposals evaluated and obligations by fiscal year.
- The NSF Directorate for Technology, Innovation and Partnerships (NSF TIP) recently launched an NSF TIP investments pilot, featuring a map and award data, to showcase the scale and impact of investments in key technology areas across the nation.

NSF advances several GSS tenets in the research community. For example, NSF has funding opportunities to build capacity in public access and open science. NSF funded the Public Access Repository and broadly available, field-appropriate data repositories.

NSF focuses on both disciplinary and multidisciplinary research in funding. NSF also funds research to advance reproducibility and the evaluation of errors and uncertainties.

Research Conduct and Oversight

NSF expects awardee institutions and NSF-supported researchers, educators, students and trainees to adhere to the highest standards of integrity as well as requirements reflected in the PAPPG and awards terms and conditions.

Required training, such as the Responsible and Ethical Conduct of Research, as well as outreach activities for the researchers and their institutions by NSF and the NSF Office of Inspector General (NSF OIG), emphasizes the importance of a positive culture of scientific integrity. All trainings handled by NSF OIG and NSF align with existing laws, policies and regulations.

NSF award recipients are also required to comply with Data Management and Sharing Plan requirements, making available their publications and associated data in publicly accessible repositories, which enables and stimulates adherence to all nine GSS tenets.

NSF recognizes the breadth of scientific fields and the diverse research methodologies that are appropriate for different fields, all leading to research excellence and key advances in scientific knowledge and high societal and economic impact.

PLANS FOR FUTURE ACTIVITIES

Statement of Commitment to GSS

NSF will continue to demonstrate a culture of scientific integrity, including scientific rigor aligned with the nine core tenets of GSS, among its scientific staff, in its policies and processes, and the STEM community it supports. NSF will continuously explore ways to improve or expand these activities, especially where gaps are identified internally or within the research community.

Updated, expanded and/or new activities include the following:

- NSF will expand the specific clauses on "differences of scientific opinion" in the upcoming updated Scientific Integrity Policy. NSF acknowledges differences in scientific opinion as an integral part of the scientific process. Respectful dialogues and contributions stemming from such differences are essential to the advancement of knowledge and progress in S&E and are encouraged as part of the NSF merit review and award decision-making processes.

- NSF will roll out a new required scientific integrity training course for all NSF staff, which will incorporate the nine tenets of GSS.

- NSF will include the adherence to the core tenets of GSS in the training material for Special Government Employees, such as panelists assigned to peer-review of proposals submitted to NSF.

- NSF will support activities to develop the culture of acceptance of negative or null results as positive outcomes in the research community, resulting in the broad dissemination of those outcomes. The corresponding cultural change will require broad engagement across the federal science agencies, research community, professional societies and publishers to establish community-driven and community-accepted norms, standards and outlets for publications and data-sharing of negative or null results, advancing the tenets of GSS.

- NSF will include clauses in the award terms and conditions stating the expectation of adherence to the core tenets of GSS, as appropriate to the relevant field of science and modality of research.

- NSF will include a general statement in all public NSF funding opportunity documents that highlights adherence to the GSS.

- The effectiveness and impact of NSF's effort to develop a culture of scientific integrity that incorporates the GSS tenets in the broader extramural STEM community will be addressed in coordination with other U.S. government science agencies with extramural STEM funding activities. Active engagement with the

extramural STEM research and education community will support the development of appropriate metrics for different science disciplines.

LEVERAGING TECHNOLOGY FOR GSS IMPLEMENTATION

In addition to the activities described above, NSF plans to identify ways to leverage technology for GSS implementation. NSF has developed software, including machine-learning-based computational tools, to assist scientific staff with several steps in the proposal merit review process and post-award oversight. NSF will continue to develop and improve these and other new tools and consistently incorporate them in the agency's workflows. NSF will also continue to monitor broader availability of artificial intelligence-based technologies and adopt them as appropriate to advance the agency's mission and increase the efficiency of all processes, without negative impact on the integrity of NSF's merit review process, award decision-making, post-award oversight and program management.

CHALLENGES FOR GSS IMPLEMENTATION

NSF anticipates that because of the breadth of scientific fields and diverse research approaches it supports (from hypothesis-driven to hypothesis-generating research and quantitative/qualitative research), it will be challenging to develop a uniform set of metrics and assessment plans. This will require broad engagement with science agencies and the broader STEM research community, beginning with a meaningful assessment plan and establishment of metrics to assess the successful implementation and adherence to the tenets of GSS.

A significant challenge will be the cultural change needed for broad adherence to some of the tenets. For example, "accepting of negative results as positive outcomes" would require a change in the culture of the academic community, professional societies and major publishers of scientific articles.

TABLE: Select NSF activities, their focus/audience, and their relationship to the GSS tenets. **Key:** O=Ongoing Activity; E=Expanded Activity.

NSF ACTIVITIES	Internal	External	TENETS OF GSS								
			Reproducible	Transparent	Communicative of error and uncertainty	Collaborative and interdisciplinary	Skeptical of its findings and assumptions	Structured for falsifiability of hypotheses	Subject to unbiased peer review	Accepting of negative results as positive outcomes	Without conflicts of interest
Merit Review Training	O					O	O	O	O	O	O
Scientific Integrity Training	E		O	O		O	O	O	O	O	O
Ethics Training	O			O					O		O
Scientific Integrity Policy	E			O		O	E	O	O	O	O
Ethics in Government Act	O										O
Funding Opportunity Documents	E		O	O	O	O	O	O		O	
Peer Reviewer Selection	E					O	O	O	O		O
Merit Review Process	O			O		O	O	O	O	O	O
Award Decision-making Process	O			O		O	O	O	O	O	O
Post-award Oversight	E		E	E	E	O	E	E	O	E	O
Award Terms & Conditions	E	E	E	E	E	O	E	E		E	
Data Management and Sharing Plan		O	O	O							
Public Access and Open Science	O	O	O	O	O			O		O	
Science and Engineering Statistics	O	O	O	O	O	O	O	O	O	O	O
Internal Evaluation and Assessment	O	O	O	O	O	O	O	O	O	O	O
Community Cultural Change	E	E	O	O	O					E	O
Public Disclosure of NSF Award Information	O	O		O	O				O	O	O